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## **Biodiversity—The Life Support System : A Review**

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### **Abstract**

India is one of the world's most biologically and culturally diverse countries. Biodiversity represents all life. It also contains two of the world's 25 biodiversity hotspots because of their extraordinarily high levels of species richness, endemism and threatened status. Biodiversity is the variety of plant and animal life in the world or in a particular habitat. Biodiversity is measured by two major components species richness and species evenness. This includes genetic diversity within and between species and of ecosystems. India is one of the mega biodiversity centres in the world and has two of the world's 25 biodiversity hotspots located in the Western Ghats and in the Eastern Himalayas. The forest cover in these areas is very dense and diverse and of pristine beauty and incredible biodiversity. Biodiversity has several values such as economical, ecological, ethical, medicinal, aesthetical, social and many more.

**Key words :** *Biodiversity, hotspots, plants, animal, habitat, forest, species, threatened.*

### **Introduction**

Biodiversity is the number and variety of organisms found within a specified geographic region. It refers to the varieties of plants, animals and micro-organisms, the genes they contain and the ecosystems they form (Rawat and Agarwal, 2015). India is one of the world's mega diversity countries. India has tremendous biodiversity, genetic as well as of species and ecosystems. The country is estimated to have over 45000 plant species and 81000 animal species representing 7% of the world's flora and 6.5% of its fauna. Plant species 49219 representing 12.5% and 81251 animal species representing 6.6% (MoEF, 1996). The sacred groves of India are some of the areas in the country where the richness of biodiversity has been well preserved. The Thar Desert and the Himalayas are two regions rich in biodiversity in India. National hot spots are in the forests of the North-East Himalaya and the Western Ghats which are included in the world's most bio-rich areas. The Andaman and Nicobar Islands are extremely rich in species and many subspecies of different animals and birds have evolved (Brooks *et al.*, 2006).

**India as a mega biodiversity nation :** India has a rich heritage of biodiversity, encompassing a wide spectrum of habitats from tropical rainforests to alpine vegetation and from temperate forests to coastal wetlands. Almost all the bio geographical regions of the world are represented here in India. India is one of the 12 mega-diversity nations of the world. With a mere 2.4% of the total land area of the world, the known biodiversity of India contributes 8.22% of the known global biodiversity. India is one of the twelve mega-diversity nations of the world accounting for 7.31%

of the global faunal and 10.88% of the global floral total species. Generally biodiversity tends to cluster in hotspots (Myers, 2000). Some of the salient features of India's biodiversity are as under :

India has two major realms called the Palaearctic and the Indo Malayan and three biomes, namely the tropical humid forests, the tropical dry deciduous forests and the warm desert/ semi-deserts.

India has ten biogeographic regions namely the TransHimalayan, the Himalayan, the Indian desert, the semi-arid zone, the Western Ghats, the Deccan Peninsula, the Genetic plain, North-East India, the Islands and the coasts.

India is one of the 12 centres of origin of cultivated plants.

There are two hotspots that extend into India. There are the Western Ghats/ Sri Lanka and the Indo-Burma region (covering the Eastern Himalayas). Further these hotspots are included amongst the top eight most important or hottest hotspots.

India has 26 recognised endemic centres that are home to nearly a third of all the flowering plants (angiosperms) identified and described to date.

India has six Ramsar Wetlands. They are – Chilika Lake, Harike Lake, Loktak Lake, Keoladeo National Park, Wular Lake and Sambhar Lake.

India has 5 world heritage sites namely, Kaziranga National Park, Keolades Ghana National Park, Manas Wildlife Sanctuary, Nanda Devi National Park and Sundarban National Park.

India has twelve biosphere reserves, namely Nilgiri,

Nanda Devi, Nokrer, Manas, Sunderbans, Gulf or Mannar, Great Nicobar, Similpal, Dibru-Saikhowa, DehangDebang, Pachmarchi and Kanchanjanga.

The protected areas there are 88 national parks and 490 sanctuaries in India covering an area of 1.53 lakh sq.km.

Biodiversity can be discussed at three levels - Genetic diversity, Species diversity and Ecosystem diversity (Anamika *et al.*, 2018).

**Genetic Diversity** : Genetic biodiversity refers to the variation of genes within species. This genetic diversity is essential for a healthy breeding of population of species.

**Species Diversity** : This refers to the variety of species. It relates to the number of species in a defined area. The diversity of species can be measured through its richness, abundance and types.

**Ecosystem Diversity** : The broad differences between ecosystem types and the diversity of habitats and ecological processes occurring within each ecosystem type constitute the ecosystem diversity. At equator terrestrial biodiversity is higher than poles (Gaston, 2000).

**Species biodiversity in India and World (B.D. Oza, 2009)**

| Species    | Number in India | Number in world |
|------------|-----------------|-----------------|
| Mammals    | 410             | 4,000           |
| Birds      | 1,228           | 10,000          |
| Reptiles   | 447             | 10,500          |
| Amphibians | 197             |                 |
| Fishes     | 2,546           | 19,000          |
| Plants     | 47,000          | 2,70,000        |

**Importance of Biodiversity** : Biodiversity is the variability among living organisms including genetic and structural difference between individual and within and between individual and within and between species (B.D. Oza, 2009). Living organisms provide many ecological services free of cost that are responsible for maintaining ecosystem health (Singh, 2006). Biodiversity is important in following ways (Aparna and Jasrai, 2013).

- Soil formation and maintenance of soil quality
- Maintain air quality
- Maintain water quality
- Pest control
- Detoxification and decomposition of wastes
- Pollination and crop production
- Climate stabilization
- Prevention and mitigation of natural disasters
- Provision of food security
- Protection of water resources
- Soil protection

Nutrient storage and cycling

Pollution reduction

Maintenance of ecological processes

Biological resources - food, fibre, medicines, fuel, wood and ornamental plants

Breeding material for crop improvement

Future resources

Social benefits – recreation and cultural values

**Common plants** : India is one of the countries with great diversity of plants. Many of these have been domesticated as crops of various kinds, fruit trees, ornamentals and also medicinal plants. They have different growth forms as trees, shrubs, herbs and climbers (Brooks *et al.*, 2006).

| S. No. | Common name | Scientific name         |
|--------|-------------|-------------------------|
| 1.     | Mango       | Mangifera indica        |
| 2.     | Jamun       | Syzgium cumini          |
| 3.     | Jack fruits | Artocarpus integrifolia |
| 4.     | Coconut     | Cocos nucifera          |
| 5.     | Neem        | Azadirachta indica      |
| 6.     | Banyan      | Ficus bengalensis       |
| 7.     | Peepal      | Ficus religiosa         |
| 8.     | Champa      | Michelia champaka       |
| 9.     | Tamarind    | Tamarindus indica       |
| 10.    | Raintree    | Albizia procera         |

**Endangered plants and animals** : Due to rapid habitat loss and over exploitation in particular large number of epiphytes, herbs, climbers disappear from their native regions over the years. Many orchids, tree, ferns, medicinal herbs of hills, cycads were considered as major endangered plant species (Koh *et al.*, 2010). Some endangered plants of India :

*Coptisteeta*

*Rheum nobile*

*Dioscorea vexans*

*Berberis asiatica*

*Hoya wightii*

*Alstonia venenata*

*Acer laevigatum*

*Penax pseudoginseug*

*Vanda coetulea*

*Caelogynenitida*

*Dendrobium falconeri*

*Cymbidium tigrinum*

*Cerbera odollam*

*Phoenix rupicola*

*Aldrovanda vasiculosa*

*Mangifera sylvatica*

Clematis thebromina

Calanthe alpine

Citrullus colocynthis

Arundinachinensis

**Biodiversity losses** : Biodiversity in a region may lead to decline in plant production, lowered resistance to environmental perturbations such as drought and increased variability in certain ecosystem processes such as plant productivity, water use and pest and disease cycles.

The threat to survival or loss may be caused in the following three ways :

**Direct ways** : Deforestation, hunting, poaching, commercial exploitation.

**Indirect ways** : Loss or modification of the natural habitats, introduction of exotic species, pollution etc.

**Natural causes** : Recent climate change such as warmer temperature in certain areas had significantly impacts on biodiversity and ecosystem (Rawat and Semwal, 2014).

**Biodiversity Conservation** : Biodiversity conservation is about saving life on earth in all its forms and keeping natural ecosystems functioning and healthy. Biodiversity is the life support system of our planet we depend on it for the air we breathe, the food we eat and the water we drink (Rawat and Agarwal, 2015).

**In situ conservation** : When we conserve and protect the whole ecosystem, its biodiversity at all levels is protected - we save the entire forest to save the tiger. This approach is called in situ (on site) conservation.

Protection of habitat

Sacred groves

National parks and sanctuaries

Biosphere Reserves

Sacred forests and sacred lakes

Species-oriented projects

**Ex-situ Conservation** : When there are situations where an animal or plant is endangered or threatened and needs urgent measures to save it from extinction, ex situ (off site) conservation is the desirable approach.

Botanical gardens, zoos etc.

Gene Banks

Cryopreservation

Conservation at molecular level

## Conclusion

Biodiversity is the life support system. An area with higher species abundance has more stable environment compared to an area with lower species abundance. Conservation of biodiversity refers to protection and management of biodiversity for sustainable benefits for present and future generation. Biodiversity conservation includes reforestation, zoological gardens, botanical gardens, national parks, biosphere reserves, germplasm banks and adoption of breeding techniques, tissue culture techniques and social forestry to minimize stress on the exploitation of forest resources.

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## **Integrated Strategies for the Management of Dry Bubble Disease of White Button Mushroom [*Agaricus bisporus* (Lange) Imbach]**

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### **Abstract**

Dry bubble disease of white button mushroom (*Agaricus bisporus* L.) is one of the major production constraint in Kashmir valley. The aim of the present study was to devise and formulate the integrated strategy for the management of dry bubble disease. For that, various fungicide and biological alternatives with minimum inhibitory dosage were screened under *in vitro* studies in which carbendazim, *Pseudomonas fluorescens* and *Artemisia annua* were selected on the basis of their effectiveness against the pathogen (*Verticillium fungicola*). Further, they were evaluated under environmentally controlled mushroom house conditions against the disease and their impact on host fungus. All the experiments, individually or in combinations, reduced the disease to a level significantly lower than that of control and appreciably enhanced the early pinhead formation, number of fruiting bodies and mushroom yield appreciably as compared to control. The spray combination to both casing and compost with carbendazim 50 W.P @ 0.05 per cent proved best, which gave least disease incidence (09.01 and 11.06 %), maximum number of fruiting bodies 10 kg<sup>-1</sup> compost (154.67 and 152.33) and yield q<sup>-1</sup> compost (15.45 and 15.17) as against the control recording highest disease incidence (73.96 and 76.47 %), lowest number of fruiting bodies (31.67 & 22.33) and yield kg q<sup>-1</sup> compost (3.00 and 2.10). However, the spray combination of casing and compost with *Pseudomonas fluorescens* proved effective, in minimum days taken to pinhead initiation (10.00 and 10.00) in comparison to all other treatments and control, recorded late pinhead initiation (24.66 and 25.66).

**Key words :** Dry bubble disease, *Verticillium fungicola*, white button mushroom, fungitoxicants, bio-agents, botanicals, management.

### **Introduction**

A number of biotic and abiotic factors have been reported influencing the cultivation of mushrooms. Among biotic, many competitors (weed fungi), pathogens (fungi, bacteria and viruses), nematodes, insects and mites have been reported associated with mushroom cultivation. Economic losses to mushroom growers vary from place to place depending upon the stage of competitor moulds and pathogenic fungi appearance and severity. Among mycoparasites, *Verticillium fungicola* (Preuss) Hasse. causing dry bubble disease of white button mushroom also known as *Verticillium* disease, brown spot, fungus spot, and *La mole* is the most common and serious disease of mushrooms. The disease was first reported by Malthouse (1901) in Scotland and later reported from all the major mushroom growing countries of the world. Dry bubble is the major disease responsible for considerable yield losses of cultivated mushrooms throughout the world (Gela, 1993; Khanna *et al.*, 2003 and Gela, 1993).

In India, the disease was first reported from Chail and Taradevi of Himachal Pradesh (Seth *et al.*, 1973) and later severe incidence of the disease has been reported from Haryana, Uttar Pradesh, Uttaranchal, Punjab and in Jammu (J&K) by reducing the yield 40-90 per cent (Kerni *et al.*, 1997; Sharma, 1995). Thapa and Jandaik (1984)

have reported the incidence of dry bubble varying from 25-50% at Solan and Kasauli upto 15 per cent at Shimla and Chail. Keeping in view the potential threat posed by dry bubble disease to the mushroom industry the present investigation was undertaken.

### **Materials and Methods**

**Isolation of Pathogen :** The pathogen *V. fungicola* was isolated following the standard procedure using Malt Extract Agar medium (Johnston and Booth, 1983). Mushroom sporophores showing typical symptoms of dry bubble disease freshly collected were repeatedly used for isolation of the pathogen. Morphological and cultural characteristics were studied under laboratory conditions and compared with standard description given by North and Wuest (1993) for identification of the *V. fungicola* (Preuss) Hassebrauk.

**Procurement of *Agaricus bisporus* Culture :** *Agaricus bisporus* culture used in the experiment was obtained from Mushroom Research and Training Centre, SKUAST-K, Srinagar.

**Preparation of Compost :** Ingredients and procedure used for preparation of compost was as per RRL-1 formula developed by Kachroo *et al.*, 1979. Prepared compost was subjected to pasteurization through steam heating at 70°C for 8 hours in pasteurization room.

Moisture content and pH of compost was maintained at  $65 \pm 5$  per cent and 7.2 to 7.3, respectively. Ten kilogram ready compost was filled in polythene bags (10kg capacity). Spawning was done @ 0.6 per cent (Kumar and Sharma, 1997) prepared on wheat grains Munjal (1973). After spawning, the compost bags were pressed gently to have uniform surface and were taken inside the spawn run room. The temperature of the spawn run room was maintained  $23 \pm 2^\circ\text{C}$  and humidity around 90 per cent.

**Preparation of Casing :** The casing material was prepared from a mixture of peat and garden soil (2:1) with pH adjusted to 7.2. The casing soil was sterilized with 2 per cent formaldehyde and was covered with a plastic sheet. The treated casing material was uncovered after 48 hrs and turned frequently to remove formalin fumes before use. After complete spawn run, a uniform 4cm thick layer of casing material was spread on fully colonized compost.

**Cropping Room Conditions :** After casing, spawn run bags were transferred to cropping room, which was fumigated with 2% formalin a week earlier. Temperature of the cropping room was maintained at  $23 \pm 2^\circ\text{C}$  for about a week to allow the mushroom mycelium to spread into casing layer. Soon after the mycelium growth in the casing soil observed, the humidity and temperature of the cropping room was maintained at 85-90 per cent and  $14-18^\circ\text{C}$ , respectively.

**Experimental Layout :** During the present investigations, the fungitoxicant (carbendazim 50%WP), biological agent (*Pseudomonas fluorescens*) and botanical (*Artemisia annua*) found promising on the basis of *in vitro* tests were evaluated under environmentally controlled mushroom house conditions. The factorial experiment of compost, casing and in combinations effect of treatments were laid in a 'Complete Randomized Design' consisting of 16 treatments in all, each replicated thrice. The experiments were conducted under environmentally controlled mushroom house at SKUAST-K, Srinagar. The experiments were laid in which carbendazim 50 WP (0.05%) was applied individually to compost, casing and in combination to compost before spawning and at the time of casing. *Pseudomonas fluorescens* 20 ml/kg of compost/casing containing  $10^{11}$  cfu  $\text{ml}^{-1}$  and *Artemisia annua* 20% @ 20 ml/kg water extract were sprayed to compost and casing at the time of spawning and casing. The pathogen was inoculated (0.5g/kg compost/casing, multiplied on wheat grains) five days before spawning and casing. Compost bags inoculated with pathogen and devoid of any treatment served as control, to which equal amount of water were sprayed instead of any treatment sprays. The experimental bags maintained in the cropping room were kept under constant observation for recording the disease incidence and other yield contributing factors

such as days taken to pin-head initiation (days post casing), number of fruiting bodies per 10 kg compost and yield of mushrooms (kg) per quintal compost were recorded. The data collected were subjected to statistical analysis wherever needed.

## Results and Discussion

**Effect on disease incidence :** The data on effect of various treatments on incidence of dry bubble disease of white button mushroom (Table-1) revealed that all the casing, compost sprays and their combinations were statistically superior over the control, which recorded highest incidence of dry bubble (73.96%). The combined effect of casing and compost sprays in reducing the dry bubble disease incidence was recorded superior over other treatments. Carbendazim treatment on both the casing and compost were proved superior over all other treatments recorded least disease incidence of 9.01 per cent followed by carbendazim application to compost plus casing with *Pseudomonas fluorescens* (18.66%). The next effective combinations were casing spray with carbendazim plus compost treatment either with *Pseudomonas fluorescens* (19.57%) or *Artemisia annua* (21.74%), and were statistically at par with each other. The highest disease incidence of 33.50 per cent in spray combinations was recorded in case of *Artemisia annua* treated compost and casing. On an overall average basis, the individual effect of all the casing treatments proved significantly superior over the control. The least average disease incidence of 18.69 per cent was recorded in case of carbendazim followed by *Pseudomonas fluorescens* (28.23 %) and *Artemisia annua* (32.24 %) as against 46.30 per cent in check. Similarly, the data on individual effect of compost sprays reveals that all the foliar sprays tested differed significantly from one another and were statistically superior over control in reducing the disease incidence. Carbendazim compost sprays recorded least disease incidence of 19.65 per cent, followed by *Pseudomonas fluorescens* and *Artemisia annua* with disease incidence of 30.07 and 32.25 per cent, respectively, as against 43.49 per cent in check.

**Effect on pinhead initiation :** Perusal of the data pertaining to effect of various casing and compost sprays on days taken to pinhead initiation of white button mushroom is presented in Table-2. The data revealed that all the sprays recorded significantly lesser number of days taken for pinhead initiation as compared to control, which recorded maximum number of days (24.66). The combined effect of casing and compost sprays on days taken to pinhead initiation was recorded superior over other treatments. The least days taken to pinhead initiation were recorded when both the casing and compost were sprayed with *Pseudomonas fluorescens*

**Table-1 : Effect of various casing and compost sprays on incidence of dry bubble disease of white button mushroom under mushroom house conditions.**

| *Casing spray          | *Compost Spray    |                        |                        | (Check-I) Water Spray | Mean             |
|------------------------|-------------------|------------------------|------------------------|-----------------------|------------------|
|                        | Carbendazim 50 WP | <i>P. fluorescence</i> | <i>Artemisia annua</i> |                       |                  |
| Carbendazim 50 WP      | 09.01<br>(17.46)  | 19.57<br>(26.23)       | 21.74<br>(27.76)       | 24.45<br>(29.51)      | 18.69<br>(25.24) |
| <i>P. fluorescence</i> | 18.66<br>(25.50)  | 28.49<br>(32.22)       | 30.63<br>(33.58)       | 35.17<br>(36.35)      | 28.23<br>(31.91) |
| <i>Artemisia annua</i> | 23.33<br>(28.86)  | 31.72<br>(34.25)       | 33.50<br>(35.33)       | 40.41<br>(39.45)      | 32.24<br>(34.47) |
| (Check-II) Water Spray | 27.61<br>(31.61)  | 40.52<br>(39.51)       | 43.13<br>(41.02)       | 73.96<br>(59.30)      | 46.30<br>(42.86) |
| Mean                   | 19.65<br>(25.86)  | 30.07<br>(33.05)       | 32.25<br>(34.42)       | 43.49<br>(41.15)      |                  |

\*Mean of 3 replications; Figures within parentheses are arc sine angular transformed values

|                                | SE(d)± | CD (p=0.05) |
|--------------------------------|--------|-------------|
| Casing sprays                  | (0.85) | (1.74)      |
| Compost sprays                 | (0.85) | (1.74)      |
| Casing sprays x compost sprays | (1.71) | (3.48)      |

**Table-2 : Effect of various casing and compost sprays on days taken to pin-head initiation of white button mushroom under environmentally controlled mushroom house conditions.**

| *Casing spray          | *Compost Spray    |                        |                        | (Check-I) Water Spray | Mean  |
|------------------------|-------------------|------------------------|------------------------|-----------------------|-------|
|                        | Carbendazim 50 WP | <i>P. fluorescence</i> | <i>Artemisia annua</i> |                       |       |
| Carbendazim 50 WP      | 13.00             | 11.33                  | 13.66                  | 16.33                 | 13.58 |
| <i>P. fluorescence</i> | 10.66             | 10.00                  | 11.00                  | 13.00                 | 11.16 |
| <i>Artemisia annua</i> | 14.00             | 12.00                  | 15.33                  | 18.00                 | 14.83 |
| (Check-II) Water Spray | 17.66             | 14.00                  | 19.33                  | 24.66                 | 18.91 |
| Mean                   | 13.83             | 11.83                  | 14.83                  | 18.00                 |       |

\*Mean of 3 replications

|                                | SE(d)± | CD (p=0.05) |
|--------------------------------|--------|-------------|
| Casing sprays                  | (0.46) | (0.94)      |
| Compost sprays                 | (0.46) | (0.94)      |
| Casing sprays x compost sprays | (0.93) | (1.89)      |

(10.00). The second effective combination of treatment was compost spray with carbendazim and *Pseudomonas fluorescens* to casing provided 10.66 days for pin-head initiation. The maximum days taken to pinhead initiation in combination treatments was recorded in case of *Artemisia annua* treatment both to compost and casing recorded 15.33 days for initiation. On an average, individual effect of casing spray with *Pseudomonas fluorescens* and water spray to compost proved most effective in reducing the number of days taken to pin head initiation of 11.16 followed by carbendazim (13.58) and *Artemisia annua* spray (14.83). All casing sprays significantly reduced the number of days as compared to check. Similarly, compost sprays individually with carbendazim, *Pseudomonas fluorescens* and *Artemisia annua* in combination with water spray to casing reduced the number of days for pin head initiation. *Pseudomonas fluorescens* when sprayed to compost reduced the number of days for pin head initiation (11.80) followed by carbendazim (13.83) and *Artemisia annua* (14.83) as compared to check (18.00). All the compost sprays were statistically significant.

**Effect on number of fruiting bodies :** Data on effect of various sprays of casing and compost on number of fruiting bodies of white button mushroom is presented in Table-3. Perusal of the data reveals that all the spray combinations enhanced the number of fruiting bodies significantly over the control, which recorded least fruiting bodies of 31.67. Treatment combination, when both the casing and compost were sprayed with carbendazim proved statistically superior over all other treatments recording highest number of fruiting bodies (154.67), followed by casing spray with *Pseudomonas fluorescens* plus compost with carbendazim (136.00) and was superior over rest of the treatments. Further, the next effective combinations were casing spray with carbendazim and compost was either treated with *Pseudomonas fluorescens* (134.33) or *Artemisia annua* (130.67). Further analysis of the data on an average, for individual effect of casing sprays revealed that the maximum number of fruiting bodies of 136.00, 116.08 and 108.83 were obtained in case of carbendazim, *Pseudomonas fluorescens* and *Artemisia annua*,

**Table-3 : Effect of various casing and compost sprays on number of fruiting bodies per 10 kg compost of white button mushroom under environmentally controlled mushroom house conditions.**

| *Casing spray          | *Compost Spray    |                        |                        | (Check-I)<br>Water Spray | Mean   |
|------------------------|-------------------|------------------------|------------------------|--------------------------|--------|
|                        | Carbendazim 50 WP | <i>P. fluorescence</i> | <i>Artemisia annua</i> |                          |        |
| Carbendazim 50 WP      | 154.67            | 134.33                 | 130.67                 | 124.33                   | 136.00 |
| <i>P. fluorescence</i> | 136.00            | 118.00                 | 114.00                 | 96.33                    | 116.08 |
| <i>Artemisia annua</i> | 128.00            | 112.67                 | 109.33                 | 85.33                    | 108.83 |
| (Check-II) Water Spray | 113.33            | 84.67                  | 81.67                  | 31.67                    | 77.83  |
| Mean                   | 133.00            | 112.42                 | 108.92                 | 84.42                    |        |

\*Mean of 3 replications

|                                | SE(d)± | CD (p=0.05) |
|--------------------------------|--------|-------------|
| Casing sprays                  | (2.24) | (4.56)      |
| Compost sprays                 | (2.24) | (4.56)      |
| Casing sprays x compost sprays | (4.49) | (9.12)      |

**Table-4 : Effect of various casing and compost sprays on yield kg q<sup>-1</sup> compost of white button mushroom under environmentally controlled mushroom house conditions.**

| *Casing spray          | *Compost Spray    |                        |                        | (Check-I)<br>Water Spray | Mean   |
|------------------------|-------------------|------------------------|------------------------|--------------------------|--------|
|                        | Carbendazim 50 WP | <i>P. fluorescence</i> | <i>Artemisia annua</i> |                          |        |
| Carbendazim 50 WP      | 15.452            | 13.292                 | 12.936                 | 12.117                   | 13.449 |
| <i>P. fluorescence</i> | 13.570            | 11.700                 | 11.110                 | 9.332                    | 11.428 |
| <i>Artemisia annua</i> | 12.659            | 10.916                 | 10.506                 | 8.246                    | 10.582 |
| (Check-II) Water Spray | 11.014            | 8.181                  | 7.868                  | 3.007                    | 7.517  |
| Mean                   | 13.174            | 11.022                 | 10.605                 | 8.176                    |        |

\*Mean of 3 replications

|                                | SE(d)± | CD (p=0.05) |
|--------------------------------|--------|-------------|
| Casing sprays                  | (0.20) | (0.42)      |
| Compost sprays                 | (0.20) | (0.42)      |
| Casing sprays x compost sprays | (0.41) | (0.84)      |

respectively, which were superior over check (77.83). On average basis, all the compost sprays increased the number of fruiting bodies in case of carbendazim (133.00) followed by *Pseudomonas fluorescens* (112.42) and *Artemisia annua* (108.92). The least number of fruiting bodies (84.42) was recorded in case of check.

**Effect on yield kg q<sup>-1</sup> compost :** Data on effect of various casing and compost sprays on yield kg q<sup>-1</sup> compost of white button mushroom is presented in Table-4. It is evident from the data that all the treatments enhanced the yield significantly over the control, which recorded least mushroom yield of 3.00 kg q<sup>-1</sup> compost. The combined effect of compost and casing sprays with carbendazim significantly provided highest yield of 15.45 kg q<sup>-1</sup> compost followed by combination treatment of compost with carbendazim or *Pseudomonas fluorescens* and casing either with *Pseudomonas fluorescens* or carbendazim, recording yield of 13.57 and 13.29 kg q<sup>-1</sup> compost, respectively. The casing sprays with carbendazim and *Artemisia annua* when compost sprayed with *Artemisia annua* gave yields of 12.93 and 12.65 kg q<sup>-1</sup> compost with no significant difference among them. The least yield 10.50 kg q<sup>-1</sup> compost was recorded when both the compost and casing were sprayed with *Artemisia annua*

extract. Further analysis of the data for individual effect of compost sprays on an average basis, revealed that the maximum yield of 13.17, 11.02 and 10.60 kg q<sup>-1</sup> compost were obtained in case of carbendazim, *Pseudomonas fluorescens* and *Artemisia annua*, respectively and were superior over check which recorded an average yield of 8.17 kg q<sup>-1</sup> compost. All the casing sprays individually differed significantly and were superior over the check, which recorded least average yield of 7.51 kg q<sup>-1</sup> compost. On an average basis, the maximum yield (13.44 kg q<sup>-1</sup> compost) was recorded in case of carbendazim followed by *Pseudomonas fluorescens* (11.42 kg q<sup>-1</sup> compost) and *Artemisia annua* (10.58 kg q<sup>-1</sup> compost), respectively. It was observed that all the sprays, individually or in combinations, restrained the disease incidence significantly lower than that of control and enhanced the early pinhead initiation, number of fruiting bodies 10 kg<sup>-1</sup> compost and yield kg q<sup>-1</sup> compost appreciably in both the experimental years. Results reveal that the spray combination of casing and compost with carbendazim proved best, which recorded least disease incidence (9.01%), maximum number of fruiting bodies (154.67) and highest yield kg q<sup>-1</sup> compost (15.452) as against the control recording highest disease incidence (73.96%), lowest number of fruiting bodies (31.67) and yield (3.007).

These findings are in agreement with Bhatt and Singh, (2002) who reported that bavistin (0.075%) was most effective in controlling the disease caused by *Verticillium fungicola* as well as giving significantly higher yields as compared to captan, ridomil MZ and check. Almost similar results have also been reported by Singh and Singh, (2005), Samuels and Johnston (1980). However, the spray combination of casing and compost with *Pseudomonas fluorescens* proved effective, in reducing days taken to pinhead initiation (10.00, 10.00) in comparison to control, recording pinhead initiation after 24.66, 25.66 during 2005 and 2006, respectively. The finding corroborate with the observations made by Hayes *et al.* (1969) who reported that the early initiation of pinheads and development of sporophores in *Agaricus bisporus* are controlled by Fluorescent pseudomonads and has been reported by other workers also (Hayes *et al.*, 1969; Urayama, 1967; Ahlawat *et al.*, 2002; Rajni *et al.*, 1998 and Singh *et al.*, 2000). It has been also reported that the Fluorescent pseudomonads are antagonistic to mushroom pathogens, colonize the compost faster than the pathogens and increase the yield of mushrooms (Byer and Sikora, 1990; Fermor *et al.*, 1991; Henry *et al.*, 1991; Bora *et al.*, 2000; Mishra & Singh, 2003).

Other spray combinations, which proved very effective, were casing spray with *Pseudomonas fluorescens* or carbendazim or *Artemisia annua* along with compost sprays of carbendazim or *Pseudomonas fluorescens* or *Artemisia annua*. The combination of *Artemisia annua* when sprayed to both casing and compost was found least effective as compared to other spray combinations, but superior over control. Singh and Singh (2005) evaluated 26 plants extracts against three different mushroom pathogens (*Verticillium fungicola* var. *fungicola*, *Mycogone perniciosa* and *Fusarium moniliforme*) and found that the extracts were effective in reducing the disease incidence and increasing the yield of *A. bisporus*. The screening of plant extracts against mushroom pathogens was carried out by several other researchers (Mishra and Singh, 2003; Sharma and Kumar, 2005; Sharma and Jarial, 2000; Sharma, 1998). All the three sprays, carbendazim, *Pseudomonas fluorescens* and *Artemisia annua* were individually superior over the check but carbendazim proved best amongst these. Present investigation is thus, substantiated by the findings of all these workers.

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## Effect of Plant Growth Regulators on *Dendrobium* Orchids cv. Sonia 17 for High Flower Yield and Quality under Shade Net Conditions in High Altitude Tribal Zone of Andhra Pradesh

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### Abstract

The present investigation entitled “Effect of plant growth regulators on *Dendrobium* orchid cv. Sonia 17 for high flower yield and quality under shade net conditions in high altitude tribal zone of Andhra Pradesh” was carried out at Horticulture Research station, Chintapalli, Visakhapatnam district of Andhra Pradesh during two consecutive years of 2016-17 and 2017-18. The experiment was laid out in a completely randomized design with 13 treatments and each treatment replicated thrice. The data recorded on various flowering parameters viz., Days taken to spike emergence, Days taken to spike development, Number of flowers per spike, Spike length, Spike girth, Spike weight, Diameter of flower and Yield of spikes per plant per year and were statistically analyzed. Significant differences were observed among different plant growth regulators on various flowering parameters in *Dendrobium* orchids cv. Sonia 17. Among all the treatments, GA<sub>3</sub> @ 50 ppm showed significantly best results with respect to days taken to spike emergence (140.61 days), days taken to spike development (24.43 days), spike length (52.51 cm), spike weight (21.68 g), number of flowers per spike (10.38), flower diameter (6.40 cm) and yield of spikes per plant per year (5.43). Spike girth (1.96 cm) was recorded maximum with foliar application of Benzyl adenine @ 200 ppm.

**Key words :** *Dendrobium*, sonia 17, cut flower, plant growth regulators, gibberellic acid, benzyl adenine, cycocel, malic hydrazide, flower yield, flower quality

### Introduction

Orchids are the most beautiful flowers in God's creation and have conquered the cut flower industry all over the world during the last few decades. Orchid cut flowers have emerged as leader in the International market and have immensely contributed to the economy of several developed and developing countries. They are valued for cut flower production and as potted plant in commercial floriculture owing to the wide range of colours, shapes, sizes and fragrance they display. Orchids are excellent for garden and can be grown in beds, pots, baskets, split hollows of bamboo pieces etc. They are marketed globally as cut flowers for making corsages, floral arrangements and bouquets. They are also suitable for interior decoration and remain fresh for many days. They comprise the largest family (Orchidaceae) of flowering plants with 25,000 to 35,000 species belonging to 600-800 genera (Chowdhery, 2001).

*Dendrobium* is the second largest orchid genera consisting of more than 16,000 species (Puchooa, 2004). Countries including Thailand, Taiwan, China, Phillipines, Germany, United States, Japan and India are major producers of *Dendrobium* orchids. Most *Dendrobium* species are epiphytic, sympodial orchids and are from subtropical and tropical regions and is a popular genus for

cut flower production. Many growers in the states of Karnataka, Kerala, Tamilnadu and Andhra Pradesh are cultivating *Dendrobium* on a commercial scale. The flower spikes of *Dendrobium* are extremely beautiful, medium sized with flowers numbering between 5-20, in colours such as white, mauve, pink, red, blue, purple, yellow and are highly popular in the National and International market. Orchids are used in Indigenous system of medicine, particularly in Ayurveda.

However, under normal conditions *Dendrobium* hybrids passed with long Juvenile period (at least two to five years) for maturity and flowering stage (Hee *et al.* 2007). The major constraints encountered in orchid cultivation are long pre-blooming period and inferior quality spikes. Most of these problems are caused by hormonal imbalance. Therefore, it's needed to develop a method which can speed up the flowering process in order to be competitive in the ever-growing orchid industry. Flowering of many orchid species have been successfully modified by using plant growth regulators. They help in breaking juvenility and enhancing the flowering frequency. Therefore the present research was conducted to study the effect of plant growth regulators on flower yield and quality of *Dendrobium* orchids cv. Sonia 17.

## Materials and Methods

The experimental site was located at the Horticulture Research Station, Chintapalli (Humid sub tropical zone), Visakhapatnam District, Andhra Pradesh and experiment was carried out during two consecutive years of 2016-17 and 2017-18. Eighteen months old tissue cultured plants which were originally imported from Thailand were used as planting material for conducting experiment. Sonia-17 is one of the popular hybrids of the genus. It is a cross between *Dendrobium caesar* × *Dendrobium tomiadrake*. The plant shows sympodial (upright) growth with club shaped pseudobulbs. Leaves are bright green, broad and acute. Flowers are white and purple coloured, sepals are creamy white with purple markings, petals purple in colour. Shade net house was used for growing orchid under partially controlled atmosphere and environment by reducing light intensity and heat radiation during day time. Plants were potted and placed on the benches of 40 m length, 18 cm width and 1 m height.

Planting was taken up in plastic pots of size 16 cm diameter with 10 drainage holes each of 2 cm diameter (to drain the excess water and for free movement of air). Orchids require a suitable potting medium for growth and development and it varies with type of orchid and the environmental conditions (Kang, 1972 and Fitch, 1981). Growing medium for *Dendrobium* should be moist but never be soggy (Rajeevan et al., 2008). The potting media used in this experiment was coconut husk + brickpieces + charcoal + garvel (1:1:1:1). After planting, the potting media were immediately irrigated thoroughly to maintain the optimum moisture condition. During vegetative phase N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O at the ratio of 3:1:1 and during blooming phase at the ratio of 1:2:2 (0.2% concentration) were provided weekly once. Nutrient combinations were made using ammonium nitrate, orthophosphoric acid and potassium nitrate. The commercially available water soluble fertilizers (19-19-19, 13-0-45) of different grades were also used as source for nutrients. Micronutrients were sprayed monthly once. Calcium nitrate and Magnesium sulphate @ 0.1% was given once in a month.

Completely randomized design was set with three replications having fifteen plants in each replication and each replication contains thirteen different treatments. The data recorded on various flowering parameters viz., Days taken to spike emergence, Days taken to spike development, Spike length, Spike girth, Spike weight, Number of flowers per spike, Flower diameter and Yield of spikes per plant per year and were statistically analyzed.

## Results and Discussion

**Days taken to spike emergence (days) :** The data pertaining to the effect of plant growth regulators on days

taken to spike emergence of *Dendrobium* orchids cv. Sonia 17 is presented in Table-1. Significant differences were observed in days taken to spike emergence with different plant growth regulators in *Dendrobium* orchid cv. Sonia 17.

Among all the treatments GA<sub>3</sub> @ 50 ppm recorded significantly the minimum number of days taken to spike emergence (140.61 days) while, plants sprayed with water (control) recorded significantly the maximum number days taken to spike emergence (179.66 days).

Early flowering in the GA<sub>3</sub> treated plants might be due to the reason that gibberellins played very important role in reducing the juvenile phase of a plant and in advancing bud formation and there by early onset of flowering. GA<sub>3</sub> promotes flower development in Arabidopsis by inhibiting the DELLA (nuclear growth repressor proteins) and increasing the expression of floral homeotic genes, APETALA 3 (AP3), PISTILLATA (PI) and AGAMOUS (AG) (Yu et al. 2000).

GA<sub>3</sub> treatment of certain *Cattleya* plants resulted in earlier flowering compared to control plants (Smith, 1958). GA<sub>3</sub> alone is effective in promoting inflorescence emergence in *Miltoniopsis* (Matsumoto, 2006). GA<sub>3</sub> promoted earlier flowering in marigold (Anuradha et al., 2017) and marigold (Kumar et al., 2014).

**Days taken to spike development (days) :** The data pertaining to the effect of plant growth regulators on days taken to spike development of *Dendrobium* orchids cv. Sonia 17 is presented in Table-1. Significant differences were observed in days taken to spike development with different plant growth regulators in *Dendrobium* orchid cv. Sonia 17.

Analysis of data revealed that, plants sprayed with GA<sub>3</sub> @ 50 ppm recorded significantly the minimum number of days taken to spike development (24.43 days) while, control (plants sprayed with water) recorded significantly the maximum number days taken to spike development (33.01 days).

The role of GA<sub>3</sub> in decreasing the number of days taken to spike development might be due to translocation of metabolites to the site of spike development as suggested by Sachs (1961). The nutrient diversion theory proclaim that chemical induction of flowering might be the result of greater source or sink activity, leading to an increased carbohydrate status of the apex. The results are in conformity with the findings of Sharifuzzaman et al. (2011) in chrysanthemum, Sisharenla (2015) in gladiolus, Matsumoto (2006) in *Miltoniopsis* orchid and Cardoso et al. (2012) in *Phalaenopsis*.

**Spike length (cm) :** The data pertaining to the effect of plant growth regulators on spike length of *Dendrobium* orchids cv. Sonia 17 is presented in Table-1. Significant

Table-1 : Effect of plant growth regulators on flowering parameters of *Dendrobium* orchid cv. Sonia 17.

| Treatments        |                          | Days taken to spike emergence (days) | Days taken to spike development (days) | Spike length (cm) | Spike girth (cm) | Spike weight (g) |
|-------------------|--------------------------|--------------------------------------|----------------------------------------|-------------------|------------------|------------------|
| T <sub>1</sub> :  | Benzyl adenine 200 ppm   | 170.39                               | 27.73                                  | 49.51             | 1.96             | 19.68            |
| T <sub>2</sub> :  | Benzyl adenine 400 ppm   | 170.56                               | 28.26                                  | 46.09             | 1.87             | 19.10            |
| T <sub>3</sub> :  | Benzyl adenine 600 ppm   | 169.61                               | 28.84                                  | 42.51             | 1.85             | 18.52            |
| T <sub>4</sub> :  | GA <sub>3</sub> 50 ppm   | 140.61                               | 24.43                                  | 52.51             | 0.98             | 21.68            |
| T <sub>5</sub> :  | GA <sub>3</sub> 100 ppm  | 157.05                               | 26.16                                  | 47.79             | 0.88             | 18.92            |
| T <sub>6</sub> :  | GA <sub>3</sub> 150 ppm  | 158.23                               | 26.41                                  | 41.05             | 0.81             | 17.56            |
| T <sub>7</sub> :  | Maliec hydrazide 200 ppm | 167.45                               | 28.38                                  | 38.51             | 1.00             | 16.56            |
| T <sub>8</sub> :  | Maliec hydrazide 400 ppm | 162.64                               | 27.11                                  | 38.16             | 1.36             | 15.01            |
| T <sub>9</sub> :  | Maliec hydrazide 600 ppm | 158.36                               | 25.18                                  | 34.22             | 1.52             | 13.22            |
| T <sub>10</sub> : | Cycocel 750 ppm          | 160.41                               | 28.20                                  | 37.80             | 1.40             | 14.65            |
| T <sub>11</sub> : | Cycocel 1000 ppm         | 158.91                               | 27.38                                  | 34.83             | 1.49             | 14.40            |
| T <sub>12</sub> : | Cycocel 1250 ppm         | 158.31                               | 25.15                                  | 33.95             | 1.74             | 12.37            |
| T <sub>13</sub> : | Control (Water spray)    | 179.66                               | 33.01                                  | 31.52             | 0.57             | 12.28            |
| Mean              |                          | 162.47                               | 27.40                                  | 40.65             | 1.34             | 16.45            |
| SEm±              |                          | 2.99                                 | 0.63                                   | 1.14              | 0.08             | 0.61             |
| CD at 5%          |                          | 8.97                                 | 1.89                                   | 3.21              | 0.25             | 1.85             |

Table-2 : Effect of plant growth regulators on flowering parameters of *Dendrobium* orchid cv. Sonia 17.

| Treatments        |                          | Number of flowers per spike | Diameter of flower (cm) | Yield of spikes per plant per year |
|-------------------|--------------------------|-----------------------------|-------------------------|------------------------------------|
| T <sub>1</sub> :  | Benzyl adenine 200 ppm   | 9.98                        | 6.08                    | 5.01                               |
| T <sub>2</sub> :  | Benzyl adenine 400 ppm   | 9.55                        | 5.85                    | 4.70                               |
| T <sub>3</sub> :  | Benzyl adenine 600 ppm   | 9.25                        | 5.21                    | 4.43                               |
| T <sub>4</sub> :  | GA <sub>3</sub> 50 ppm   | 10.38                       | 6.40                    | 5.43                               |
| T <sub>5</sub> :  | GA <sub>3</sub> 100 ppm  | 9.45                        | 5.59                    | 4.15                               |
| T <sub>6</sub> :  | GA <sub>3</sub> 150 ppm  | 9.08                        | 5.11                    | 3.94                               |
| T <sub>7</sub> :  | Maliec hydrazide 200 ppm | 7.65                        | 4.94                    | 2.98                               |
| T <sub>8</sub> :  | Maliec hydrazide 400 ppm | 7.85                        | 4.70                    | 3.30                               |
| T <sub>9</sub> :  | Maliec hydrazide 600 ppm | 8.58                        | 4.25                    | 3.56                               |
| T <sub>10</sub> : | Cycocel 750 ppm          | 7.78                        | 4.87                    | 3.16                               |
| T <sub>11</sub> : | Cycocel 1000 ppm         | 8.25                        | 4.47                    | 3.38                               |
| T <sub>12</sub> : | Cycocel 1250 ppm         | 8.71                        | 4.19                    | 3.71                               |
| T <sub>13</sub> : | Control (Water spray)    | 6.81                        | 4.05                    | 2.23                               |
| Mean              |                          | 8.71                        | 5.05                    | 3.84                               |
| SEm±              |                          | 0.08                        | 0.12                    | 0.05                               |
| CD at 5%          |                          | 0.24                        | 0.39                    | 0.16                               |

differences were observed in spike length at peak flowering stage in *Dendrobium* orchids cv. Sonia 17.

Among all the treatments, GA<sub>3</sub> @ 50 ppm recorded significantly the maximum spike length (52.51 cm) which was on par with Benzyl adenine @ 200 ppm (49.51 cm) while, control (plants sprayed with water) recorded significantly the minimum spike length (31.52 cm).

The increased spike length by GA<sub>3</sub> might be due to rapid internodal elongation that could be ascribed to the enhanced cell division, increased carbohydrate hydrolysis and increased cell wall plasticity (Sachs, 1961). The results were in conformity with findings of Mishra *et al.* (2018) in *Phalaenopsis*. The mechanism of action of

gibberellins on cell elongation could be through its effect on cell wall plasticity (Lockhart, 1960). GA<sub>3</sub> increase plasticity of cell wall either by acidification of cellular wall or by absorption of calcium ion inside cytoplasm (Baninasab and Rahemi, 1994). Elongation of stem cells takes place through the uptake of water and concurrent stretching of the cell wall, which eventually resulted in increased length of the flowering stalk. Acid invertase activity was increased in response to GA<sub>3</sub> application and helps in hydrolysis of sucrose into hexose sugars. The hexose sugars thus formed were easily transported to the sink, thereby increasing sink strength and resulted in rapid elongation of flowering stalk (Iqbal *et al.* 2011). The results were similar to the findings of Mishra *et al.* (2018)

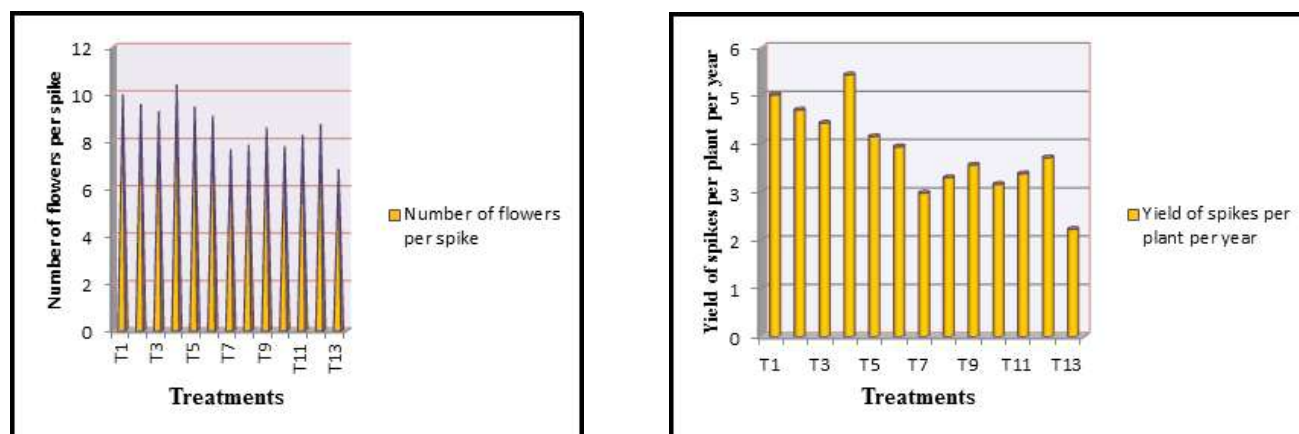


**Fig :** Effect of plant growth regulators on Number of flowers per spike and yield of spikes per plant per year of *Dendrobium* orchid cv. Sonia 17

|                                           |                                           |
|-------------------------------------------|-------------------------------------------|
| T <sub>1</sub> : Benzyl adenine 200 ppm   | T <sub>8</sub> : Maliec hydrazide 400 ppm |
| T <sub>2</sub> : Benzyl adenine 400 ppm   | T <sub>9</sub> : Maliec hydrazide 600 ppm |
| T <sub>3</sub> : Benzyl adenine 600 ppm   | T <sub>10</sub> : Cycocel 750 ppm         |
| T <sub>4</sub> : GA <sub>3</sub> 200 ppm  | T <sub>11</sub> : Cycocel 1000 ppm        |
| T <sub>5</sub> : GA <sub>3</sub> 400 ppm  | T <sub>12</sub> : Cycocel 1250 ppm        |
| T <sub>6</sub> : GA <sub>3</sub> 600 ppm  | T <sub>13</sub> : Control (Water spray)   |
| T <sub>7</sub> : Maliec hydrazide 200 ppm |                                           |

in *Phalaenopsis*, Kumar *et al.* 2014 in marigold and Sharma *et al.* (2004) in gladiolus.

**Spike girth (cm) :** The data pertaining to the effect of plant growth regulators on spike girth of *Dendrobium* orchids cv. Sonia 17 is presented in Table-1. Significant differences were observed in spike girth at the peak flowering stage in *Dendrobium* orchids cv. Sonia 17.

Foliar application of Benzyl adenine @ 200 ppm recorded significantly the maximum spike girth (1.96 cm) which was on par with Benzyl adenine 400 ppm (1.87 cm) and Benzyl adenine 600 ppm (1.85 cm) while, control (plants sprayed with water) recorded significantly the minimum spike girth (0.57 cm).

Increased spike girth by foliar application of Benzyl adenine is due to the physiological effect of Benzyl adenine as it induces cell division. The results are in conformity with findings of Barman *et al.* (2014) in *Dendrobium* hybrid Thongchai Gold and Saravanan and Amit kanawjia in *Dendrobium* hybrid Sonia 17.

**Spike weight (g) :** The data pertaining to the effect of plant growth regulators on spike weight of *Dendrobium* orchids cv. Sonia 17 is presented in Table-1. Significant differences were observed in spike weight at the peak flowering stage.

Treatments had marked influence on spike weight and the data revealed that spray application GA<sub>3</sub> 50 ppm recorded maximum spike weight (21.68 g) further, control (plants sprayed with water) recorded significantly the

minimum spike weight (12.28 g) which was on par with Cycocel 1250 ppm (12.37 g).

Increase in spike weight with GA<sub>3</sub> was attributed to the production of more number of bigger size florets as gibberellins are important for differentiation and growth of more number of flower primordia (Alpi *et al.*, 1976). The results were in agreement with findings of Padmalatha *et al.* (2013) in gladiolus and Kumar *et al.* (2014) in marigold.

**Number of flowers per spike :** The data pertaining to the effect of plant growth regulators on number of flowers per spike of *Dendrobium* orchids cv. Sonia 17 is presented in Table-2. Significant differences were observed in number of flowers per spike at the peak flowering stage in *Dendrobium* orchids cv. Sonia 17.

It is evident from the data that, among all the treatments foliar spray of GA<sub>3</sub> @ 50 ppm recorded significantly the more number of flowers per spike (10.38) while, control (water spray) recorded significantly the less number of flowers per spike (6.81).

High quantities of energy are necessary for inducing flowering and development of the flowers. The number and size of leaves increase the photosynthetic area, leading to high energy production, that sustain the development of spikes and flowers by application of GA<sub>3</sub> and BA. (Cardoso *et al.*, 2012 in *Phalaenopsis*). The results were in conformity with findings of Bhatt and Chauhan (2012) in *Dendrobium*, Barman *et al.* (2014) in *Dendrobium* hybrid Thongchai Gold and Saravanan and

Amit (2009) in *Dendrobium* and Kumar *et al.* 2014 in marigold.

**Diameter of flower (cm) :** The data pertaining to the effect of plant growth regulators on diameter of flower of *Dendrobium* orchids cv. Sonia 17 is presented in Table-2. Significant differences were observed in diameter of flower at the peak flowering stage in *Dendrobium* orchids cv. Sonia 17.

Among all the treatments, plants sprayed with GA<sub>3</sub> @ 50 ppm recorded significantly the maximum flower diameter (6.40 cm) which was on par with BA 200 ppm (6.08 cm) While, control (water spray) recorded significantly the minimum flower diameter (4.05 cm).

The increase in diameter of the petals creates a visual appearance having good impact, increasing the quality of the flowers. Application of GA<sub>3</sub> @ 50 ppm increased diameter of flower, it might be due to diversion of food reserves to only a few sinks that enhanced to produce bigger flowers and favorable effect of application of gibberellins on floret diameter improved physiological efficiency, selective ion uptake and sufficient water uptake causing high rate of accumulate deposition (Rani and Singh, 2013). The results were in conformity with the findings of Kumar *et al.* 2014 in marigold.

The fact that higher concentration of GA<sub>3</sub> promoted reduction in size of the flowers and the diameter of the petals may be explained due to the phyto toxicity of GA<sub>3</sub> applied in high concentrations (Cardoso *et al.*, 2012 in *Phalaenopsis*)

BA also increase the diameter of flower which might be due to role of Benzyl adenine in lateral expansion of petals (Mishra *et al.*, 2018 in *Miltoniopsis*).

**Yield of spikes per plant per year :** The data pertaining to the effect of plant growth regulators on yield of spikes per plant per year of *Dendrobium* orchids cv. Sonia 17 is presented in Table-2. Significant differences were observed in yield of spikes per plant per year with different plant growth regulators in *Dendrobium* orchid cv. Sonia 17.

Among all the treatments, GA<sub>3</sub> @ 50 ppm recorded significantly the maximum number of spikes (5.43) per plant per year while, control (plants sprayed with water) recorded significantly the minimum number of spikes (2.23) per plant per year.

Gibberellins are biochemically described as tetra cyclic diterpene acids and are associated with flowering induction in several species (Cardoso *et al.*, 2012 in *Phalaenopsis*).

Sugar may be a component of the floral stimulus and its production in apical meristem could be enhanced by GA<sub>3</sub> treatment and stimulate the transport of assimilate

through the phloem and divert to sink organs. GA<sub>3</sub> through alpha amylase activity, auxin stimulating effect and cell wall loosening, increased cell elongation along with the cell enlargement; all these caused effect on increased plant height, number of leaves, number of shoots and leaf area, thereby causing increased photosynthetic area. Thus, this caused increase in carbohydrate food material and diversion of this food reserves to sink organs ultimately produced more spikes and more number of flowers per spike (Sharifuzzaman *et al.*, 2011 in chrysanthemum).

The results are in agreement with findings of Barman *et al.* (2014) in *Dendrobium* hybrid Thongchai Gold, Anuradha *et al.* (2017) in marigold and Kumar *et al.* (2014) in marigold.

During winter the production was fallen drastically, the cause is that most of the hybrids of *Dendrobium* are warm loving plant and growth seized in winter months.

Benzyl adenine application @ 200 ppm also increased the spike production in *Dendrobium* orchids. The similar results were obtained by Sakai *et al.* (2000) in *Dendrobium* Jaquelyn when BA applied @ 100 mM with increased the flower size and number of spikes.

A reduction in flower yield observed here with the application of Growth retardants might be due to its inhibition effect on vegetative growth and on floral attributes like spike length, flower diameter, weight of flower, number of flowers per spike and delayed flowering (Syamal *et al.* 1990 in marigold).

However, increase in concentration of Benzyl adenine decreased the spike length and flower diameter as reported earlier by Po and Doris (2011) in *Phalaenopsis*. Higher concentration of BA causes the yellowing and withering of the flower bud before it could bloom. Lorteau *et al.* (2001) showed that BA could stimulate ethylene production in plants. In the present study, the yellowing happened in some occasion at a very early stage when the first bud started to form. This could be because of ethylene formation in plants that were treated with BA especially when higher concentrations were used (Nisha *et al.* 2012, in *Dendrobium* hybrid). Higher concentration of GA<sub>3</sub> also showed negative effect on vegetative growth and flower quality of orchids due to the phytotoxicity of GA<sub>3</sub> at higher concentrations (Cardoso *et al.*, 2012 in *Phalaenopsis*).

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## Neem Coated Urea Fertilizer : Effect on Increase in Yield Parameters of Rice (*Oryza sativa*)

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### Abstract

The experiment was laid out in randomized block design with ten treatments in three replications. Among the different treatments, the growth parameters of rice viz. plant height, number of tillers plant<sup>-1</sup>, leaf area, root length, root volume and dry matter accumulation were observed significantly higher in T<sub>2</sub>: 100% RDN as NCU in 3 Splits (Basal + Max Tillering + Panicle Initiation) and was followed by T<sub>3</sub>: 100% RDN as NCU in 2 Splits (Basal + Max Tillering). Yield and yield attributes of rice viz. number of panicles m<sup>-2</sup>, panicle weight and total number of grains panicle<sup>-1</sup>, grain and straw yield were recorded significantly highest in T<sub>2</sub>: 100% RDN as NCU in 3 Splits (Basal + Max Tillering + Panicle Initiation) and was found on par with T<sub>3</sub>: 100% RDN as NCU in 2 Splits (Basal + Max Tillering) and T<sub>8</sub>: NCU based on LCC. Significantly lowest growth and yield parameters was found under T<sub>10</sub>: control. LCC and SPAD readings were recorded significantly higher in application of 100% RDN as NCU in 3 splits (Basal + Max Tillering + Panicle Initiation) (T<sub>2</sub>) as compared to other treatments followed by 100% RDN as NCU in 2 splits (Basal + Max Tillering) (T<sub>3</sub>) and 75% RDN as NCU in 2 splits (Basal + Max Tillering) (T<sub>5</sub>). Whereas, significantly lowest LCC and SPAD meter reading was observed in control (T<sub>10</sub>).

**Key words :** RND, NCU, Leaf colour chart (LCC), SPAD, Basal and PI

### Introduction

Rice is the world's single most important food crop, being the primary food source for more than a third of the world's population and grown on 11% of the world's cultivated area. Specially, it is important in case of Asians, Africans, and Latin Americans living in the tropics and subtropics. For India, it is estimated that the rice consumption in 2015-16 was 99.5 million tonnes and in 2025, the demand will be around 140 million tonnes and the world demand for rice is projected to increase by as much as 70% over the next 30 years (33). With consumption of fertilizer-nitrogen increasing from 0.6 million tonnes in 1965-66 to 16.95 million tonnes in 2014-15, India has emerged as the second largest consumer of N in the world. Since 1970s, urea is the major source of fertilizer-N; 83.1 % fertilizer-N was consumed as urea in 2014-15 (5). With record urea production of 24.5 million tonnes in 2015-16, its dominance as source of fertilizer N in India is likely to continue. While urea provides the most N at the lowest cost, has no storage risks and can be used for all types of crops and soils with little or no harm to the soil, use efficiency of urea-N by different crops can be as low as 20% and it rarely exceeds 50%. From an agronomic perspective, controlling the losses of urea-N should lead to increased crop productivity. Some chemicals categorized as nitrification inhibitors temporarily delay/inhibit the bacterial oxidation of the ammonium-N by depressing over a certain period of time (4 to 10 weeks) the activity of *Nitrosomonas* bacteria in the soil. Thus

nitrification inhibitors control the loss of nitrate by leaching and/or denitrification from the topsoil by keeping N in the ammonium form longer duration and thereby increasing the fertilizer N use efficiency and yield of crops.

Nitrification inhibiting property of neem and its role in increasing urea N use efficiency in rice was first reported in early 1970s by (7). Neem oil as an alternative to neem cake has been used to coat urea granules to retard nitrification of ammonium-N in the soil. The neem oil coated urea (NOCU) has two advantages: (i) only 0.5 kg neem oil is needed per ton of urea and (ii) the N content in urea meets the Fertilizer Control Order standards (Prasad *et al.*, 2002). On the basis of the performance of NCU and NOCU in studies carried out with several crops in different parts of the country, the Government of India allowed urea manufacturers to coat granular urea with neem oil to produce NOCU up to 35 % of total capacity of their plants. Depending upon the concentration of triterpenoids or neem bitters, the active nitrification inhibitor compounds, neem cake, extract or oil have been used in different quantities to coat urea. Although mean increase in the grain yield of rice and wheat by applying NCU / NOCU was around 5 to 6 % over the yields obtained by urea at same N level, in about 30% comparisons no increase was observed. Same applies to other crops such as sugarcane, cotton where also respectively, 8.7 and 4.3 % increase in yields have been recorded in researcher's plots.

Besides efficient N fertilizer sources another approach to increase N fertilizer use efficiency is to

achieve synchrony between N needs of the crop and N supply. The use of leaf colour chart (LCC), relatively an inexpensive tool, has shown great promise in optimizing N use in rice based on colour of the leaf which in turn reflects total N supply in different countries of Asia, (6); (24); (3) and (25). Farmers can easily use the LCC to quantitatively assess foliar N status and adjust top dressing accordingly as it is proved that the current recommendation of three split application at specified growth stages is not adequate to synchronize N supply with crop N demand, (26); (24) and (4).

## Materials and Methods

The field experiments pertaining to the research topic were carried out during *Kharif*, 2016 at Indian Institute of Rice Research (IIRR) formerly Directorate of Rice Research (DRR) farm, Rajendranagar, Hyderabad situated at an altitude of 542.3 m above mean sea level and located at 17°19' N latitude and 78°23' E longitude. It represents the Southern Telangana agro-climatic zone of Telangana state. The climate of the region is semi-arid with an average rainfall of 900 mm from which 722.3 mm total rainfall was received during entire crop growth duration. The average maximum temperature for different months varied from 29.1° to 33.1°C, while monthly average minimum temperature ranged from 15.6° to 23.9°C. Relative humidity varied from 83.0 to 95.7 per cent at morning and 32.7 to 72.1 per cent in evening hours. The wind velocity ranged between 0.2 to 6.8 km hour<sup>-1</sup>. The soil of the experimental field was clayey in texture (*Vertisols*). The available nitrogen, phosphorus and potassium content were low, high and medium, respectively.

Rice variety "Vardhan" was grown as a test crop. Rice was planted with spacing 20 x 15cm. The crop was fertilized with 150, 60, and 40 kg N, P<sub>2</sub>O<sub>5</sub> and K<sub>2</sub>O ha<sup>-1</sup>, respectively. The experiment was laid out in randomized block design with ten treatments in three replications. The treatments comprised of T<sub>1</sub>: 100% RDN as PU in 3 Splits (Basal + Max Tillering + Panicle Initiation); T<sub>2</sub>: 100% RDN as NCU in 3 Splits (Basal + Max Tillering + Panicle Initiation); T<sub>3</sub>: 100% RDN as NCU in 2 Splits (Basal + Max Tillering); T<sub>4</sub>: 100% RDN as NCU as Basal; T<sub>5</sub>: 75% RDN as NCU in 3 Splits (Basal + Max Tillering + Panicle Initiation); T<sub>6</sub>: 75% RDN as NCU in 2 Splits (Basal + Max Tillering); T<sub>7</sub>: 75% RDN as NCU as Basal; T<sub>8</sub>: NCU application based LCC readings; T<sub>9</sub>: PU application based LCC readings and T<sub>10</sub>: Control.

In LCC based nitrogen management treatment, the LCC values were recorded as per standard procedure (IRRI, 1996) at weekly interval starting from 14 DAT to flowering. Whenever the LCC values were found to be below the fixed critical level of three, recommended

quantity of nitrogen was applied @ 25 kg ha<sup>-1</sup> and the basal dose of nitrogen was applied @ 30 kg ha<sup>-1</sup>. The colour of the single leaf (topmost fully expanded) was measured by holding the leaf colour chart vertically and placing the middle part of leaf, 1 cm in front of colour strip for comparison. Ten readings were taken for each plot and average was computed by rounding off to the nearest 0.5 to determine the need for nitrogen top dressing. Chlorophyll meter (model SPAD 502 of Minotta co., Japan) was used to measure SPAD values. The leaf selected for measurement of SPAD reading was between fourth from base to leaf tip of the plant. The SPAD values were measured on 10 leaves in each plot and then mean value was calculated. Observations were recorded five randomly selected plants from each plot and analysed as per standard statistical procedure (RCBD) suggested by (9).

## Results and Discussion

**Growth parameters :** The data pertaining to growth and yield attributes have been summarized and presented in Table-1. Among different treatments, the plant height was recorded significantly higher in application of 100% RDN as NCU in 3 splits (Basal + Max Tillering + Panicle Initiation) (T<sub>2</sub>) (92.90 cm) and was found on par with 100% RDN in the form of NCU as Basal (T<sub>4</sub>) (89.53 cm), 75% RDN as NCU as Basal (T<sub>7</sub>) (88.97 cm). Significantly lowest plant height was recorded in control (T<sub>10</sub>) (77.57 cm). The findings can also be supported by work of (1), (21), (2), (28) and (1).

Total number of tillers hill<sup>-1</sup> was significantly higher in application of 100% RDN as NCU in 3 splits (Basal + Max Tillering + Panicle Initiation) (T<sub>2</sub>) (13.4) and was found on par with 100% RDN as NCU as 2 splits (Basal + Max Tillering) (T<sub>3</sub>) (12.7). Whereas, lowest tillers hill<sup>-1</sup> (5.0) was recorded in control (T<sub>10</sub>). The results reveal that there was a significant difference in tiller production hill<sup>-1</sup> which might have been observed due to continuous availability of nitrogen during entire growth period to split application of N fertilizer. This was in agreement with the findings of (17), (29), (12), (30) and (8). (23) Also observed that nitrogen at transplanting or in two equal splits dressing at transplanting and tillering increased the total number of tillers hill<sup>-1</sup>.

Root length (27.43 cm) was recorded significantly higher in application of 100% RDN as NCU in 3 splits (Basal + Max Tillering + Panicle Initiation) (T<sub>2</sub>) and all treatments was found on par except control (T<sub>10</sub>). Lowest root length (24.20 cm) was observed in control (T<sub>10</sub>). Root volume (25.0 cm<sup>3</sup>) was recorded significantly higher in 100% RDN as NCU in 3 splits (Basal + Max Tillering + Panicle Initiation) (T<sub>2</sub>) and was found on par with all treatments except 75% RDN as NCU as Basal (T<sub>7</sub>) (21.0

Table-1 : Growth parameters of rice as influenced by neem coated urea fertilizer.

| Treatment                                           | Plant height (cm) | Total number of tillers hill <sup>-1</sup> | Root length (cm) | Root volume (cm <sup>3</sup> ) | Dry matter accumulation (g plant <sup>-1</sup> ) |
|-----------------------------------------------------|-------------------|--------------------------------------------|------------------|--------------------------------|--------------------------------------------------|
| T <sub>1</sub> : 100% PU-(Basal + Max. till. + PI)  | 91.27             | 11.0                                       | 26.11            | 22.8                           | 40.28                                            |
| T <sub>2</sub> : 100% NCU-(Basal + Max. till. + PI) | 92.90             | 13.4                                       | 27.43            | 25.0                           | 44.12                                            |
| T <sub>3</sub> : 100% NCU-(Basal + Max. till)       | 92.00             | 12.7                                       | 27.39            | 24.3                           | 41.50                                            |
| T <sub>4</sub> : 100% NCU-Basal                     | 89.53             | 9.1                                        | 25.71            | 21.4                           | 38.43                                            |
| T <sub>5</sub> : 75 % NCU-(Basal + Max. till. + PI) | 91.60             | 11.2                                       | 26.91            | 24.0                           | 40.66                                            |
| T <sub>6</sub> : 75% NCU-(Basal + Max. till)        | 90.97             | 9.5                                        | 26.07            | 22.6                           | 39.93                                            |
| T <sub>7</sub> : 75% NCU-Basal                      | 88.97             | 8.3                                        | 25.70            | 21.0                           | 37.88                                            |
| T <sub>8</sub> : NCU based on LCC                   | 91.40             | 11.6                                       | 26.19            | 23.5                           | 40.32                                            |
| T <sub>9</sub> : PU based on LCC                    | 90.83             | 9.4                                        | 25.86            | 22.3                           | 39.62                                            |
| T <sub>10</sub> : Control                           | 77.57             | 5.0                                        | 24.20            | 16.4                           | 25.07                                            |
| SEm ±                                               | 0.71              | 0.3                                        | 0.70             | 1.27                           | 1.50                                             |
| CD (P = 0.05)                                       | 2.13              | 0.8                                        | 2.09             | 3.76                           | 4.47                                             |

Table-2 : LCC and SPAD reading of rice at different growth stages as influenced by neem coated urea fertilizer.

| Treatment                                           | LCC reading |        | SPAD meter reading |        |        |
|-----------------------------------------------------|-------------|--------|--------------------|--------|--------|
|                                                     | 30 DAT      | 60 DAT | 30 DAT             | 60 DAT | 90 DAT |
| T <sub>1</sub> : 100% PU-(Basal + Max. till. + PI)  | 3.68        | 3.51   | 35.96              | 39.48  | 38.64  |
| T <sub>2</sub> : 100% NCU-(Basal + Max. till. + PI) | 3.74        | 3.96   | 34.94              | 43.39  | 42.28  |
| T <sub>3</sub> : 100% NCU-(Basal + Max. till)       | 4.05        | 3.66   | 38.79              | 42.07  | 41.05  |
| T <sub>4</sub> : 100% NCU-Basal                     | 4.28        | 3.03   | 39.39              | 37.99  | 37.25  |
| T <sub>5</sub> : 75% NCU-(Basal + Max. till. + PI)  | 3.52        | 3.47   | 33.23              | 41.55  | 40.57  |
| T <sub>6</sub> : 75% NCU-(Basal + Max. till)        | 3.78        | 3.13   | 37.39              | 39.08  | 38.27  |
| T <sub>7</sub> : 75% NCU-Basal                      | 3.79        | 2.99   | 38.67              | 36.16  | 35.54  |
| T <sub>8</sub> : NCU based on LCC                   | 3.48        | 3.25   | 35.46              | 40.62  | 39.70  |
| T <sub>9</sub> : PU based on LCC                    | 3.46        | 3.22   | 36.33              | 38.55  | 37.77  |
| T <sub>10</sub> : Control                           | 2.47        | 1.96   | 25.54              | 27.90  | 27.87  |
| SEm ±                                               | 0.11        | 0.12   | 1.39               | 1.52   | 1.42   |
| CD (P = 0.05)                                       | 0.35        | 0.35   | 4.13               | 4.53   | 4.22   |

cm<sup>3</sup>), 100% RDN as NCU as Basal (T<sub>4</sub>) (21.4 cm<sup>3</sup>). Whereas, lowest root volume was observed in control (T<sub>10</sub>). Root volume as a function of root length was significantly influenced by NCU and Split application of nutrient. Nutrients and water availability. The results are in accordance with the findings of (11).

Among different treatments, significantly highest dry matter accumulation was recorded in application of 100% RDN as NCU in 3 splits (Basal + Max Tillering + Panicle Initiation) (T<sub>2</sub>) (51.0 g). Whereas, lowest dry matter (28.03 g) was recorded in control (T<sub>10</sub>). Dry matter accumulation depends upon the photosynthesis and respiration rate, which finally increase the plant growth with respect to increased plant height results. It might be due to direct, higher availability and translocation of nutrients particularly N and K during development phase of growth stage which facilitates more photosynthesis process and resulted in higher dry matter accumulation. The effect of split application of nitrogen fertilizer was statistically significant on the dry matter of roots, stem, and leaves as

well as total dry matter at the three growth stages. These findings are in agreement with (20), (10), (32) and (13).

**LCC and SPAD (Soil Plant Analysis Development) readings :** The regarding the LCC readings of rice recorded at 30 and 60 DAT as influenced by neem coated urea fertilizer are presented in Table 2. At 30 DAT, application of 100% RDN in the form of NCU as basal (T<sub>4</sub>) was recorded the highest LCC reading followed by 100% RDN as NCU in 2 splits (Basal + Max Tillering) (T<sub>3</sub>) 4.28 and 4.05 respectively. Whereas, at 60 DAT application of 100% RDN as NCU in 3 splits (Basal + Max Tillering + Panicle Initiation) (T<sub>2</sub>) (3.96) recorded highest LCC readings followed by 100% RDN as NCU in 2 splits (Basal + Max Tillering) (T<sub>3</sub>) (3.66). Lowest LCC reading was observed in control (T<sub>10</sub>) (1.96). This result was supported by (14) who revealed that application of NCU using LCC produced significantly higher rice yield than ordinary urea. A dose of 110 kg N ha<sup>-1</sup> applied in 4 splits at 7, 21, 35 and 56 DAT using LCC was sufficient to produce grain yield equivalent to that produced by applying 120 kg N ha<sup>-1</sup> in

Table-3 : Yield and yield attributes of rice as influenced by neem coated urea fertilizer.

| Treatment                                           | Number of panicles m <sup>-2</sup> | Panicle length (cm) | Panicle weight (g) | Number of grains panicle <sup>-1</sup> | Grain yield (t ha <sup>-1</sup> ) | Straw yield (t ha <sup>-1</sup> ) |
|-----------------------------------------------------|------------------------------------|---------------------|--------------------|----------------------------------------|-----------------------------------|-----------------------------------|
| T <sub>1</sub> : 100% PU-(Basal + Max. till. + PI)  | 286.2                              | 21.17               | 3.65               | 155.9                                  | 5.55                              | 6.66                              |
| T <sub>2</sub> : 100% NCU-(Basal + Max. till. + PI) | 355.7                              | 21.71               | 3.89               | 185.4                                  | 6.21                              | 7.45                              |
| T <sub>3</sub> : 100% NCU-(Basal + Max. till)       | 336.9                              | 21.55               | 3.83               | 178.5                                  | 6.08                              | 7.11                              |
| T <sub>4</sub> : 100% NCU-Basal                     | 258.8                              | 20.41               | 3.34               | 147.5                                  | 4.47                              | 5.36                              |
| T <sub>5</sub> : 75 % NCU-(Basal + Max. till. + PI) | 325.5                              | 21.21               | 3.74               | 165.1                                  | 5.66                              | 6.76                              |
| T <sub>6</sub> : 75% NCU-(Basal + Max. till)        | 251.6                              | 21.03               | 3.47               | 155.7                                  | 4.90                              | 5.88                              |
| T <sub>7</sub> : 75% NCU-Basal                      | 225.7                              | 20.32               | 3.31               | 143.1                                  | 4.21                              | 5.05                              |
| T <sub>8</sub> : NCU based on LCC                   | 333.1                              | 21.19               | 3.69               | 169.7                                  | 5.84                              | 7.01                              |
| T <sub>9</sub> : PU based on LCC                    | 279.5                              | 21.00               | 3.41               | 143.1                                  | 5.47                              | 6.57                              |
| T <sub>10</sub> : Control                           | 145.9                              | 19.82               | 3.13               | 134.1                                  | 3.00                              | 3.66                              |
| SEm ±                                               | 10.6                               | 0.46                | 0.12               | 8.2                                    | 0.13                              | 0.16                              |
| CD (P = 0.05)                                       | 31.5                               | NS                  | 0.36               | 24.3                                   | 0.39                              | 0.50                              |

three equal split doses from both the N sources. These results regarding LCC use are in line with data reported by (25), (31) and (15).

SPAD meter readings of rice was recorded at 30, 60, and 90 DAT as influenced by neem coated urea fertilizer are presented in Table 2. At 30 DAT, the application of 100% RDN in the form of NCU as Basal (T<sub>4</sub>) recorded (39.39) significantly higher SPAD meter reading as compared to other treatments, but, it was found on par with 100% RDN as NCU in 2 splits (Basal + Max Tillering) (T<sub>3</sub>) (38.79), 75% RDN as NCU as Basal (T<sub>7</sub>) (38.67) and 75% RDN as NCU in 2 splits (Basal + Max Tillering) (T<sub>6</sub>) (37.39). The lowest SPAD meter reading (25.54) was recorded in control (T<sub>10</sub>). At 60 DAT, application of 100% RDN as NCU in 3 splits (Basal + Max Tillering + Panicle Initiation) (T<sub>2</sub>) recorded significantly higher SPAD meter reading (43.39) as compared to other treatments and was found on par with 100% RDN as NCU in 2 splits (Basal + Max Tillering) (T<sub>3</sub>) (42.07), 75% RDN as NCU in 2 splits (Basal + Max Tillering) (T<sub>5</sub>) (41.55) and NCU based on LCC (T<sub>8</sub>) (40.62). The lowest SPAD meter reading (27.90) was recorded in control (T<sub>10</sub>). At 90 DAT, application of 100% RDN as NCU in 3 splits (Basal + Max Tillering + Panicle Initiation) (T<sub>2</sub>) (42.28) recorded significantly higher SPAD meter values as compared to other treatments followed by 100% RDN as NCU in 2 splits (Basal + Max Tillering) (T<sub>3</sub>) (41.05) and 75% RDN as NCU in 2 splits (Basal + Max Tillering) (T<sub>5</sub>) (27.85). The lowest SPAD meter reading (27.85) was recorded in control (T<sub>10</sub>). The SPAD values recorded at periodical intervals showed significant differences with split application of NCU and PU both. This result can be supported by (14) who reported that the nitrogen application in three splits, gave the highest SPAD meter reading.

**Yield and yield parameters :** The data pertaining to yield and yield parameters have been presented in

Table-3. Among the different treatments, maximum number of panicles m<sup>-2</sup> (355.7) was produced in 100% RDN as NCU in 3 splits (Basal + Max Tillering + Panicle Initiation) (T<sub>2</sub>) as compared to all other treatments. However, it was also found on par with the treatment of 100% RDN as NCU in 2 splits (Basal + Max Tillering) (T<sub>3</sub>) (336.9), NCU based on LCC (T<sub>8</sub>) (333.1) and significantly lowest panicles m<sup>-2</sup> (145.9) was recorded in control (T<sub>10</sub>). Panicle length was recorded non-significantly highest in application of 100% RDN as NCU in 3 splits (Basal + Max Tillering + Panicle Initiation) (T<sub>2</sub>) (21.71 cm) as compared to all other treatments. The panicle weight was recorded significantly higher (3.89 g) under the treatment of 100% RDN as NCU in 3 splits (Basal + Max Tillering + Panicle Initiation) (T<sub>2</sub>) as compared to other treatments. However, it was found on par with treatments of 100% RDN as NCU as 2 splits (Basal + Max Tillering) (T<sub>3</sub>) (3.83 g), 75% RDN as NCU in 3 splits (Basal + Max Tillering + Panicle Initiation) (T<sub>5</sub>) (3.74 cm) and NCU based on LCC (T<sub>8</sub>) (3.69 cm). Lowest number of Panicle length, panicle weight and total number of grains panicle<sup>-1</sup> was recorded in control (T<sub>10</sub>).

The total number of grains panicle<sup>-1</sup> (185.4) was recorded significantly higher under the treatment of 100% RDN as NCU in 3 splits (Basal + Max Tillering + Panicle Initiation) (T<sub>2</sub>) as compared to other treatments followed by 100% RDN as NCU as 2 splits (Basal + Max Tillering) (T<sub>3</sub>) (178.5) and NCU based on LCC (T<sub>8</sub>) (169.7). Lowest number of Panicle length, panicle weight and total number of grains panicle<sup>-1</sup> was recorded under control (T<sub>10</sub>), which was significantly inferior to rest of the treatments.

Grain yield (6.21 t ha<sup>-1</sup>) of rice was recorded significantly higher in application of NCU applied 100% RDN as NCU in 3 splits (Basal + Max Tillering + Panicle Initiation) (T<sub>2</sub>). However, it was found on par with application 100% RDN as NCU in 2 splits (Basal +

Max Tillering) ( $T_3$ ) ( $6.08 \text{ t ha}^{-1}$ ) and NCU based on LCC ( $T_8$ ) ( $5.84 \text{ t ha}^{-1}$ ). Lowest grain yield of rice was recorded in control ( $T_{10}$ )  $3.0 \text{ t ha}^{-1}$  and the yield increased significantly in all treatments over control indicating N application has significant effect in increasing yield of rice. Straw yield of rice was recorded significantly higher in application of NCU applied 100% RDN as NCU in 3 splits (Basal + Max Tillering + Panicle Initiation) ( $T_2$ ) ( $7.45 \text{ t ha}^{-1}$ ). However, it was found on par with treatments of 100% RDN as NCU as 2 splits (Basal + Max Tillering) ( $T_3$ ) ( $7.11 \text{ t ha}^{-1}$ ). The lowest straw yield ( $3.66 \text{ t ha}^{-1}$ ) was produced under control ( $T_{10}$ ).

The number of panicles  $\text{m}^{-2}$  is an important yield attributing characters which ultimately determinates the yield of rice crop. Increase in plant height more number of leaves, number of tillers in successive growth stages helped in increasing the effective tillers. This was mainly due to higher photosynthetic efficiency and net assimilation which helped in increasing the overall growth of the plant. These findings are in agreement with (19), (29), (30), and (28) observed that split application of NCU gave better yield than its basal application, when supplemented with one third of NCU applied at panicle initiation stage in split dose. Split application of NCU at panicle initiation stage maintained good supply of  $\text{NH}_4\text{-N}$  up to the flowering stage which might have resulted in better yield attributes as reported by (22) and (16).

## Conclusions

The present investigation was carried out only for one season. Hence, definite conclusion could not be drawn. However, on the basis of results obtained, it is clear that application of 100% RDN as NCU in 3 splits (Basal + Max Tillering + Panicle Initiation) produced the highest grain yield, which was followed by 100% RDN as NCU in 2 splits (Basal + Max Tillering). By these results it can be easily concluded that the use of NCU in 3 splits is very much beneficial in terms of grain output and economic benefits.

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## **A Study on Personal, Socio-Economic and Psychological Attributes of Anganwadi Workers in Raipur District of Chhattisgarh**

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### **Abstract**

With the objective of breaking the vicious cycle of malnutrition, morbidity, reduced learning capacity and mortality etc. Government of India launched the Integrated Child Development Services programme the kingpin of which are the Anganwadi workers. This study focused on the profile characteristics of anganwadi workers in Raipur district of Chhattisgarh. A total of seventeen villages from two ICDS projects of Arang block of Raipur was selected and sixty anganwadi workers were interviewed for the study which revealed that majority of them were in middle age category with 68.33 per cent. Nearly 76 per cent of anganwadi workers were married. Approximately 58 per cent had medium service experience of 0-20 years. Nearly 58 per cent of the anganwadi workers had educational qualification upto intermediate level. 60 per cent had received orientation and refresher trainings both. Nearly 56 per cent of the workers had low level of family annual income.

**Key words :** Anganwadi, anganwadi worker, integrated child development services programme, profile characteristics

### **Introduction**

Early years of a child's life is very important for his or her healthy development when the foundation for cognitive, social, emotional, physical/motor development and cumulative life long learning are laid. There has to be a holistic approach including education, health and nutrition. As per the provisional census 2011 figures, out of the total population of India 13.12% lies in the tender age bracket of 0-6 years. Of the total population of Chhattisgarh 14.03% and that of the total population of Raipur district 14.02% lies in this age group of 0-6 years. Several amendments and policies have been claimed by the government to provide support and services for different needs of children. One such program called the Integrated Child Development Services (ICDS) was introduced for the holistic development of child in a convergent manner.

Launched on 2nd October, 1975, by the government of India in the Ministry of Social and Women's welfare, the Integrated Child Development Services (ICDS) Scheme is one of the flagship programmes which represents one of the world's largest and unique programmes for early childhood care and development. It is the foremost symbol of country's commitment to its children and nursing mothers, as a response to the challenge of providing pre-school non-formal education on one hand and breaking the vicious cycle of malnutrition, morbidity, reduced learning capacity and mortality on the other. The beneficiaries under the Scheme are children in the age group of 0-6 years, pregnant women and lactating mothers.

Anganwadi worker is the kingpin of ICDS

programme. She is a woman in the age group of 21-45 years. They are usually selected from within the village/local community considering their acceptability by them. They are the community – based voluntary frontline workers of the ICDS Programme. For a population of 1000 in rural and urban projects, one anganwadi worker is appointed and so for a population of 700 (with an upper limit of 1000) in tribal projects. Since, an anganwadi worker is the main functionary of the ICDS scheme, the success of the scheme rests to a large extent on her ability and capacity to perform her role and responsibilities.

As a part of Indian public health care system, an anganwadi centre is responsible for providing basic health care in a village. For the establishment of an anganwadi centre in a village it is essential to know whether the target community is in need of it. Also it is necessary to consider the availability of suitable space sufficient for both indoor and outdoor activities, availability of safe drinking water is a must and the contributions by the community in the form of cash, kind or labour to supplement the resources of ICDS.

At the Anganwadi level, Anganwadi Level Monitoring and Support Committee (ALMSC) oversee and coordinate with AWW in implementation of the Project. Village Health Sanitation and Nutrition Committee (VHSNC) is the committee monitoring implementation of the scheme at Village Level, supporting the AWW and Supervisor in implementation of the programme.

### **Research Methodology**

The present study was conducted in Raipur district of Chhattisgarh. Out of the four blocks of Raipur namely

**Table-1 : Distribution of anganwadi workers according to their personal attributes.** (n=60)

| S.No.                 | Attributes and their categories | Frequency | Percentage |
|-----------------------|---------------------------------|-----------|------------|
| <b>Age</b>            |                                 |           |            |
| 1.                    | Young age (<30 years)           | 15        | 25         |
| 2.                    | Middle age (30-50 years)        | 41        | 68.33      |
| 3.                    | Old age (>50 years)             | 04        | 6.67       |
| <b>Marital Status</b> |                                 |           |            |
| 1.                    | Unmarried                       | 09        | 15         |
| 2.                    | Married                         | 46        | 76.67      |
| 3.                    | Others (divorced/ widow)        | 05        | 8.33       |
| <b>Caste</b>          |                                 |           |            |
| 1.                    | Schedule Tribe                  | 01        | 1.67       |
| 2.                    | Schedule Caste                  | 08        | 13.33      |
| 3.                    | Other backward caste            | 41        | 68.33      |
| 4.                    | General                         | 10        | 16.67      |
| <b>Education</b>      |                                 |           |            |
| 1.                    | Junior high school              | 03        | 5          |
| 2.                    | High school                     | 14        | 23.33      |
| 3.                    | Intermediate                    | 35        | 58.33      |
| 4.                    | Graduate                        | 08        | 13.33      |
| <b>Experience</b>     |                                 |           |            |
| 1.                    | Low (<10 years)                 | 19        | 31.67      |
| 2.                    | Medium (10-20 years)            | 35        | 58.33      |
| 3.                    | High (>20 years)                | 06        | 10         |

Dharsiwa, Tilda, Arang and Abhanpur, Arang block was purposively selected due to presence of second highest number of Anganwadi centres and also because the researcher was well acquainted. Arang block has two ICDS projects running under them. 9 villages were randomly selected from the project-1 Chandkhuri (arang) and 8 villages were randomly selected from the project-2 Mandir Hasaud (arang). Hence a total of 17 villages were selected for the study. 32 AWWs were selected from the project-1 Chandkhuri (arang) and 28 AWWs were selected from the project-2 Mandir Hasaud (arang). Hence a total of 60 AWWs were selected for the study. For collection of data the respondents were personally interviewed, for which an interview schedule was developed. The data so collected were tabulated and analyzed using appropriate statistical tools and applications.

## Results and Discussion

The findings on personal attributes of anganwadi workers are presented in table-1. The findings indicates that out of the total anganwadi workers , 25.00 per cent belonged to young age group(<30 years), whereas 68.33 per cent were from middle age(30-50 years) and only 6.67 percent were from old age group(>50 years). Similar finding was reported by Patil,S.B. and Doibale,M.K. (2013), Borgohain,H. and Saikia,J.P. (2017). 76.67 per cent of the

**Table-2 : Distribution of anganwadi workers according to socio-economic attributes.** (n=60)

| S. No.                      | Attributes and their categories       | Frequency | Percentage |
|-----------------------------|---------------------------------------|-----------|------------|
| <b>Annual family income</b> |                                       |           |            |
| 1.                          | Low (< Rs. 2,00,000)                  | 34        | 56.67      |
| 2.                          | Medium (Rs. 2,00,000 to Rs. 4,00,000) | 21        | 35         |
| 3.                          | High (> Rs. 4,00,000)                 | 05        | 8.33       |
| <b>Honorarium</b>           |                                       |           |            |
| 1.                          | Rs. 6500 to Rs. 7000                  | 40        | 66.67      |
| 2.                          | Rs. 7001 to Rs. 7500                  | 12        | 20         |
| 3.                          | Rs. 7501 to Rs. 8000                  | 08        | 13.33      |

anganwadi workers were found to be married whereas 15.00 per cent were unmarried and only 8.33 percent were found to be divorced or widow. Similar findings were reported by Agarwal, A. *et al.* (2018). 1.67 per cent anganwadi workers belonged to schedule tribe, 13.33 per cent were schedule caste, whereas 68.33 per cent were of Other backward caste and only 16.67 per cent belonged to general category, resembling the findings of Arya, M. *et al.* (2018), and Sarkar, R. (2018). It was found that 5.00 per cent anganwadi workers were educated upto junior high school, 23.33 percent were educated upto high school, 58.33 per cent workers were educated upto intermediate level and 13.33 per cent workers were graduated. Similar findings were revealed by Joshi, K. (2018), Barodia, S. (2015). The data regarding the experience of respondents as anganwadi workers revealed that 31.67 per cent had experience of less than 10 years whereas 58.33 per cent had experience between 10-20 years and only 10.00 percent had more than 20 years of experience. The results were in accordance with the results of Pandey *et al.* (2019).

The findings regarding socio-economic attributes of anganwadi workers are presented in table-2. The findings revealed that majority i.e 56.67 per cent anganwadi workers had an annual family income below Rs. 2,00,000 whereas 35 per cent had annual family income ranging from Rs. 2,00,000 to Rs. 4,00,000 and only 8.33 per cent had annual family income above Rs. 4,00,000. The data regarding the honorarium received by the anganwadi workers showed that 66.67 per cent received honorarium ranging from Rs. 6500 to Rs. 7000, 20 per cent received honorarium ranging from Rs. 7001 to Rs. 7500 and 13.33 received honorarium ranging from Rs.7501 to Rs. 8000. The results were in accordance with the results of Salunke, S. and Hengde, R.P. (2018).

The findings on psychological attributes of anganwadi workers are presented in table-3. The findings revealed that majority i.e 70 per cent of the anganwadi workers perceived the workload in their job to be medium,

**Table-3 : Distribution of anganwadi workers according to their Psychological attributes.** (n=60)

| S. No.                        | Attributes and their categories | Frequency | Percentage |
|-------------------------------|---------------------------------|-----------|------------|
| <b>Workload Perception</b>    |                                 |           |            |
| 1.                            | Low                             | 08        | 13.33      |
| 2.                            | Medium                          | 42        | 70         |
| 3.                            | High                            | 10        | 16.67      |
| <b>Achievement Motivation</b> |                                 |           |            |
| 1.                            | Low                             | 11        | 18.33      |
| 2.                            | Medium                          | 42        | 70         |
| 3.                            | High                            | 07        | 11.67      |
| <b>Attitude towards ICDS</b>  |                                 |           |            |
| 1.                            | Unfavourable                    | 10        | 16.67      |
| 2.                            | Neutral                         | 40        | 66.66      |
| 3.                            | Favourable                      | 10        | 16.67      |

whereas 16.67 per cent had high workload perception and 13.33 per cent had low workload perception. Similar results found by Dash, L. and Priyadarshini, V. (2018). It was found that out of total Anganwadi workers 18.33 per cent belonged to low achievement motivation category whereas 70.00 per cent belonged to medium and only 11.67 per cent workers belonged to high achievement motivation category. Based on the attitude of anganwadi workers towards ICDS, it was revealed that 16.67 per cent had unfavourable attitude, whereas 66.67 per cent had neutral attitude and 16.67 per cent workers had favourable attitude towards ICDS.

## Conclusion

Majority of the anganwadi workers were found to be in the middle age category with ages between 30-50 years and most of them were married. Majority of the anganwadi workers in the study area belonged to Other Backward Caste. Approximately half of them had medium service experience between 10-20 years. Most of the anganwadi workers had educational qualification upto intermediate level. Majority of the workers had low annual family income of below Rs 2,00,000. The honorarium received for delivery of services by majority of the anganwadi workers ranged from Rs. 6500 to Rs. 7000. Majority of the anganwadi workers had medium level of workload perception and possess medium Achievement motivation.

More than half of the total anganwadi workers included in the study had a neutral attitude towards ICDS.

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## Effect of Sowing Times and Varieties on Quality Performance and Economics of Wheat (*Triticum aestivum* L.)

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### Abstract

The present investigation was carried out during the *Rabi* season of 2016-17 at the research farm of Wheat & Barley Section, Chaudhary Charan Singh Haryana Agricultural University, Hisar. The experiment was laid out in a split plot design with four sowing times (5<sup>th</sup> November, 15<sup>th</sup> November, 25<sup>th</sup> November, 5<sup>th</sup> December) in the main plots and four wheat varieties (WH 1105, HD 2967, HD 3086, DBW 88) in the subplots with three replications. Quality parameters viz. sedimentation value and hectolitre weight were maximum in 5<sup>th</sup> November sowing while protein content was maximum in 5<sup>th</sup> December sowing. Sowing of wheat on 5<sup>th</sup> November resulted in 27.4 and 20.5 per cent higher grain yield and B:C, respectively, as compared to the 5<sup>th</sup> December sowing. Among varieties, the highest sedimentation value and protein yield were recorded with WH 1105, while, HD 3086 registered the highest hectolitre weight. The maximum grain yield (5822 kg/ha), net returns (₹ 37,320/ha) and B:C (1.40) were obtained from the wheat variety HD 3086.

**Key words :** Sowing time, varieties, quality, yield, economics.

### Introduction

Wheat (*Triticum aestivum* L.) is an important cereal grain and a staple food for millions of people worldwide. It is a winter season crop, widely cultivated under varied agro-ecological conditions and cropping systems throughout the world. It is the second most important food grain in India after rice. Wheat contributes nearly 35 per cent to the national food basket and plays an important role in food and nutritional security. It contains about 12% protein, 70% carbohydrates, 2.7% minerals, 1.7% fat, 2% fiber and 12% moisture (1). India is the second largest producer of wheat after China, contributing 13.3% wheat to the world's production. In India, wheat is cultivated on area of 31.4 mha with production of 107.9 mt (2). The stagnation in the productivity of this crop is now all-apparent. Among various factors responsible for the lower yield of the wheat crop in the country, sowing time and varietal selection are of primary importance. A sustainable increase in the grain yield of the wheat varieties can be achieved by sowing the wheat crop at the optimum time, which varies according to variety or genotype, climatic conditions and availability of resources. Quality parameters are crucial for wheat crop competitiveness. Several factors affect quality traits of wheat such as sowing time (3), varieties (4), drought (5), growing environment (6), temperature *etc.* So, keeping in view, present study was aimed at determining the impact of the sowing time and varieties on the various quality parameters, yield and economics of wheat.

### Materials and Methods

The experiment was conducted during the *Rabi* season 2016-17 at Research Farm of Wheat and Barley Section, Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana (India), situated at 29°10' N latitude and 75°46' E longitude at an elevation of 215.2 m above mean sea level. The soil of the field was sandy loam in texture, slightly alkaline in reaction with a pH of 8.3, low in organic carbon (0.29-0.32 %) and available nitrogen, medium in available phosphorus and high in available potassium. The experimental design used was a split plot with three replications. In the main plot, four sowing dates, *i.e.* D<sub>1</sub> - 5<sup>th</sup> November, D<sub>2</sub> - 15<sup>th</sup> November, D<sub>3</sub> - 25<sup>th</sup> November and D<sub>4</sub> - 5<sup>th</sup> December were taken and wheat varieties, *i.e.* V<sub>1</sub>- WH 1105, V<sub>2</sub>- HD 2967, V<sub>3</sub>- HD 3086 and V<sub>4</sub>- DBW 88 were taken in subplot. Sowing of different varieties of wheat was done manually with the help of hand plough by *Pora* method at 5 cm depth according to treatments. Recommended dose of fertilizers (half dose of N, full dose of P<sub>2</sub>O<sub>5</sub>, K<sub>2</sub>O and ZnSO<sub>4</sub>) was applied to all the plots one day before sowing. Remaining half dose of nitrogen was top dressed at 1<sup>st</sup> irrigation. Weeding was done with hand hoe in all the plots after 30-35 days of sowing. Other management practices were adopted as per recommendations for the wheat crop. Sedimentation value in wheat flour and blends was determined according to standard procedure (7). Hectolitre weight of grain samples was recorded with the help of hectolitre weight equipment available in the Wheat Quality Laboratory of

Table-1 : Effect of sowing times and varieties on quality and yields of wheat.

| Treatments                | Quality parameters       |                           |                     |                       | Yields              |                     |
|---------------------------|--------------------------|---------------------------|---------------------|-----------------------|---------------------|---------------------|
|                           | Sedimentation value (ml) | Hectolitre weight (kg/hl) | Protein content (%) | Protein yield (kg/ha) | Grain yield (kg/ha) | Straw yield (kg/ha) |
| <b>Sowing times</b>       |                          |                           |                     |                       |                     |                     |
| 5 <sup>th</sup> November  | 51.8                     | 83.2                      | 10.1                | 619.0                 | 6178                | 8588                |
| 15 <sup>th</sup> November | 49.5                     | 81.5                      | 11.7                | 676.8                 | 5845                | 8429                |
| 25 <sup>th</sup> November | 48.3                     | 78.3                      | 12.8                | 695.3                 | 5395                | 8182                |
| 5 <sup>th</sup> December  | 46.4                     | 75.6                      | 13.2                | 639.8                 | 4850                | 7890                |
| SEm±                      | 0.9                      | 0.3                       | 0.1                 | 8.8                   | 93                  | 131                 |
| CD (p=0.05)               | 3.1                      | 1.2                       | 0.4                 | 31.0                  | 302                 | 426                 |
| <b>Varieties</b>          |                          |                           |                     |                       |                     |                     |
| WH 1105                   | 54.1                     | 80.2                      | 12.0                | 679.8                 | 5707                | 8004                |
| HD 2967                   | 46.1                     | 77.0                      | 12.1                | 646.7                 | 5402                | 8488                |
| HD 3086                   | 46.9                     | 81.6                      | 11.7                | 672.8                 | 5822                | 8201                |
| DBW 88                    | 48.9                     | 79.8                      | 12.0                | 631.7                 | 5336                | 8397                |
| SEm±                      | 0.7                      | 0.3                       | 0.1                 | 12.0                  | 71                  | 126                 |
| CD (p=0.05)               | 2.0                      | 1.0                       | NS                  | 35.3                  | 204                 | 363                 |

Table-2 : Effect of sowing times and varieties on economics of wheat.

| Treatments                | Gross return (₹/ha) | Cost of cultivation (₹/ha) | Net return (₹/ha) | B : C |
|---------------------------|---------------------|----------------------------|-------------------|-------|
| <b>Sowing times</b>       |                     |                            |                   |       |
| 5 <sup>th</sup> November  | 1,39,021            | 94,793                     | 44,228            | 1.47  |
| 15 <sup>th</sup> November | 1,32,933            | 94,793                     | 38,140            | 1.40  |
| 25 <sup>th</sup> November | 1,24,442            | 93,610                     | 30,832            | 1.33  |
| 5 <sup>th</sup> December  | 1,14,318            | 93,610                     | 20,708            | 1.22  |
| <b>Varieties</b>          |                     |                            |                   |       |
| WH 1105                   | 1,28,764            | 94,203                     | 34,563            | 1.37  |
| HD 2967                   | 1,25,974            | 94,203                     | 31,773            | 1.34  |
| HD 3086                   | 1,31,521            | 94,203                     | 37,320            | 1.40  |
| DBW 88                    | 1,24,453            | 94,203                     | 30,252            | 1.32  |

CCSHAU, Hisar. Per cent nitrogen content in grain was determined by Nessler's reagent method. Then, the protein content in wheat grains was calculated by multiplying the percentage of nitrogen in the grains by 6.25. Protein content thus obtained was multiplied by grain yield to work out protein yield in wheat. Cost of cultivation for each treatment was calculated by using the rates of different agronomic practices and the inputs used in a particular treatment. The minimum support price (₹ 1625 /q) was multiplied by grain yield and straw rate (₹ 450 /q) by straw yield and both were summed to find out the gross returns of each treatment. The cost of cultivation was subtracted from gross returns to find out net returns. Treatment wise benefits cost (B: C) ratio was calculated to ascertain economic viability using the following formula :

$$B : C = \frac{\text{Gross returns (₹/ha)}}{\text{Cost of cultivation (₹/ha)}}$$

The data collected were subjected to statistical analysis by using 'Analysis of Variance Technique' as suggested by Gomez and Gomez (1983). Standard errors

of mean and critical difference (CD) values at 5% level of probability were computed for making comparison between treatments.

## Results and Discussion

### Quality Parameters

**Sedimentation value :** Sedimentation value decreased with delay in sowing time (Table-1) and highest value was obtained when crop was sown on 5<sup>th</sup> November (51.8 ml), which was significantly higher than 25<sup>th</sup> November (48.3 ml) and 5<sup>th</sup> December (46.4 ml) sowings but at par with 15<sup>th</sup> November sowing (49.5 ml). Each delay in sowing time from 5<sup>th</sup> November to 15<sup>th</sup> November, 25<sup>th</sup> November and 5<sup>th</sup> December reduced the sedimentation value by 4.4, 6.8 and 10.4 per cent, respectively. The highest sedimentation value (51.8 ml) was recorded in WH 1105, which was significantly higher than the other three varieties. The wheat variety WH 1105 resulted in 10.6, 15.4 and 17.4 per cent higher sedimentation value as compared to DBW 88, HD 3086 and HD 2967, respectively.

**Hectolitre weight :** The highest hectolitre weight was obtained in the 5<sup>th</sup> November sowing (83.2 kg/hl), which decreased significantly in delayed sowings (Table-1). The crop sown on 5<sup>th</sup> November resulted in 2.1, 6.3 and 10.1 per cent higher hectolitre weight in comparison to 15<sup>th</sup> November (81.5 kg/hl), 25<sup>th</sup> November (78.3 kg/hl) and 5<sup>th</sup> December (75.6 kg/hl) sowings, respectively. Similar results were also reported by many authors (9). The highest hectolitre weight was recorded in wheat variety HD 3086, which was significantly superior to other varieties while minimum was obtained in HD 2967. The wheat variety HD 3086 resulted in 1.8, 2.3 and 6.0 per cent higher hectolitre weight as compared to WH 1105, DBW 88 and HD 2967, respectively. These highly significant differences in quality parameters among varieties can be attributed to their genetic characteristics.

**Protein content and protein yield :** Protein content (%) markedly increased with a delay in sowing time (Table-1). The wheat crop sown on 5<sup>th</sup> December resulted in maximum protein content (13.2%) which was significantly higher than 5<sup>th</sup> November (10.1%) and 15<sup>th</sup> November (11.7%) sowings but at par with 25<sup>th</sup> November (12.8%) sowing. The per cent increase in protein content with a delay in sowing from 5<sup>th</sup> November to 15<sup>th</sup> November, 25<sup>th</sup> November and 5<sup>th</sup> December was found to be 15.8, 26.7 and 30.7 per cent, respectively. The highest protein yield (695.3 kg/ha) was obtained on the 25<sup>th</sup> November sowing which was at par with the 15<sup>th</sup> November sowing (676.8 kg/ha) but significantly higher than the 5<sup>th</sup> November (619.0 kg/ha) and 5<sup>th</sup> December (639.8 kg/ha) sowings. High temperatures in the post anthesis period of late sown wheat shortened the grain filling period, resulting in a smaller endosperm, lower grain weight and increased protein content (10, 11). Wheat varieties failed to produce significant variation in case of protein content. However, the wheat variety HD 2967 registered maximum protein content while minimum was recorded in HD 3086. Wheat variety WH 1105 recorded highest protein yield (679.8 kg/ha), which was at par with HD 2967 and HD 3086 but significantly higher than DBW 88. The cumulative effect of protein content and grain yield might have resulted in the highest and lowest protein yield in WH 1105 and DBW 88, respectively.

**Grain and straw yield :** The wheat crop sown on 5<sup>th</sup> November recorded the highest grain yield (6178 kg/ha) which was significantly higher than the subsequent later sowings and it was found that each delay in sowing by 10 days from 5<sup>th</sup> November to 5<sup>th</sup> December resulted in 5.4, 12.7 and 21.5 per cent reduction in grain yield (Table-1). Among the varieties, the highest grain yield was recorded in HD 3086 (5822 kg/ha) which was significantly higher than HD 2967 (5402 kg/ha) and DBW 88 (5336) but at par

with WH 1105 (5707 kg/ha). This might be due to prevailing favorable temperatures required for the wheat crop to have higher photosynthate accumulation, consequently resulting in higher yield parameters in the 5<sup>th</sup> November sowing (12, 13). The maximum straw yield was recorded in the 5<sup>th</sup> November sowing (8588 kg/ha) whereas, the minimum straw yield was recorded in the 5<sup>th</sup> December sowing (7890 kg/ha). The wheat variety HD 2967 produced 1.1, 3.5 and 6.1 per cent higher straw yield as compared to DBW 88, HD 3086 and WH 1105, respectively. Several workers have also noticed the variation in the varieties of wheat for yields (14).

**Economics :** Gross returns, net returns and B:C decreased with the delay in sowing from 5<sup>th</sup> November to 5<sup>th</sup> December (Table-2). The increase in gross and net returns was ₹ 24,703/ha and ₹ 23,520/ha, respectively, for the 5<sup>th</sup> November sowing as compared to 5<sup>th</sup> December. Also, highest B:C was obtained in 5<sup>th</sup> November sowing which was 5.0, 10.5 and 20.8 per cent higher than the 15<sup>th</sup> November, 25<sup>th</sup> November and 5<sup>th</sup> December sowings, respectively. This was due to the higher grain and straw yields in the 5<sup>th</sup> November sowing, as the cost of cultivation in the first two sowings was the same. Also, the cost of cultivation for the last two sowings was the same. These results are in line with the findings of several authors (15, 16). The highest gross return, net return and B:C were recorded in the wheat variety HD 3086 (₹ 1,31,521/ha, ₹ 37,320/ha and 1.40, respectively), while the lowest was recorded in the DBW 88 (₹ 1,24,453/ha, ₹ 30,252/ha, and 1.32, respectively). There was an increase of 2.1, 4.4 and 5.7 per cent in gross return; 8.0, 17.5 and 23.4 per cent in net return and 2.2, 4.5 and 6.1 per cent in B:C in HD 3086 as compared to WH 1105, HD 2967 and DBW 88, respectively. Since the cost of cultivation in the case of the four varieties was equal, the sole deciding factor for net return was gross return that, indeed, was dependent on grain and straw yield. Thus, the variety with highest grain yield recorded highest net return and B:C. Differences in the economics of different wheat varieties were also reported by many researchers (17).

## Conclusion

Quality parameters like sedimentation value and hectolitre weight decreased with the delayed sowing of wheat after 5<sup>th</sup> November, while protein content markedly increased with delay in sowing time. Among varieties, the highest sedimentation value and protein yield was recorded in WH 1105 while the highest hectolitre weight was obtained in wheat variety HD 3086. The sowing of the wheat crop on 5<sup>th</sup> November was found to be suitable in terms of yields as well as economic returns. Among wheat varieties, HD 3086 produced the highest grain yield and economic returns, closely followed by the wheat variety WH 1105.

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## Effect of Zinc Application Techniques for Nutrient Uptake, Yield and Quality of Wheat Grown on Inceptisols

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### Abstract

The present investigation was undertaken to study the effect of zinc application techniques for yield and quality of wheat grown on Inceptisol. The field experiment was conducted at Research Farm, Agricultural Research Station, Niphad, Dist. Nashik, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra. The soil application of  $\text{ZnSO}_4$  @ 20 kg ha<sup>-1</sup> + sprays of Zn EDTA (0.2 %) at tillering and milking stage with Recommended Dose of Fertilizers (RDF) produced significantly higher grain (48.69 q ha<sup>-1</sup>) (18.43 % higher over RDF) and straw yield (64.73 q ha<sup>-1</sup>). This also resulted into significantly higher total nitrogen uptake (148.46 kg ha<sup>-1</sup>) and potassium uptake (100.86 kg ha<sup>-1</sup>) of wheat while application of recommended dose of fertilizers (120:60:40 N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O kg +10 t FYM ha<sup>-1</sup>) resulted into higher phosphorus uptake (27.24 kg ha<sup>-1</sup>). Sprays of Zn EDTA (0.2 %) at tillering and milking stage along with RDF significantly increased the Fe uptake (425.96 g ha<sup>-1</sup>). Mn uptake (310.82 g ha<sup>-1</sup>) was significantly higher due to soil application of  $\text{ZnSO}_4$  @ 20 kg ha<sup>-1</sup> + sprays of Zn EDTA (0.2 %) at milking and dough stage along with RDF. The soil application of  $\text{ZnSO}_4$  @ 20 kg ha<sup>-1</sup> + sprays of Zn EDTA (0.2 %) at tillering and milking stage along with RDF resulted into significantly higher Cu (42.39 g ha<sup>-1</sup>) and Zn (239.73 g ha<sup>-1</sup>) uptake.

**Key words :** Zinc, foliar spray, inceptisol, wheat.

Micronutrient deficiency is widespread in many Asian countries due to the calcareous nature of soils, high pH, low organic matter, salt stress, continuous draught, high bicarbonate content in irrigation water and imbalance application of NPK fertilizers (Mortvedt, *et al.* 1991). Agricultural soils usually show iron, copper and zinc deficiency. The average zinc content of the earth's crust is 70 mg kg<sup>-1</sup>. Only a small part of it (about 1%) is in the form which is absorbable by plants. Zinc deficiency is widespread in wheat grown on alkaline calcareous soils; therefore, a large population of the world as a result of this also lacks adequate Zn nutrition as Zn is major staple food over the globe (Maqsood, *et al.* 2009). Zn deficiency was first reported in the rice areas in Pakistan (Kausar, *et al.* 1976). Despite of being graded as less sensitive (Clark, 1990), wheat is severely affected by Zn deficiency.

In India, zinc is now considered the fourth most important yield limiting nutrient after, N, P and K, respectively. Analysis of 256,000 soils and 25,000 plant samples from all over India showed that 48.5 per cent of the soils and 44 per cent of the plant samples were potentially zinc deficient and this was the most common micronutrient problem affecting crop yields in India. Deficiency of zinc has increased in southern states due to extensive use of NPK without micronutrient. Periodic assessment of soil test data also suggests that zinc deficiency in soils of India is likely to increase from 49 to 63 per cent by the year 2025 as most of the marginal soils brought under cultivation are showing zinc deficiency. Zinc supplementation is therefore, essential for

maintaining high zinc content in soil, seed and blood plasma of human and animals (Singh, 2009).

It has been estimated that about 50 per cent of cereal cultivated soils of India are considered deficient in Zn in terms of supporting high crop yields and providing grains of high nutritional quality. As a result, Zn deficiency in humans is prevalent in regions with Zn-deficient soils, particularly in the developing world. Plants emerged from seeds with low concentrations of Zn could be highly sensitive to biotic and abiotic stresses (Obata *et al.* 1999).

### Materials and Methods

The field experiment was conducted to study influence of zinc through soil and foliar application on growth, yield and quality parameters of wheat (cv. *Phule Samadhan*) during *rabi* 2018-19 at Mahatma Phule Krishi Vidyapeeth, Agricultural Research Station, Niphad, Dist. Nashik, Maharashtra. The experimental site was selected on the basis of deficiency of zinc and suitability of land for the cultivation of wheat. The experimental soils was medium deep black, belongs to an Inceptisol order and taxonomically classified as fine montmorillonitic isohyperthermic calcareous family of *Vertic Haplustept*. Textural class was clay loam and slightly alkaline in reaction (pH 7.69), low in soluble salts (EC-0.25 dSm<sup>-1</sup>), medium in carbon content (0.62%) and CaCO<sub>3</sub> content (8.22 %). Low in soil available nitrogen (184 kg ha<sup>-1</sup>), medium in available phosphorous (19.22 kg ha<sup>-1</sup>) and very high in available potassium (322 kg ha<sup>-1</sup>). The DTPA extractable micronutrient Zn was deficient (0.51 mg kg<sup>-1</sup>)

**Table-1 : Effect of seed fortification, soil application and foliar spray of zinc on yield and major nutrient uptake of wheat grown on Inceptisol.**

| Tr. No.        | Treatment                                                                                                                                         | Yield (q ha <sup>-1</sup> ) |       |
|----------------|---------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------------|-------|
|                |                                                                                                                                                   | Grain                       | Straw |
| T <sub>1</sub> | Absolute control                                                                                                                                  | 26.87                       | 27.23 |
| T <sub>2</sub> | Recommended dose of fertilizers (120:60:40 N:P <sub>2</sub> O <sub>5</sub> :K <sub>2</sub> O kg +10 t FYM ha <sup>-1</sup> )                      | 41.11                       | 52.70 |
| T <sub>3</sub> | Seed fortification with Zn EDTA                                                                                                                   | 41.74                       | 53.51 |
| T <sub>4</sub> | Soil application of ZnSO <sub>4</sub> @ 20 kg ha <sup>-1</sup>                                                                                    | 47.18                       | 63.19 |
| T <sub>5</sub> | Sprays of Zn EDTA (0.2%) at tillering (40-45 DAS) and milking stage (60-65 DAS)                                                                   | 45.67                       | 59.72 |
| T <sub>6</sub> | Sprays of Zn EDTA (0.2%) at milking stage (60-65 DAS) and dough stage (80-85 DAS)                                                                 | 44.96                       | 60.93 |
| T <sub>7</sub> | Soil application of ZnSO <sub>4</sub> @20 kg ha <sup>-1</sup> +Sprays of Zn EDTA (0.2%) at tillering (40-45 DAS) and milking stage (60-65 DAS)    | 48.69                       | 64.73 |
| T <sub>8</sub> | Soil application of ZnSO <sub>4</sub> @20 kg ha <sup>-1</sup> + Sprays of Zn EDTA (0.2%) at milking stage (60-65 DAS) and dough stage (80-85 DAS) | 48.35                       | 62.83 |
| T <sub>9</sub> | Application of cow dung slurry with ZnSO <sub>4</sub> @4%                                                                                         | 46.62                       | 59.73 |
|                | SE (+)                                                                                                                                            | 2.48                        | 2.60  |
|                | CD at 5%                                                                                                                                          | 7.44                        | 7.81  |

**Table-2 : Effect of seed fortification, soil application and foliar spray of zinc on yield contributing characters of wheat grown on Inceptisol.**

| Tr. No.        | Test weight (g) | Number of grains/earhead | Number of earheads/m <sup>2</sup> | Tillers/m <sup>2</sup> |
|----------------|-----------------|--------------------------|-----------------------------------|------------------------|
| T <sub>1</sub> | 30.07           | 22.14                    | 193                               | 202                    |
| T <sub>2</sub> | 35.07           | 30.90                    | 259                               | 216                    |
| T <sub>3</sub> | 36.80           | 31.23                    | 267                               | 242                    |
| T <sub>4</sub> | 40.11           | 38.50                    | 296                               | 250                    |
| T <sub>5</sub> | 38.07           | 33.07                    | 287                               | 259                    |
| T <sub>6</sub> | 37.67           | 33.50                    | 283                               | 255                    |
| T <sub>7</sub> | 40.17           | 40.14                    | 309                               | 263                    |
| T <sub>8</sub> | 39.87           | 39.87                    | 300                               | 260                    |
| T <sub>9</sub> | 38.68           | 37.85                    | 292                               | 257                    |
| SE (+)         | 1.49            | 2.30                     | 8.73                              | 5.03                   |
| CD at 5%       | 4.47            | 6.91                     | 26.18                             | 15.07                  |

and Fe, Mn and Cu were sufficient (4.51, 13.46 and 0.71 mg kg<sup>-1</sup>, respectively). The experiment was laid out in a randomized block design with nine treatments replicated three times.

The treatment comprised of absolute control, recommended dose of fertilizer (120:60:40 N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O kg + 10 t FYM ha<sup>-1</sup>), seed fortification with Zn EDTA, soil application of ZnSO<sub>4</sub> @ 20 kg ha<sup>-1</sup>, sprays of Zn EDTA (0.2%) at tillering (40-45 DAS) and milking stage (60-65 DAS), sprays of Zn EDTA (0.2%) at milking (60-65 DAS) and dough stage (80-85 DAS), soil application of ZnSO<sub>4</sub> @ 20 kg ha<sup>-1</sup> + sprays of Zn EDTA (0.2%) at tillering (40-45 DAS) and milking stage (60-65 DAS), soil application of ZnSO<sub>4</sub> @ 20 kg ha<sup>-1</sup> + sprays of Zn EDTA (0.2%) at milking (60-65 DAS) and dough stage (80-85 DAS), spraying of cowdung slurry with ZnSO<sub>4</sub> @ 4% (30 DAS). The recommended dose of fertilizers was common to all treatments except absolute control.

## Results and Discussion

**Grain Yield :** The wheat grain yield (48.69 q ha<sup>-1</sup>) was significantly influenced due to soil application of ZnSO<sub>4</sub> @

20 kg ha<sup>-1</sup> + sprays of Zn EDTA (0.2 %) at tillering (40-45 DAS) and milking stage (60-65 DAS) along with RDF compared to other treatments. It was at par with the treatment soil application of ZnSO<sub>4</sub> @ 20 kg ha<sup>-1</sup>+ sprays of Zn EDTA (0.2 %) at milking stage (60-65 DAS) and dough stage (80-85 DAS) (48.35 q ha<sup>-1</sup>), soil application of ZnSO<sub>4</sub> @ 20 kg ha<sup>-1</sup> (47.18 q ha<sup>-1</sup>), application of cow dung slurry with ZnSO<sub>4</sub> @ 4 % (46.62 q ha<sup>-1</sup>), sprays of Zn EDTA (0.2 %) at tillering (40-45 DAS) and milking stage (60-65 DAS) (45.67 q ha<sup>-1</sup>), seed fortification with Zn EDTA (41.74 q ha<sup>-1</sup>). Soil application of ZnSO<sub>4</sub> @ 20 kg ha<sup>-1</sup> + sprays of Zn EDTA (0.2 %) at tillering (40-45 DAS) and milking stage (60-65 DAS) along with RDF increased the wheat grain yield by 18.43 per cent as compared to only application of recommended dose of wheat crop. The results in close confirmation to these were also reported by Pallavi and Sudha (2017), Argal, *et al.* (2017), Jat, *et al.* (2018), Kumar, *et al.* (2018), Javed, *et al.* (2020) and Ramzan, *et al.* (2020).

**Straw Yield :** The straw yield (64.73 q ha<sup>-1</sup>) of wheat was increased significantly due to soil application of ZnSO<sub>4</sub> @ 20 kg ha<sup>-1</sup> + sprays of Zn EDTA (0.2 %) at tillering (40-45

**Table-3 : Effect of seed fortification, soil application and foliar spray of zinc on major nutrient uptake of wheat grown on Inceptisol.**

| Tr. No.        | Nutrient uptake (kg ha <sup>-1</sup> ) |       |        | Micronutrient uptake (g ha <sup>-1</sup> ) |        |       |        | Protein (%) |
|----------------|----------------------------------------|-------|--------|--------------------------------------------|--------|-------|--------|-------------|
|                | N                                      | P     | K      | Fe                                         | Mn     | Cu    | Zn     |             |
| T <sub>1</sub> | 39.67                                  | 13.05 | 37.68  | 116.09                                     | 103.85 | 12.74 | 53.01  | 7.11        |
| T <sub>2</sub> | 97.11                                  | 27.24 | 74.86  | 366.88                                     | 238.74 | 25.42 | 156.33 | 10.41       |
| T <sub>3</sub> | 112.25                                 | 26.62 | 82.15  | 377.97                                     | 211.57 | 26.80 | 160.02 | 11.76       |
| T <sub>4</sub> | 128.46                                 | 19.68 | 93.54  | 406.47                                     | 255.60 | 30.40 | 198.04 | 12.50       |
| T <sub>5</sub> | 136.11                                 | 20.95 | 92.29  | 425.96                                     | 306.77 | 37.61 | 194.60 | 13.25       |
| T <sub>6</sub> | 137.92                                 | 19.72 | 95.91  | 386.34                                     | 300.80 | 33.65 | 205.21 | 13.38       |
| T <sub>7</sub> | 148.46                                 | 19.57 | 100.86 | 396.30                                     | 299.78 | 42.39 | 239.73 | 13.42       |
| T <sub>8</sub> | 143.96                                 | 20.05 | 97.90  | 393.28                                     | 310.82 | 35.39 | 232.92 | 13.23       |
| T <sub>9</sub> | 130.30                                 | 21.94 | 89.14  | 325.12                                     | 243.78 | 27.54 | 194.82 | 11.87       |
| SE(+)          | 7.51                                   | 1.63  | 5.28   | 23.38                                      | 15.58  | 1.95  | 15.87  | 0.40        |
| CD at 5%       | 22.51                                  | 4.89  | 15.84  | 70.12                                      | 46.73  | 5.87  | 47.58  | 1.20        |

DAS) and milking stage (60-65 DAS) along with RDF. This was at par with rest of the treatments except absolute control and application of recommended dose of fertilizers. Application of zinc not only relived the chlorosis and produced healthy green plants but also increased the synthesis of chlorophyll, growth promoting substances and mobility of minerals, water, photosynthesis and amino acids from source to sink which may have resulted into increase in the wheat grain and straw yields. These results are in conformity with findings of Argal, *et al.* (2017), Jat, *et al.* (2018), Kumar, *et al.* (2018), Javed, *et al.* (2020) and Ramzan, *et al.* (2020).

**Test weight :** The data pertaining to test weight of wheat revealed that soil application of ZnSO<sub>4</sub> @ 20 kg ha<sup>-1</sup> + sprays of Zn EDTA (0.2 %) at tillering (40-45 DAS) and milking stage (60-65 DAS) along with RDF significantly increased the test weight of wheat (40.17 g) over T<sub>1</sub> and T<sub>2</sub>. This might be due to the fact that zinc favor the storage of more carbohydrates through photosynthesis and plays role in chlorophyll synthesis. This might have contributed towards improving the test weight of wheat. The results of these findings are in confirmatory by Bhutto *et al.* (2016), Pallavi and Sudha (2017).

**Number of grains/ earhead :** The data on number of grains per earhead as affected by different treatments of zinc application revealed that the soil application of ZnSO<sub>4</sub> @ 20 kg ha<sup>-1</sup> + sprays of Zn EDTA (0.2 %) at tillering (40-45 DAS) and milking stage (60-65 DAS) significantly improved grains per earhead (40.14) over other treatments.

**Earheads per Square Meter :** The earheads per square meter were significantly higher (309) with the soil application of ZnSO<sub>4</sub> @ 20 kg ha<sup>-1</sup> + sprays of Zn EDTA (0.2 %) at tillering (40-45 DAS) and milking stage (60-65 DAS) with RDF. The results are in conformity with the findings of Dewal and Pareek (2004), Bhutto, *et al.* (2016) and Pallavi and Sudha (2017).

**Tillers per Square Meter :** Tillering is an important developmental stage that allows the plants to compensate under low plant populations or taking advantage of good growing conditions. Number of tillers per square meter were significantly affected by the zinc application. Maximum number of tillers per square meter (263) was observed with the soil application of ZnSO<sub>4</sub> @ 20 kg ha<sup>-1</sup> + sprays of Zn EDTA (0.2 %) at tillering (40-45 DAS) and milking stage (60-65 DAS). While, minimum number of tillers per square meter (202) were observed in control plots. Similar results were reported by Abdallah and Mohamad (2013), and Kandoliya *et al.* (2018).

#### Nutrient Uptake

**Nitrogen :** The nitrogen uptake of wheat was significantly influenced due to various zinc application techniques. Soil application of ZnSO<sub>4</sub> @ 20 kg ha<sup>-1</sup> + sprays of Zn EDTA (0.2 %) at tillering (40-45 DAS) and milking stage (60-65 DAS) significantly improved nitrogen uptake (148.46 kg ha<sup>-1</sup>) of wheat crop. Since zinc is an essential component of certain enzymes of nitrogen assimilation hence application of various levels of zinc might have increased the activity of the enzymes leading to more assimilation of nitrogen by the wheat plant resulting in increased content and uptake of nitrogen. Similar results were also reported by Argal, *et al.* (2017), Jat *et al.* (2018), Javed, *et al.* (2020) and Ramzan, *et al.* (2020).

**Phosphorus :** The results of the phosphorus uptake revealed that the application of recommended dose of fertilizers (120:60:40 N:P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O kg +10t FYM ha<sup>-1</sup>) significantly improved the P uptake (27.24 kg ha<sup>-1</sup>) as compared to rest of the treatments. It was at par with the treatment of seed fortification with Zn EDTA. The phosphorus uptake was decreased significantly with increasing application of zinc which may be due to the antagonistic effect of zinc and phosphorus. Dogra *et al.* (2014) also reported the decreased P uptake significantly

with increasing level of zinc in the soil probably due to their antagonistic effect on phosphorus. Results in close confirmatory to these findings are reported by Dewal and Pareek (2004), and Zhang *et al.* (2012).

**Potassium :** The data on potassium uptake as affected by zinc application techniques are presented in Table-3. The results revealed that, the treatment soil application of  $\text{ZnSO}_4$  @ 20 kg ha<sup>-1</sup> + sprays of Zn EDTA (0.2 %) at tillering (40-45 DAS) and milking stage (60-65 DAS) significantly influenced the potassium uptake (100.86 kg ha<sup>-1</sup>). Dogra *et al.* (2014) reported increase in potassium content of grain to the extent of 3.68 and 2.70%, while that of straw to the extent of 2.43 and 1.65%, respectively, as compared to Zn<sub>0</sub> (control). Similar results to these findings were also reported by Choudhary *et al.* (1997), Dewal and Pareek (2004), Javed, *et al.* (2020) and Ramzan, *et al.* (2020).

**Iron :** The iron uptake by wheat was significantly influenced due to zinc application in wheat. The sprays of Zn EDTA (0.2 %) at tillering (40-45 DAS) and milking stage (60-65 DAS) significantly improved the iron uptake (425.96 g ha<sup>-1</sup>). It was at par with rest of the treatments except the absolute control treatment. Cakmak *et al.* (2010) reported that the knowledge base concerning the genetic control and molecular and physiological mechanisms affecting the accumulation of Zn and Fe in grain and plant of durum wheat is incomplete. Both biosynthesis and root release of phytosiderophores are stimulated by Zn and Fe deficiency in wheat plants (Cakmak *et al.* 1994; Suzuki *et al.* 2006).

**Manganese :** It was observed that the soil application of  $\text{ZnSO}_4$  @ 20 kg ha<sup>-1</sup> + sprays of Zn EDTA (0.2 %) at milking stage (60-65 DAS) and dough stage (80-85 DAS) significantly improved the manganese uptake (310.82 g ha<sup>-1</sup>) in wheat crop. It was at par with the treatment of sprays of Zn EDTA (0.2 %) at tillering (40-45 DAS) and milking stage (60-65 DAS), soil application of  $\text{ZnSO}_4$  @ 20 kg ha<sup>-1</sup> + sprays of Zn EDTA (0.2 %) at tillering (40-45 DAS) and milking stage (60-65 DAS) and sprays of Zn EDTA (0.2 %) at milking stage (60-65 DAS) and dough stage (80-85 DAS). Similar results were also reported by Choudhary *et al.* (1997), Stepien and Wojtkowiak (2016).

**Copper :** The data on copper uptake of the wheat crop as influenced by zinc application techniques revealed that the soil application of  $\text{ZnSO}_4$  @ 20 kg ha<sup>-1</sup> + sprays of Zn EDTA (0.2 %) at tillering (40-45 DAS) and milking stage (60-65 DAS) improved the copper uptake (42.39 g ha<sup>-1</sup>) of the wheat. Kumar *et al.* (2015) reported that wheat is inherently very low in the bioavailability of Cu. The availability range of Cu in the wheat varieties in India varies from 2 to 5 mg kg<sup>-1</sup>.

**Zinc :** The zinc uptake of the wheat due to seed fortification, soil application and foliar spray of zinc are presented in Table-2. The results of zinc uptake revealed that soil application of  $\text{ZnSO}_4$  @ 20 kg ha<sup>-1</sup> + sprays of Zn EDTA (0.2 %) at tillering (40-45 DAS) and milking stage (60-65 DAS) significantly improved the zinc uptake (239.73 g ha<sup>-1</sup>). This was at par with the soil application of  $\text{ZnSO}_4$  @ 20 kg ha<sup>-1</sup> + sprays of Zn EDTA (0.2 %) at milking stage (60-65 DAS) and dough stage (80-85 DAS), sprays of Zn EDTA (0.2 %) at milking stage (60-65 DAS) and dough stage (80-85 DAS), soil application of  $\text{ZnSO}_4$  @ 20 kg ha<sup>-1</sup> and application of cow dung slurry with  $\text{ZnSO}_4$  @ 4 %. The application of zinc either through foliar or soil might have resulted into improvement of the zinc uptake of wheat. The findings in close to this are also reported by Kumar *et al.* (2018), Dapkekar *et al.* (2018), Liu *et al.* (2019), Javed, *et al.* (2020) and Ramzan, *et al.* (2020).

**Protein :** The wheat protein content was significantly influenced by the various zinc application techniques. Soil application of  $\text{ZnSO}_4$  @ 20 kg ha<sup>-1</sup> + sprays of Zn EDTA (0.2 %) at tillering (40-45 DAS) and milking stage (60-65 DAS) with RDF resulted into significantly higher protein content (13.42 %). This treatment was at par with sprays of Zn EDTA (0.2 %) at milking stage (60-65 DAS) and dough stage (80-85 DAS), sprays of Zn EDTA (0.2 %) at tillering (40-45 DAS) and milking stage (60-65 DAS), soil application of  $\text{ZnSO}_4$  @ 20 kg ha<sup>-1</sup> + sprays of Zn EDTA (0.2 %) at milking stage (60-65 DAS) and dough stage (80-85 DAS) and soil application of  $\text{ZnSO}_4$  @ 20 kg ha<sup>-1</sup>. Zhang *et al.* (2012) reported that foliar Zn application has a slight effect on protein concentration and gluten characteristics of wheat. These results are in accordance with Goswami (2007).

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## **Economic Assessment of Wastewater Filtration Technology and Ecological Health Risk in Peri-Urban Wastewater-Irrigated Soils of Kamptee Block, Nagpur District**

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### **Abstract**

The present study undertaken at Peri-urban area of Kamptee block in Nagpur district, where farmers were doing agriculture through wastewater irrigation. The major objective of study, to assess the economics before and after intervention of water filtration technology through suitable land use management practices has been worked out in study area. Ecological-health risk and performance of major crops grown in the peri-urban wastewater-irrigated soils of Kamptee Periurban areas has been carried out through collecting secondary data from various published sources on land use land cover, healthcare expenditure, environmental damage, cost of cultivation and price of commodities. The results showed that the environmental damage in study area observed as Rs. 42.14 lakh due to pollutants in Nag River. After intervention of the technology, it was reduced by 20% (33.71 lakh rupees). The technology generated employment of 52 man days per year and cropped area to be increased by 2 percent. The study further revealed that the technology found feasible for agricultural land use planning in terms of productivity and profit to the farmers. Before the technology intervention average productivity of all the crops were observed as 13.12 q/ha, gross return arrived at Rs. 44.46 thousand per quintal with BC ratio 1.04. After the intervention, as shown in figure 1, average productivity of all the crops were 14.89 q/ha, gross return arrived at Rs. 52.64 thousand per quintal with BC ratio 1.20. The overall impact of technology showed that average productivity, gross return and BC ratio increased by 13.52%, 18.40% and 16.09% respectively (Fig.2). This study found that the technology to treat the wastewater was significantly influenced on the health, environment, agricultural productivity and profitability of the farmers in study area through suitable land use management practices.

**Key words :** *Ecological, environmental, filtration, peri-urban, wastewater.*

### **Introduction**

Agriculture is an important economic sector for maintaining the social equilibrium in any country. Relative to the total economy of India, share of agriculture and allied sector in terms of gross domestic product (GDP) was 15.4 percent in 2017. Gross value added (GVA) at current price was (20.19%) in 2020-21 (Statisticstimes.com, 2021). On the other hand, about 41.49 percent of the workforces were employed in the sector in 2020 (Statista.com, 2021). Even the agricultural situation has significantly improved in country, many challenges also facing by the sector such as less use of modern technologies, insufficient water for irrigation, scarcity of other resources, traditional way of farming etc. Water is the major input in food production system including animal husbandry and fisheries. India's water demand increasing over the years due to the population growth, industrial development and agricultural use. Particularly in semi-arid regions, irrigation is an important component for agricultural production (World Bank, 2003). To fulfil the need of population of over 1.3 billion people, India has only 4% of the world's fresh water resources. Water scarcity in India affects the huge rural and urban population also extensively affects the ecosystem and

agriculture (Dhawan, 2017). Insufficient water availability alarming to the people's health risk, lives of wild animals and drop out from agricultural activities across India. (Somya, 2016, The Hindu, 2020 and The New India Express, 2020). For agriculture purpose in India, irrigation system used mainly from rivers, lakes, rain water harvesting, canal networks, ground water, wells etc. (Dhawan, 2017). In India, major portion of agricultural land (39 million ha) irrigated by ground water followed by canals (22 million ha) and about two third of cultivation is depends on monsoon (Dhawan, 2017).

As discussed above and many studies revealed that the water is an essential scarce resource, wastage and pollution of water is also a major constraint in all over the world. Normally, wastewater is formed by household and industrial activities of daily usage, production and consumption activities (Hussain *et al*, 2002). Wastewater gets contaminated through the toxic chemicals, industrial waste materials, sewage and other waste products. Direct use of such water may impact on environmental degradation and health hazards also harm to fish, wildlife and depletion of oxygen. Available Metals in contaminated water such as arsenic, mercury cadmium, lead and chromium can have chronic lethal effects on animals, species and human being. Many studies in

concern subject showed that improvement of water quality is favoured over cost minimization (Schwarz and McConnell 1993). Wastewater treatment technology removes the suspended solids from wastewater and this water can be used in industrial activities, irrigation, landscaping and other ecosystem services (Hussain *et al*, 2002). It may help to increase agricultural productivity, improve public health, reduce water scarcity, water table balancing and leads to a healthy agro-ecosystem.

Land is crucial input in food production system because it provides environment and quality of land leads to agricultural productivity. For benefit of present and future generations with the objectives of providing environmental, economic and social convenience, feasible land management is most essential with maintaining and strengthening the quality of land including soil, water and air resource (Smyth and Dumanski, 1993). Deshpande in there analytical report indicated that 86% of land holdings are less than 2 hectares and about two-third of total cropped area occupied by food grains in India. As per The Ministry of Agriculture, Govt. of India, at the rate of 16.4 tonne/hectare, about 5.3 billion tonnes of soil erosion experiencing every year in India and deteriorating the quality of soils. Over the period of time, imbalanced fertilizers used in country for enhancement of agricultural productivity, it's led to such issues like declined the water table and water quality and it lead to overall degradation of soil health. Therefore in view of this, present study has been carried out.

## Materials and Methods

**Study area and data :** To fulfil the most imperative objective of assessing the economics of water filtration technology and economical health risk before and after intervention of technology through suitable land use management practices, Kamptee block of Nagpur district in Maharashtra state of India has been selected where the farmers in peri-urban areas doing agriculture by using wastewater for irrigation. The tehsil surrounded by Nag and Pilli rivers and as per Maharashtra Pollution Control Board (MPCB), these rivers are contaminated due to inhabitants and industrial pollution. Secondary data on land use land cover, healthcare expenditure, environmental damage, cost of cultivation and price of commodities etc. has been collected from various published sources such as Statistical abstracts, Agricultural statistics reports, Bulletin of agricultural prices, Economic survey of India and Directorate of Economics and Statistics, Maharashtra for the year 2016-17.

**Analytical framework :** Simple economic tools, derivatives and percentage calculations has been used for

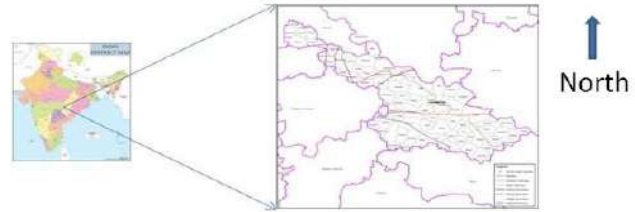


**Fig.-1 :** Location map of Kamptee tehsil of Nagpur district in Maharashtra state of India.

comparing the total cost and benefit of technology before and after intervention of suitable land use practices, annual healthcare expenditure of people, environmental damage in study area and productivity of different crops along with the benefit cost ratio as follows :

**Benefit Cost Ratio :** BCR was calculated as gross returns accrued divided by total cost resulted the productivity and profitability gained due to technology intervention, which was actually incurred in the study area. This may be expressed as follows :

$$BCR = GR/TC$$

Where,

BCR = Benefit Cost Ratio

GR = Gross Returns

TC = (a) Total cost of technology intervention and  
(b) Total cost of cultivation

## Result and Discussions

**Socio economic and demographic profile of study area :** Kamptee tehsil lies at coordinates of 21.2333° north, 79.2° east with elevation of 269 m (883 ft) is surrounded by Parseoni at North, Kuhu at south, Nagpur rural at west and Mouda tehsil at east of Nagpur district, Maharashtra state, India. As per Census 2011, Total population of Kamptee teshil is 238870. Sex ratio is 930 per 1000 male and Literacy rate is 87.57%. Out of total population, 97069 male females were working populations, of which 85289 are main and 11780 are marginal workers. In tehsil, 9427 persons are main cultivators and 17347 are agricultural labourers. The area exhibits gently undulating terrain and gently slopes towards south and southeast. As per GSDA, geological formation percentage of area observed as Alluvial (5%), Gondwana (10%) and Archeans (35%). The average rainfall is about 1059.5 mm. In study area, the main drainage is controlled by southerly flowing Kanhan river which lies about 2 km. The tehsil surrounded by Nag and Pilli rivers originated to Ambazari lake and Gorewada tank respectively. The study of water quality in the rivers conducted by Maharashtra Pollution Control Board

revealed that rivers are gradually contaminated and inhabitants and industries are major contributors of pollution in water bodies (Nag river basin action plan, MPCB, 2011).

**Land use land cover pattern in Kamptee block in year 2019 :** Biophysical parameters, irrigation facilities, socioeconomic conditions and market structures are most important factor for making land use pattern dynamic and profitable in any area. The land use pattern in study area revealed that (figure2) agriculture is the major activity in Kamptee tehsil with about 86 thousand ha (64%) of land engaged in agriculture followed by scrubs (14.65%), wasteland (5.86%), settlements (5.59%), forest coverage (3.63%), total plantation (2.90%), water-bodies (2.83%) and mining area is about 07 hundred hectare (052%) area covered respectively.

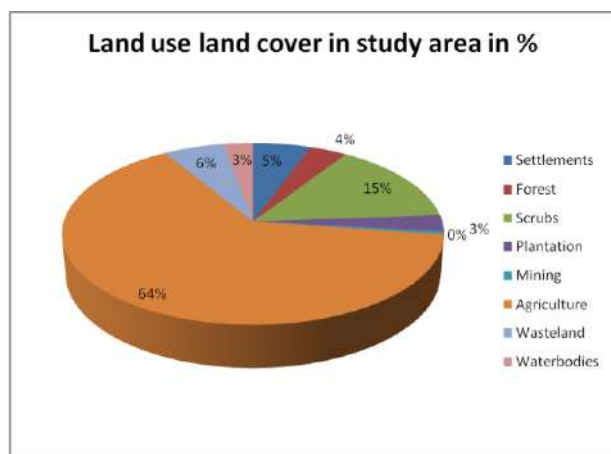


Fig.-2 : Land use land cover pattern in Kamptee block in year 2019.

**Suggested land management practices based on Land Resources Inventory (LRI) and Best Management Practices (BMP) :** Table-1 showed the suggested land management practices based on Land Resources Inventory (LRI) and Best Management Practices (BMP). It revealed that the soil depth plays an important role for any crops selected for sustainable improvement in productivity. Area based crops and cropping sequences with the area specific land resource inventory (LRI) and best management practices (BMP) helps in soil and water conservation in the rain-fed or irrigated farming system. The best soil and water management practices with integrated approach in the study area together with nutrient management practices in site specific mode ensures the productivity and profit of the farmers with the suitable package of practices and use of modern production technologies with Participatory rural appraisal (PRA). It is also expected that the high organic carbon foot print in soils may reduce the load of inorganic particulates in the environment. Thus the state sponsored

or state owned soil and water conservation plans ensures successful execution of watershed plans, which restrict soil erosion and improve the productivity of agriculture in the study area. Climatic conditions, varietal selection and length of growing period etc. also significant factors in sustainable land management practices to be adopted in the study area.

#### **Economics of wastewater filtration unit in study area :**

The results showed that before intervention of wastewater filtration unit, total area under kharif+Rabi crops was 33.82 thousand hectare and it was increased by 2 percent after the technology intervention. Further revealed that the environmental damage in study area due to pollutants in Nag river observed as Rs. 42.14 lakh. After intervention of the technology, it was reduced by 20% (33.71 lakh rupees). The technology generated employment of 52 man days per year and cropped area to be increased by 2 percent. The annual healthcare expenditure of people was Rs. 6180.5 in study area before installation of wastewater filtration unit. With the total cost of technology intervention (Rs 4 lakh), annual healthcare expenditure of people was reduced by 20 percent (Table-2). The technology found feasible for agricultural land use planning in terms of productivity and profit to the farmers.

Before the technology intervention average productivity of all the crops were observed as 13.12 q/ha, gross return arrived at Rs. 44.46 thousand per quintal with BC ratio 1.04. After the intervention, as shown in figure 3, average productivity of all the crops were 14.89 q/ha, gross return arrived at Rs. 52.64 thousand per quintal with BC ratio 1.20. The overall impact of technology showed that average productivity, gross return and BC ratio increased by 13.52%, 18.40% and 16.09% respectively.

#### **Economic evaluation of major crops, before and after technology intervention in study area :**

Economic evaluation of major crops showed that the technology found feasible for agricultural land use planning in terms of productivity and profit to the farmers. Table-3 revealed that, before the technology intervention average productivity of all the crops were observed as 13.12 q/ha, gross return arrived at Rs. 44.46 thousand per quintal with BC ratio 1.04. After the intervention, as shown in figure3, average productivity of all the crops were 14.89 q/ha, gross return arrived at Rs. 52.64 thousand per quintal with BC ratio 1.20. The overall impact of technology showed that average productivity, gross return and BC ratio increased by 13.52%, 18.40% and 16.09% respectively (Fig.-4). This study found that the technology to treat the wastewater were significantly influenced on the health, environment, agricultural productivity and profitability of the farmers in study area through suitable land use management practices.

**Table-1 : Suggested land management practices based on LRI and BMP in study area.**

| Selected criteria for sustainable land management practices |                  | Suggested land use management practices based on LRI+BMP                                                                                                                                                                                                                            |
|-------------------------------------------------------------|------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Soil type (Land management unit)                            | Soil depth in cm |                                                                                                                                                                                                                                                                                     |
| Shallow soils                                               | 10-14 cm         | <ul style="list-style-type: none"> <li>● Integrated farming system (IFS) models with soil and water conservation measures</li> <li>● Vegetables and agri-horti based cropping system</li> <li>● Application of FYM and other organic manuring for improve soil fertility</li> </ul> |
| Moderately shallow soils                                    | 14-35 cm         | <ul style="list-style-type: none"> <li>● Livestock based farming system</li> <li>● Application of FYM and other organic manuring for improve soil fertility</li> </ul>                                                                                                              |
| Moderately deep soils                                       | 35-42 cm         | <ul style="list-style-type: none"> <li>● Integrated farming system (IFS) models with soil and water conservation measures</li> <li>● Application of FYM and other organic manuring for improve soil fertility</li> </ul>                                                            |
| Deep soils                                                  | 42-64 cm         | <ul style="list-style-type: none"> <li>● Trenching and mulching to improve water use efficiency</li> <li>● Application of FYM and other organic manuring for improve soil fertility</li> </ul>                                                                                      |
| Very deep soils                                             | 64-150 cm        | <ul style="list-style-type: none"> <li>● Trenching and mulching to improve water use efficiency</li> <li>● Application of FYM and other organic manuring for improve soil fertility</li> </ul>                                                                                      |

**Table-2 : Economic comparison of wastewater filtration unit in study area.**

| Particulars                                                                  | Before intervention | After intervention            |
|------------------------------------------------------------------------------|---------------------|-------------------------------|
| Total cost of technology intervention (Rs.)                                  | 0                   | 400000                        |
| Total area under kharif+Rabi crops in study area (ha)                        | 33939.82            | 34618.62<br>(Increased by 2%) |
| Annual healthcare expenditure of people (Rs.)                                | 6180.5              | 4944.4<br>(Reduced by 20%)    |
| Environmental damage in study area due to pollutants in Nag river (lakh Rs.) | 42.14               | 33.71<br>(Reduced by 20%)     |
| Employment generation by technology intervention per year (man days)         | 0                   | 52                            |

**Table-3 : Economic evaluation of major crops, before and after technology intervention in study area.**

| Crops before and after intervention |        | Cost of cultivation (Rs./ha) | Productivity (q/ha) | Minimum support price (Rs./q) | Gross profit (Rs./q) | Benefit cost ratio | Percentage change in profitability after intervention |
|-------------------------------------|--------|------------------------------|---------------------|-------------------------------|----------------------|--------------------|-------------------------------------------------------|
| Cotton                              | Before | 52229.27                     | 12.4                | 5150                          | 63860                | 1.22               | 40                                                    |
|                                     | After  |                              | 17.4                |                               | 89610                | 1.72               |                                                       |
| Soybean                             | Before | 32722.9                      | 11.37               | 3399                          | 38646.63             | 1.18               | 5                                                     |
|                                     | After  |                              | 11.94               |                               | 40584.06             | 1.24               |                                                       |
| Pigeon pea                          | Before | 51286.99                     | 11.18               | 5675                          | 63446.5              | 1.24               | 25                                                    |
|                                     | After  |                              | 14.06               |                               | 79790.5              | 1.56               |                                                       |
| Gram                                | Before | 34054.62                     | 7.92                | 4620                          | 36590.4              | 1.07               | 5                                                     |
|                                     | After  |                              | 8.32                |                               | 38438.4              | 1.13               |                                                       |
| Wheat                               | Before | 32127.27                     | 16.84               | 1840                          | 30985.6              | 0.96               | 5                                                     |
|                                     | After  |                              | 17.68               |                               | 32531.2              | 1.01               |                                                       |
| Paddy                               | Before | 61903.02                     | 18.99               | 1750                          | 33232.5              | 0.54               | 5                                                     |
|                                     | After  |                              | 19.94               |                               | 34895                | 0.56               |                                                       |
| Average                             | Before | 44054.01                     | 13.12               | 3739                          | 44460.27             | 1.04               | 14.36                                                 |
|                                     | After  |                              | 14.89               |                               | 52641.53             | 1.20               |                                                       |

## Conclusions

Water and soil are the crucial inputs in food production system including animal husbandry and fisheries. Insufficient water availability alarming to the people's health risk, lives of wild animals and drop out from

agricultural activities across India. Wastewater treatment technology removes the suspended solids from wastewater and this water can be used in industrial activities, irrigation, landscaping and other ecosystem services. It may help to increase agricultural productivity, improve public health, reduce water scarcity, water table

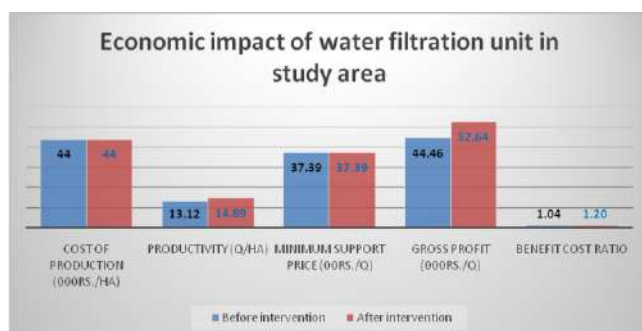


**Fig-3 : Graphical presentation of economic evaluation, before and after technology intervention in study area.**

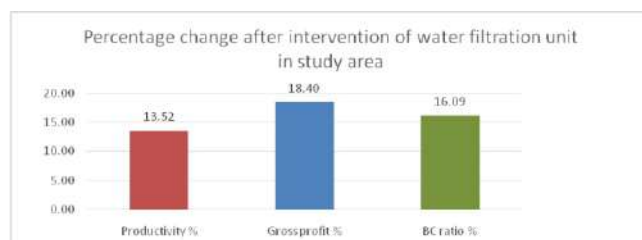


**Fig-4 : Graphical presentation of percentage changes in productivity, gross return and BC ratio after technology intervention in study area.**

balancing and leads to a healthy agro-ecosystem. Area based crops and cropping sequences with the area specific land resource inventory and best management practices helps in soil and water conservation in the rain-fed or irrigated farming system. Therefore present study has been found that the technology to treat the wastewater were significantly influenced on the health, environment, agricultural productivity and profitability of the farmers in study area through suitable land use management practices.

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## Inducing Effect of Pre-Sowing Treatments with Certain Growth Hormones on Seed Germination of Ginger Lily (*Hedychium spicatum*)

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### Abstract

An utmost attempt to augment the germinability of Ginger lily seeds using gradual sensible doses of certain plant growth hormones was made at College of Horticulture, Veer Chandra Singh Garhwali Uttarakhand University of Horticulture and Forestry, Bharsar (30° 05' N latitude and 78° 99' E longitude) during 2020. The experiment entails of two parts viz., laboratory experiment and polyhouse condition experiment comprising of gradual concentrations of GA<sub>3</sub>, IAA and NAA and an untreated check treatment tallying a total of 10 treatments. Various germination parameters were studied critically and results witnessed superiority of the treatment GA<sub>3</sub> @ 750 ppm over rest of the treatments in all the traits under study and analyzed statistically significant observations. The treatment incidentally resulted in minimum time taken for first germination appearance under both laboratory (12.00 days) and polyhouse (26.33 days) condition. The laboratory condition ensured lesser time consumption on germination. Maximum germination was also noticed in GA<sub>3</sub> @ 750 ppm under both laboratory (93.30 %) and polyhouse (47.92 %) condition, indicating preferability of laboratory condition over polyhouse condition for germination. Also, the highest germination energy per cent [22.67 % (lab.) and 16.67 % (polyhouse)], maximum mean daily germination (MDG) [0.77 % seeds /day (lab.) and 0.11 % seeds /day (polyhouse)], fastest speed of germination [1.000 seeds/day (lab.) and polyhouse (0.20 seeds/day)]. germinator maintaining a constant temperature of 25 ± 2° C and 75-80 % relative humidity. Seed germination in lab condition using seed germinator creating consistent favorable conditions by regulating temperature, humidity and light appeared to have resulted in better germination potential of seeds over the seeds germinated in polyhouse condition (naturally ventilated even type). The poorer seed germination in polyhouse condition could possibly be due the fluctuation in the environmental conditions which directly influences imbibition and other important biochemical processes responsible for seed germination. Thus, the seed germination *Hedychium spicatum* could effectively be improved judiciously by simply using seed germinator and growth hormones like GA<sub>3</sub> @ 750 ppm.

**Key words :** Ginger lily, germination, pre-sowing treatment, plant growth regulators (PGRs) GA<sub>3</sub>, IAA, NAA.

### Introduction

*Hedychium spicatum* Ham-ex-Smith (Zingiberaceae) is an Ayurvedic traditional medicinal plant popularly known as Shati in sanskrit and known as Spiked Ginger Lily in English. The rhizome of the plant is carminative, spasmolytic, hepatoprotective, anti-inflammatory, antiemetic, antidiarrhoeal, analgesic, expectorant, antiasthmatic, emmenagogue, hypoglycaemic, hypotensive, antimicrobial, anthelmintic. Due to excessive unscientific harvesting, this herb is listed under vulnerable medicinal plant list by IUCN [9]. Based on empirical data, a number of the plants were used traditionally to treat various diseases. Recently, Zingiberaceae plants are extensively studied for their phytochemical and pharmacological properties including the genus *Hedychium*. A unique bioactive compound has been isolated from these plants and that they were known to possess the pharmacological effect. The *Hedychium* plants are prospective as a natural product medicine. The spread of these plants commonly grown as wild types within the forest makes this family interesting to study and

focuses mainly on their phytochemical and pharmacological aspects [5].

It is believed by many researchers from their studies that most of the higher plants begin their life cycle as a seed, and seed germination is believed to be the first adaptive natural process in their development. In fact, it is typically prevented for a specified period of time, even under apparently optimal environmental conditions, by a trait known as seed dormancy. In agricultural crops, a certain degree of dormancy is a desirable trait because it prevents precocious germination or preharvest sprouting of seeds. However, a high level of seed dormancy is undesirable as this usually results in nonuniform germination and seedling establishment, and incurs extra costs for seed storage until dormancy is lost. Seed dormancy is defined as the inability of intact viable seeds to complete germination under favorable environmental conditions [2]. Several chemicals are proven to increase seed germination of different plant species. In general, only seeds with internal dormancy receive this treatment. Some of the important examples of germination stimulators include gibberellic acid, ethylene, smoke, potassium hydroxide etc. [11]. Further, some plant

**Table-1 : Influence of different growth hormones on some germination attributes of *Hedychium spicatum* under laboratory condition.**

| Treatment       | Number of days taken for germination | Germination per cent | Germination energy per cent | Mean daily germination (per cent seeds/day) | Germination speed (seeds /day) |
|-----------------|--------------------------------------|----------------------|-----------------------------|---------------------------------------------|--------------------------------|
| T <sub>1</sub>  | 17.000 ± 1.000                       | 64.000 ± 2.309       | 9.333 ± 1.333               | 0.345 ± 0.018                               | 0.517 ± 0.020                  |
| T <sub>2</sub>  | 14.333* ± 0.882                      | 74.667* ± 3.528      | 17.333* ± 1.333             | 0.535* ± 0.028                              | 0.757* ± 0.013                 |
| T <sub>3</sub>  | 13.000* ± 0.000                      | 89.333* ± 1.333      | 21.333* ± 1.333             | 0.616* ± 0.025                              | 0.860* ± 0.010                 |
| T <sub>4</sub>  | 12.000* ± 0.557                      | 93.333* ± 1.333      | 22.667* ± 1.333             | 0.774* ± 0.026                              | 1.000* ± 0.000                 |
| T <sub>5</sub>  | 13.333* ± 0.333                      | 66.667 ± 1.333       | 13.333* ± 1.333             | 0.471* ± 0.007                              | 0.657* ± 0.012                 |
| T <sub>6</sub>  | 13.667* ± 0.333                      | 78.667* ± 1.333      | 17.333* ± 1.333             | 0.591* ± 0.012                              | 0.687* ± 0.015                 |
| T <sub>7</sub>  | 12.667* ± 0.333                      | 80.000* ± 2.309      | 20.000* ± 0.000             | 0.603* ± 0.031                              | 0.790* ± 0.031                 |
| T <sub>8</sub>  | 16.333 ± 0.882                       | 66.667 ± 1.333       | 12.000 ± 0.000              | 0.377 ± 0.015                               | 0.560 ± 0.021                  |
| T <sub>9</sub>  | 15.333 ± 0.667                       | 69.333 ± 1.333       | 16.000* ± 0.000             | 0.418* ± 0.014                              | 0.613* ± 0.022                 |
| T <sub>10</sub> | 15.667 ± 0.333                       | 68.000 ± 0.000       | 14.667* ± 1.333             | 0.410* ± 0.022                              | 0.603* ± 0.007                 |
| SE(d)           | 0.829                                | 2.599                | 1.578                       | 0.030                                       | 0.024                          |
| C.D. (0.05)     | 1.826                                | 5.460                | 3.314                       | 0.063                                       | 0.051                          |

\*Significant at 5% level of significance as compared with control.

**Table-2 : Influence of different growth hormones on some germination attributes of *Hedychium spicatum* under polyhouse condition.**

| Treatment       | Number of days taken for germination | Germination per cent | Germination energy per cent | Mean daily germination (per cent seeds/day) | Germination speed (seeds /day) |
|-----------------|--------------------------------------|----------------------|-----------------------------|---------------------------------------------|--------------------------------|
| T <sub>1</sub>  | 36.000 ± 1.000                       | 20.833 ± 2.083       | 6.250 ± 0.000               | 0.045 ± 0.005                               | 0.076 ± 0.007                  |
| T <sub>2</sub>  | 31.333* ± 0.333                      | 35.417 ± 5.512       | 12.500* ± 0.000             | 0.075 ± 0.014                               | 0.136 ± 0.020                  |
| T <sub>3</sub>  | 29.000* ± 0.577                      | 43.750* ± 6.250      | 16.667* ± 2.083             | 0.091* ± 0.019                              | 0.173* ± 0.024                 |
| T <sub>4</sub>  | 26.333* ± 0.333                      | 47.917* ± 3.661      | 20.833* ± 2.083             | 0.105* ± 0.024                              | 0.200* ± 0.054                 |
| T <sub>5</sub>  | 30.000* ± 0.000                      | 33.333 ± 2.083       | 10.417 ± 2.083              | 0.087* ± 0.002                              | 0.124 ± 0.008                  |
| T <sub>6</sub>  | 28.667* ± 0.882                      | 41.667* ± 2.083      | 14.583* ± 2.083             | 0.087* ± 0.001                              | 0.162* ± 0.012                 |
| T <sub>7</sub>  | 27.333* ± 0.882                      | 45.833* ± 5.512      | 18.750* ± 0.000             | 0.101* ± 0.012                              | 0.183* ± 0.021                 |
| T <sub>8</sub>  | 32.000* ± 0.577                      | 25.000 ± 3.608       | 6.250 ± 0.000               | 0.056 ± 0.006                               | 0.094 ± 0.014                  |
| T <sub>9</sub>  | 32.333* ± 0.667                      | 29.167 ± 2.083       | 8.333 ± 2.083               | 0.063 ± 0.002                               | 0.109 ± 0.009                  |
| T <sub>10</sub> | 31.333* ± 0.667                      | 31.250 ± 3.608       | 8.333 ± 2.083               | 0.069 ± 0.011                               | 0.116 ± 0.013                  |
| SE(d)           | 0.931                                | 8.122                | 2.283                       | 0.017                                       | 0.032                          |
| C.D. (0.05)     | 1.956                                | 17.062               | 4.794                       | 0.036                                       | 0.067                          |

\*Significant at 5% level of significance as compared with control.

hormones are involved in the regulation of the induction, maintenance and release of seed dormancy [1 & 2]; Absciscic acid (ABA) and Gibberellic acid (GA) also play major roles in this respect. ABA actually regulates dormancy induction and maintenance [7], while GA promotes seed dormancy decay and germination. In addition to ABA and GA, other plant hormones such as ethylene, cytokinin, brassinosteroid, auxin, and jasmonates (JA) have been implicated in the regulation of seed dormancy and germination [11]. Considering the importance of the roles played these several growth hormones on boosting germination of variety of plant species we felt if the germination of *Hedychium spicatum* could be improved. Also, *Hedychium spicatum* is believed to be an important vulnerable medicinal plant of Indian Himalayan region [3], the rejuvenation of the plant species by enhancing germination potential could be worthy study.

## Materials and Methods

The present study was conducted during February 2020 for a period of about 4-5 months. Seeds of *Hedychium spicatum* and plant growth hormones were collected from Department of Medicinal and Aromatic Plants. Seeds surface sterilization done with 0.1 % mercuric chloride (HgCl<sub>2</sub>) for 2-3 min for prevent seed decay, pre-emergence damping and protection against fungus. Then the seeds were washed for 3-4 times with double distilled water. Stock solution of GA<sub>3</sub>, IAA and NAA (250 ppm, 500 ppm and 750 ppm) were prepared by accurately weighed 250 mg, 500 mg and 750 mg GA<sub>3</sub>, IAA and NAA dissolved in 1000 mL distilled water separately. The seeds were treated with PGRs for experiment purpose. Seeds were placed in the different prepared test solutions for 24 h, followed by cleaning of seeds. The concentrations of each plant growth regulators are used solutions were 250

ppm, 500 ppm and 750 ppm of GA<sub>3</sub>, IAA and NAA. After soaking for 24 h seeds were removed from the solution. For the seed germination in laboratory condition, seed germinator was used as a growth chamber for providing consistent favorable conditions by regulating temperature, humidity which are responsible for germination of seeds. The seeds were transferred into petri dish (25 seeds/petri plate). Petri dishes containing seeds of different treatments were kept carefully in a germinator maintaining a constant temperature of  $25 \pm 2^\circ \text{C}$  and 75-80 % relative humidity. In the case of polyhouse condition trays were used for seeds sowing. For the filling of trays garden soil was used and 16 seeds are in each tray in triplicates in complete randomized design (CRD). Naturally ventilated even type polyhouse was used for the experiment which we could expect more or less partially controlled climatic condition. During the experiment polyhouse temperature ranged between  $20 - 25^\circ \text{C}$  and humidity 70-80 % most probably due to diurnal variation and the polyhouse type. The study comprises of ten (10) different treatment levels constituted by varying doses of three (3) different growth hormones viz., T<sub>2</sub> (GA<sub>3</sub> @ 250 ppm), T<sub>3</sub> (GA<sub>3</sub> @ 500 ppm), T<sub>4</sub> (GA<sub>3</sub> @ 750 ppm), T<sub>5</sub> (IAA @ 250 ppm), T<sub>6</sub> (IAA @ 500 ppm), T<sub>7</sub> (IAA @ 750 ppm), T<sub>8</sub> (NAA @ 250 ppm), T<sub>9</sub> (NAA @ 500 ppm), T<sub>10</sub> (NAA @ 750 ppm), and T<sub>1</sub> as checked treatment or control.

## Results and Discussion

The seed germination was recorded after 11 days and continued till 31 days in laboratory condition. In polyhouse condition seed germination was observed to begin after 26 days and it continued till 45 days. Results of various germination parameters under study indicated that T<sub>4</sub> (750 ppm GA<sub>3</sub>) is superior in all the study parameters among the different treatments and proved statistically significant observations. The treatment T<sub>4</sub> incidentally resulted in minimum time taken for first germination appearance under both laboratory (12.00 days) and polyhouse (26.33 days) condition. The laboratory condition resulted in lesser time consumption on germination. Maximum germination was also recorded in T<sub>4</sub> under laboratory (93.30 %) and polyhouse (47.92 %) condition, indicating preferability of laboratory condition over polyhouse condition for germination. Also, the highest germination energy per cent [22.67 % (lab.) and 16.67 % (polyhouse)], maximum mean daily germination (MDG) [0.77 % seeds /day (lab.) and 0.11 % seeds /day (polyhouse)], fastest speed of germination [1.000 seeds/day (lab.) and polyhouse (0.20 seeds/day)] showed in Table 1 and Table 2. This superiority result of T<sub>4</sub> (26.333 days) over other treatments is confirmed under polyhouse study as well. It might due to the altered physiological of embryos and liberating enzymes so that the development process

occurs more rapidly after sowing [6]. In addition, the finding here suggested the better suitability of the gibberellic acid dose GA<sub>3</sub> @ 750 ppm to boost the germination of *Hedychium spicatum*. The findings reported here is in accordance with the findings reported by [3] who claimed that GA<sub>3</sub> helps to promote the initial germination in laboratory condition and nursery condition in *Hedychium spicatum*. The result of germination per cent study under the present investigation clearly indicates that T<sub>4</sub> provided the highest germination per cent (93.333 %) under laboratory condition. Similarly, in the case of polyhouse condition also T<sub>4</sub> evidently provided highest germination per cent (47.917 %). This result might also be due to altered physiology of embryos and liberating enzymes so that the development process occurs more rapidly after sowing in *Hedychium spicatum* [3 & 6]. Highest germination energy occurred under T<sub>4</sub> (22.667 %) which was found significantly higher than all other treatments in laboratory condition under polyhouse condition also treatment T<sub>4</sub> (GA<sub>3</sub> @ 750 ppm) provided maximum germination energy per cent (20.833 %). [12] also reported a significant variation in germination energy due to stratification period as well as GA<sub>3</sub> treatments. The increased germination percentage in GA<sub>3</sub> treated seeds might be attributed to fact that the GA<sub>3</sub> helps in breaking the seed dormancy which results in early and enhanced seed germination due to the diffusion of endogenous auxin and gibberellins like substances [4, 10]. Mean daily germination (% seeds per day) was found highest T<sub>4</sub> under both laboratory condition and polyhouse condition (0.774 and, 0.105 respectively). [8] also reported a higher mean value of mean daily germination (3.77) in seeds at GA<sub>3</sub> with concentration 760 ppm in *Cassia fistula*. However, it is also seen that the germination speed is faster in laboratory condition (1.000 seeds/day) than polyhouse condition (0.200 seeds/day). It might be due to altered physiology of embryos and liberating enzymes so that the development process occurs more rapidly after sowing in *Hedychium spicatum* [3, 6].

## Conclusion

The pre-sowing treatments of plant growth regulators showed that *Hedychium spicatum* seeds was found to be effective with gibberellic acid (GA<sub>3</sub> @750 ppm) compared with other treatments. In our opinion seeds germination study in this species by applying various PGRs treatments under different conditions were significantly effective. This methodology is simple; cost effective technique and could be easily implemented by nursery growers and commercial laboratories. By using this significant and simple methodology we could propagate a large number of seedlings for conservation of this vulnerable medicinal plant and for commercial purpose.

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## Virulence Monitoring of Rice Gall Midge Population at Nellore, Andhra Pradesh

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### Abstract

The virulence of rice gall midge, *Orseolia oryzae* (Wood-Mason) biotypes in Nellore district, Andhra Pradesh was studied during 2017-18 under field conditions. The virulence composition of rice gall midge population was studied using four standard differentials viz., W1263 (Gm1 gene for resistance), Aganni (Gm8), RP 2068-18-3-5 (*gm3*) and Purple (susceptible without any gene). The local gall midge populations in Nellore expressed their highest virulence of 27.76 per cent against susceptible group consisting purple, 19.54 per cent on Aganni, 12.60 per cent on RP 2068-18-3-5 and 1.54 per cent on W 1263 indicating low virulence on W 1263. Hence, W 1263 (*Gm1*) has low virulence against the biotype existing at ARS, Nellore. All the test individuals reacted similar to biotype VI pattern (R-S-S-S) in Nellore with greater virulence against Purple (susceptible check).

**Key words :** Rice gall midge, monitoring, virulence.

### Introduction

Rice is the major food grain crops in India. A study carried out by Rock feller foundation [1] revealed that seven out of 20 major challenges in rice production are biotic factors which include insect pests and diseases. Among the biotic factors, insect pests cause about 10-15 per cent yield losses, accounting for an estimated yield loss of 21-51 per cent. Yellow stem borer, brown plant hopper and gall midge are the key pests in rice causing 25-30 per cent, 15-60 per cent and 10-70 per cent yield losses respectively. Rice crop is attacked by a number of insect pests of which gall midge continues to be one of the key biotic stresses constraining rice production across different rice ecosystems in India. Percent plant damage due to incidence of rice gall midge was 100 in a screening trial conducted at Agricultural Research Station, Ragolu during *Kharif*, 2016-17 was reported by [2]

Due to wide cultivation of high yielding varieties over years resulted in the emergence of new virulent population capable of overcoming resistance. The emergence of a new biotype 4M at Warangal was reported by [3]. The characterization of gall midge biotype and their virulence pattern are urgently needed. Hence, the present study was taken up to record the virulence of rice gall midge population in Nellore.

### Materials and Methods

One week old seedlings of all the four differentials (Purple, RP 2068-18-3-5, Aganni and W1263) were transplanted in 165 small plastic pots with 4 hills and each hill with 5 seedlings per variety was planted at equidistance spots in clockwise order. Single female insect collected at light source from 6 pm to 9 pm was released in each pot, the

infested pots were covered with plastic bags for two days. On third day, the bags were removed, the plants were watered and extra humidity was provided by a humidifier for two more days for promoting egg hatching and maggot establishment. Plants were taken care for 3 more weeks until gall development. Pots were once again covered to record the sex of the adult insects emerging from each pot.

### Data recorded

Number of damaged plants in each differential and the number of galls in each variety was also recorded.

The sex of the insect was recorded based on the size of the pupae or pupal case.

### Results and Discussion

The virulence of the insect showed that, among 165 females tested, only 85 were able to form galls in plants. Of these 85 females, 65 females showed virulence in Aganni (*Gm8*), 46 females showed virulence in RP 2068-18-3-5 (*gm3*), 66 females were virulent in Purple (Susceptible check), whereas, only nine females were able to cause infestation in W 1263 (*Gm1*). A total of 168 insects emerged from Purple, of which 108 insects (64.28%) were female progeny and 60 (35.71%) were male progeny. In case of W 1263, out of ten insects emerged, six insects (60.00%) were female and four (40.00 %) were male progeny. Of the 70 insects emerged from RP 2068-18-3-5, 49 insects (70.00%) were female progeny and 21 insects (30.00%) were male progeny. A total of 141 adults were emerged from Aganni, of which 65 (46.10 %) were male progeny and 76 insects (53.9 %) were female progeny. The sex ratio in W 1263, RP

Table-1 : Virulence Composition of Gall midge Population at ARS, Nellore during kharif, 2017.

| Differential   | R Gene | No. of females tested | No. of Pots with Silver shoots | No. of Plants with Silver shoots | Sex of the F <sub>1</sub> adults emerged |        | Sex Ratio | Percent Virulence |            |
|----------------|--------|-----------------------|--------------------------------|----------------------------------|------------------------------------------|--------|-----------|-------------------|------------|
|                |        |                       |                                |                                  | Male                                     | Female |           | Pot wise          | Plant wise |
| W 1263         | Gm 1   | 165                   | 9                              | 10                               | 4                                        | 6      | 1:1.5     | 10.59             | 1.54       |
| RP-2068-18-3-5 | Gm 3   |                       | 46                             | 70                               | 21                                       | 49     | 1:2.33    | 54.12             | 12.60      |
| Aganni         | Gm 8   |                       | 65                             | 141                              | 65                                       | 76     | 1:1.17    | 76.47             | 19.54      |
| Purple         | —      |                       | 66                             | 168                              | 60                                       | 108    | 1:1.8     | 77.65             | 27.76      |
| Total          |        |                       |                                | 389                              |                                          |        |           |                   |            |

2068-18-3-5, Aganni and Purple was 1:1.5, 1:2.33, 1:1.17 and 1:1.8 respectively.

The data on percent virulence of gall midge population reveal that when considered pot wise, out of 165 females infested, 77.65 per cent were virulent on purple, 76.47 per cent on Aganni, 54.12 per cent on RP 2068-18-3-5 and 10.59 per cent on W 1263. When considered plant wise, out of 85 females infested, 27.76 per cent damage was noticed in purple, 19.54 per cent on Aganni, 12.60 per cent on RP 2068-18-3-5 and 1.54 per cent on W 1263 (Fig. 4.6) indicating low virulence on W 1263. Hence, W 1263 (*Gm1*) has low virulence against the biotype existing at ARS, Nellore. All the test individuals reacted similar to biotype VI pattern (R-S-S-S) in Nellore with greater virulence against Purple (susceptible check) (Table-1).

Analogous studies were conducted by [4] at Warangal and reported the virulence attributes of Warangal rice gall midge population during *kharif*, 2017. "Of 100 females tested, only 56 were able to infest the plants. Out of these 56 females, 30 females showed virulence in Purple (Susceptible check), 28 females showed virulence in gene pyramided line (*gm3*, *Gm4* and *Gm8*), 18 females showed virulence on W 1263 (*Gm1*), 17 females showed virulence in RP 2068-18-3-5 (*gm3*), whereas, only four females were able to cause infestation on Aganni (*Gm8*)".

Virulence composition of Raipur rice gall midge population on three differentials and reported that, out of 200 tested females, only 190 were able to infest the differentials. Out of 190 females, 14 insects were able to cause infestation on Phalguna (*Gm2*) whereas only one female had virulent progeny on Kavya (*Gm1*) when the differentials studied were TN 1, Phalguna (*Gm2*) and Kavya (*Gm1*) [5].

Virulence against a specific resistance gene is simply inherited and conditioned by a single autosomal or sex-linked gene [6 & 7]. To be virulent to a particular resistant rice cultivar, gall midge must be homozygous for recessive virulence genes at loci corresponding to the loci

at which the rice cultivar has resistance genes. If the female parent is virulent, then all the male and female progeny will receive the virulent genes from the female parent. Successive generations will cause severe damage to rice crop if the virulent female parent exist in a particular location. Durability of plant resistance gene is influenced by the nature of inheritance of virulence in the insect and that virulence monitoring helps in the selection of appropriate genes for pyramiding through marker assisted breeding for durable resistance.

## Conclusion

Continuous virulence monitoring is necessary to confirm the prevalence of genetically heterogeneous or homogeneous gall midge populations or emergence of a new biotype at a location to breed varieties with durable resistance against rice gall midge.

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## Choosing Rice Genotypes for Drought Tolerance Attributes under Field Conditions

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### Abstract

Identification of rice genotypes based on drought tolerant attributes is one of crucial research work in current environmental situation where water stress increase day by day. The work was conducted at Regional research station (Red and Laterite zone) Jhargram, BCKV, W.B. with 38 rice genotypes including check under stress and normal condition. The analysis of variance revealed highly significant variation among the genotypes for all the traits studied, under both the environments. The genotypes exhibited high variability along with high heritability for the characters plant height, flag leaf area, proline content in leaves, relative water content, recovery per cent after stress, number of grains per panicle, harvest index. Drought susceptibility index, stress tolerance index, tolerance index, yield stability index, root traits like root length, root shoot ratio, flowering delay, seed vigour index and grain yield per plant in irrigated & stress condition suggesting that direct selection of genotypes based on these characters may be useful for future improvement of genotypes under respective environments.

**Key words :** Rice, drought stress, DSI, proline content and genetic variability.

### Introduction

Rice is the most important crop in India covering more area under irrigation. But now a day's area under irrigation is decreasing day by day. Rice is widely cultivated crop under variable environmental conditions including irrigated, rainfed-upland, rainfed deep-water condition. Among the various abiotic stress, drought is one of the basic factors for restricting crops production (Vallivodan and Nguyen, 2006; Sinclairs, 2011). The recent scenario of global climate change and unpredictable rainfall patterns lead to severe drought spells in rainfed areas. Although the country has a high potential for production rice in irrigated areas, lack of adaptable varieties is one of the major problem. The uncertain water supply in rainfed lowland areas, together with the infertile soil that can be acidic or saline and the varying crop management methodologies, provide a highly heterogeneous set of breeding targets with a range of environmental conditions that influence the phenotypic response of the genotypes. This complex and diverse situation very often lies within small geographical regions. Genetic improvement under such complex situations would be a key challenge for any plant breeding program.

Drought may delay the phenological development of the rice plant and affect physiological processes like transpiration, photosynthesis, respiration and translocation of assimilates to the grain. Plant processes that depend on cell volume enhancement are particularly sensitive to water deficit. Leaf expansion and leaf gas exchange rates are two such sensitive processes. At the plant level, reduced leaf area is probably the obvious mechanism by which plants and crops restrict their water

loss in response to drought (Sadras and Milroy, 1996). Quantification of physiological and morphological responses of rice to water stress is essential to predict the impact of soil and weather conditions on rice production using process-based crop simulation models. Modeling plant responses to water deficit requires not only an understanding but also quantitative relationships for the effects of water deficits on leaf growth expansion and gas exchange rates (Sadras and Milroy, 1996). Therefore, in order to quantify the drought tolerance in rice genotypes and contribution of yield components due to water availability of rice with different drought tolerance/resistant indices obtained from the yield data under rainfed upland stressed and irrigated non stressed condition experiments.

### Materials and Methods

A set of 38 rice genotypes including check viz., Sahabgadhian, Vandana, IR-36 and IR-64 were tested under both irrigated and water stress condition in RBD with three replication at experimental field of RRS Jhargram (Red and Laterite Zone) BCKV, W.B. during 2016 growing season. Direct seeding was done in both irrigated and water stress condition. The irrigated experiment was considered to be a favourable condition so that plots were watered at planting, tillering, heading, flowering and grain filling stages. Nitrogen and phosphorus Potash fertilizers were applied at the rate of 60:40:30 Kg/ha. Half dose of nitrogen + full doses of phosphorus Potash fertilizers at the time of sowing and remaining half dose of nitrogen in two equal doses at the time of tillering and panicle initiation stages of crop growth were applied. Fifteen days of stress condition were done

**Table-1 : Analysis of Variance for different quantitative characters in Rice under stress and normal condition in year 2016.**

| No. | Characters             | Mean sum of squares |                  |              |                  |         |                  |
|-----|------------------------|---------------------|------------------|--------------|------------------|---------|------------------|
|     |                        | Replication         |                  | Treatments   |                  | Error   |                  |
|     |                        | Normal              | Control (Stress) | Normal       | Control (Stress) | Normal  | Control (Stress) |
| 1.  | DFF                    | 0.07                | 5.71             | 69.13**      | 81.93**          | 0.49    | 8.15             |
| 2.  | FD                     | -                   | 0.38             | -            | 12.29**          | -       | 0.74             |
| 3.  | DM                     | 44.32               | 2.35             | 166.14**     | 65.34**          | 157.02  | 1.03             |
| 4.  | PH(cm)                 | 20.06               | 12.15            | 251.00**     | 363.72**         | 10.93   | 1.43             |
| 5.  | FLA (cm <sup>2</sup> ) | 0.16                | 2.19             | 123.42**     | 165.51**         | 0.16    | 0.75             |
| 6.  | CHL.C.                 | 1.38                | 0.84             | 22.55**      | 10.00**          | 0.26    | 1.19             |
| 7.  | NTPP                   | 0.21                | 0.18             | 10.98**      | 10.20**          | 0.96    | 0.27             |
| 8.  | LR                     | 0.94                | 0.71             | 0.72**       | 0.59**           | 0.43    | 0.49             |
| 9.  | LD                     | 1.95                | 0.11             | 0.69**       | 0.76**           | 0.56    | 0.54             |
| 10. | RWC                    | 10.12               | 1.11             | 24.90**      | 44.67**          | 1.19    | 0.94             |
| 11. | PL(cm)                 | 0.64                | 0.54             | 19.34**      | 36.60**          | 0.73    | 0.40             |
| 12. | SF                     | 2.35                | 0.16             | 477.48**     | 480.02**         | 2.18    | 0.90             |
| 13. | RAS                    | 0.18                | 2.64             | 89.99**      | 98.95**          | 3.12    | 0.51             |
| 14. | NGPP                   | 8.76                | 0.42             | 390.53**     | 139.90**         | 14.40   | 2.33             |
| 15. | TGW(g)                 | 0.40                | 0.06             | 20.99**      | 22.27**          | 0.63    | 0.19             |
| 16. | R %                    | -                   | 48.18            | -            | 739.66**         | -       | 51.41            |
| 17. | HI                     | 0.35                | 3.60             | 71.15**      | 97.04**          | 0.33    | 0.96             |
| 18. | SYPP(g)                | 0.01                | 0.31             | 13.22**      | 10.19**          | 0.29    | 0.39             |
| 19. | SVI                    | 18780.03            | 38450.57         | 1753831.13** | 1316984.30**     | 3708.34 | 8069.95          |
| 20. | RL(cm)                 | 0.07                | 4.88             | 14.61**      | 20.56**          | 0.43    | 0.57             |
| 21. | SL (cm)                | 1.36                | 3.02             | 226.68**     | 170.27**         | 0.41    | 1.31             |
| 22. | RSR                    | 0.01                | 0.14             | 0.43**       | 1.51**           | 0.01    | 0.09             |
| 23. | DWR (g)                | 0.60                | 1.30             | 18.98**      | 14.53**          | 0.21    | 0.42             |
| 24. | FWR (g)                | 0.09                | 1.20             | 61.07**      | 12.45**          | 0.42    | 0.59             |
| 25. | DWS (g)                | 0.65                | 0.12             | 69.48**      | 29.86**          | 0.36    | 1.04             |
| 26. | FWS (g)                | 0.03                | 7.46             | 323.07**     | 219.06**         | 0.44    | 1.65             |
| 27. | DSI                    | -                   | 0.00             | -            | 0.29**           | -       | 0.00             |
| 28. | TOL                    | -                   | 0.48             | -            | 11.35**          | -       | 0.85             |
| 29. | STI                    | -                   | 0.17             | -            | 35.48**          | -       | 0.51             |
| 30. | YI                     | -                   | 0.01             | -            | 0.00**           | -       | 0.01             |
| 31. | YSI                    | -                   | 0.00             | -            | 0.01**           | -       | 0.00             |
| 32. | PROL.C.                | 0.02                | 0.00             | 0.23**       | 0.66**           | 0.01    | 0.00             |

\*\*Significance at 1% level, \*Significance at 5% level

**Abbreviations :** DFF-Days to 50% Flowering, FD-Flowering Delay, DM-Day to Maturity, PH-Plant Height (cm), FLA-Flag Leaf Area (cm<sup>2</sup>), CHL.C.-Cholorophyll Content, NTPP-Number of Tillers/plant, LR-Leaf rolling at Veg. Stage, LD-Leaf Drying at Veg. Stage, RWC-Relative Water Content, PL-Panicle Length (cm), SF-Spikelet Fertility, RAS-Recovery After Stress, NGPP-No. of Grains/Panicle, TGW-Thousand Grain Weight, R%-Reduction (%), HI-Harvest Index, SYPP-Seed Yield/Plant, SVI-Seed Vigor Index, RL-Root Length (cm), SL-Shoot Length (cm), RSR-Root-Shoot Ratio, DWR-Dry Weight of Root (g), FWR-Fresh Weight of Root (g), DWS-Dry Weight of Shoot(g), FWS-Fresh Weight of Shoot(g), DSI-Drought susceptibility index, TOL-Tolerance index, STI-Stress tolerance index, YI-Yield index, YSI-Yield stability index, PROL.C.-Proline Content.

at reproductive stage. Data were recorded on five randomly and competitive plants of each genotype from each replications for thirty two traits viz., Days to 50% Flowering, Flowering Delay, Day to Maturity, Plant Height (cm), Flag Leaf Area (cm<sup>2</sup>), Cholorophyll Content, Number of Tillers/plant, Leaf rolling at Veg. Stage, Leaf Drying at Veg. Stage, Relative Water Content, Panicle Length (cm), Spikelet Fertility, Recovery After Stress, No. of Grains/Panicle, Thousand Grain Weight, Reduction (%), Harvest Index, Seed Yield/Plant, Seed Vigor Index,

Root Length (cm), Shoot Length (cm), Root-Shoot Ratio, Dry Weight of Root (g), Fresh Weight of Root (g), Dry Weight of Shoot(g), Fresh Weight of Shoot(g), Drought susceptibility index, Tolerance index, Stress tolerance index, Yield index, Yield stability index and Proline Content. Heritability (broad sense) was estimated according to Hanson *et al.* (1956). Phenotypic and genotypic coefficients of variation were estimated as per Burton (1952). Genetic advance as percent of mean was estimated according to Johnson *et al.* (1955).

Table-2 : Genetic Parameter analysis for various quantitative and qualitative traits of Rice genotypes under stress and non-stress condition in year 2016.

| No. | Charac-<br>ters        | $\sigma^2_g$ |           | $\sigma^2_p$ |           | GCV    |         | PCV    |         | $h^2$ (Broad<br>sense) % |        | Genetic<br>Advance as<br>% of Mean |         |
|-----|------------------------|--------------|-----------|--------------|-----------|--------|---------|--------|---------|--------------------------|--------|------------------------------------|---------|
|     |                        | Normal       | Control   | Normal       | Control   | Normal | Control | Normal | Control | Normal                   | Stress | Normal                             | Control |
| 1.  | DFF                    | 22.87        | 24.59     | 23.37        | 32.74     | 6.26   | 6.64    | 6.33   | 7.66    | 0.97                     | 0.75   | 12.76                              | 11.85   |
| 2.  | DM                     | 3.03         | 21.43     | 160.06       | 22.47     | 1.72   | 4.43    | 12.53  | 4.54    | 0.01                     | 0.95   | 0.49                               | 8.92    |
| 3.  | PH (cm)                | 80.02        | 120.76    | 90.95        | 122.20    | 9.81   | 12.29   | 10.46  | 12.36   | 0.88                     | 0.98   | 18.96                              | 25.18   |
| 4.  | FLA (cm <sup>2</sup> ) | 41.08        | 54.91     | 41.25        | 55.67     | 19.13  | 22.05   | 19.17  | 22.20   | 0.99                     | 0.98   | 39.34                              | 45.12   |
| 5.  | CHL.C.                 | 7.43         | 2.93      | 7.69         | 4.13      | 7.21   | 4.76    | 7.34   | 5.64    | 0.96                     | 0.71   | 14.60                              | 8.27    |
| 6.  | NTPP                   | 3.34         | 3.31      | 4.30         | 3.58      | 16.70  | 21.53   | 18.97  | 22.41   | 0.77                     | 0.92   | 30.31                              | 42.63   |
| 7.  | LR                     | 0.09         | 0.03      | 0.53         | 0.52      | 25.88  | 18.28   | 60.25  | 72.64   | 0.18                     | 0.06   | 22.90                              | 9.47    |
| 8.  | LD                     | 0.04         | 0.07      | 0.61         | 0.62      | 18.06  | 36.11   | 68.55  | 104.43  | 0.06                     | 0.12   | 9.80                               | 25.72   |
| 9.  | RWC                    | 7.90         | 14.57     | 9.09         | 15.52     | 3.58   | 5.01    | 3.84   | 5.17    | 0.86                     | 0.93   | 6.88                               | 10.01   |
| 10. | PL (cm)                | 6.20         | 12.06     | 6.93         | 12.46     | 9.65   | 14.52   | 10.20  | 14.76   | 0.89                     | 0.96   | 18.80                              | 29.42   |
| 11. | SF                     | 158.43       | 159.70    | 160.62       | 160.61    | 18.82  | 19.47   | 18.95  | 19.53   | 0.98                     | 0.99   | 38.51                              | 40.01   |
| 12. | RAS                    | 28.95        | 32.81     | 32.07        | 33.32     | 7.25   | 7.91    | 7.63   | 7.97    | 0.90                     | 0.98   | 14.2                               | 16.17   |
| 13. | NGPP                   | 125.37       | 45.85     | 139.78       | 48.19     | 9.92   | 6.70    | 10.47  | 6.87    | 0.89                     | 0.95   | 19.35                              | 13.47   |
| 14. | TGW                    | 6.78         | 7.36      | 7.42         | 7.55      | 11.05  | 13.49   | 11.56  | 13.67   | 0.91                     | 0.97   | 21.77                              | 27.44   |
| 15. | HI                     | 23.60        | 32.02     | 23.94        | 32.99     | 10.25  | 13.37   | 10.32  | 13.57   | 0.98                     | 0.97   | 20.97                              | 27.15   |
| 16. | SYPP                   | 4.31         | 3.26      | 4.60         | 3.66      | 17.97  | 19.73   | 18.57  | 20.89   | 0.93                     | 0.89   | 35.83                              | 38.41   |
| 17. | SVI                    | 583374.30    | 436304.80 | 587082.60    | 444374.80 | 16.28  | 15.33   | 16.33  | 15.47   | 0.99                     | 0.98   | 33.44                              | 31.29   |
| 18. | RL                     | 4.72         | 6.66      | 5.16         | 7.23      | 8.70   | 11.91   | 9.10   | 12.41   | 0.91                     | 0.92   | 17.15                              | 23.54   |
| 19. | SL                     | 75.42        | 56.32     | 75.83        | 57.63     | 13.68  | 12.46   | 13.72  | 12.61   | 0.99                     | 0.97   | 28.11                              | 25.39   |
| 20. | RSR                    | 0.14         | 0.47      | 0.15         | 0.56      | 20.69  | 34.48   | 21.48  | 37.80   | 0.92                     | 0.83   | 41.07                              | 64.79   |
| 21. | DWR                    | 6.25         | 4.70      | 6.47         | 5.13      | 22.26  | 34.38   | 22.65  | 35.92   | 0.96                     | 0.91   | 45.09                              | 67.80   |
| 22. | FWR                    | 20.21        | 3.95      | 20.64        | 4.55      | 27.57  | 22.27   | 27.86  | 23.90   | 0.98                     | 0.86   | 56.21                              | 42.75   |
| 23. | DWS                    | 23.04        | 9.60      | 23.40        | 10.65     | 23.91  | 26.85   | 24.09  | 28.27   | 0.98                     | 0.90   | 48.88                              | 52.54   |
| 24. | FWS                    | 107.54       | 72.47     | 107.98       | 74.12     | 17.55  | 20.09   | 17.58  | 20.32   | 0.99                     | 0.97   | 36.08                              | 40.93   |
| 25. | FD                     | -            | 3.85      | -            | 4.59      | -      | 81.52   | -      | 89.07   | -                        | 0.83   | -                                  | 153.72  |
| 26. | R %                    | -            | 229.41    | -            | 28.83     | -      | 18.83   | -      | 20.83   | -                        | 0.81   | -                                  | 35.72   |
| 27. | DSI                    | -            | 0.096     | -            | 0.10      | -      | 51.06   | -      | 52.39   | -                        | 0.95   | -                                  | 102.50  |
| 28. | TOL                    | -            | 3.49      | -            | 4.35      | -      | 77.99   | -      | 87.03   | -                        | 0.80   | -                                  | 143.98  |
| 29. | STI                    | -            | 11.65     | -            | 12.17     | -      | 16.48   | -      | 16.84   | -                        | 0.95   | -                                  | 33.23   |
| 30. | YI                     | -            | -0.00     | -            | 0.01      | -      | 3.87    | -      | 5.49    | -                        | -0.49  | -                                  | -5.64   |
| 31. | YSI                    | -            | 0.02      | -            | 0.02      | -      | 18.79   | -      | 20.79   | -                        | 0.81   | -                                  | 34.98   |
| 32. | Prol.C.                | 0.07         | 0.22      | 0.086        | 0.22      | 131.46 | 60.67   | 141.31 | 60.90   | 0.86                     | 0.99   | 251.95                             | 124.51  |

**Abbreviations-** DFF-Days to 50% Flowering, FD-Flowering Delay, DM-Day to Maturity, PH-Plant Height (cm), FLA-Flag Leaf Area (cm<sup>2</sup>) CHL.C.-Chlorophyll Content, NTPP-Number of Tillers/plant, LR-Leaf rolling at Veg. Stage, LD-Leaf Drying at Veg. Stage, RWC-Relative Water Content, PL-Panicle Length (cm), SF-Spikelet Fertility, RAS-Recovery After Stress, NGPP-No. of Grains/Panicle, TGW-Thousand Grain Weight, R%-Reduction (%), HI-Harvest Index, SYPP-Seed Yield/Plant SVI-Seed Vigor Index, RL-Root Length (cm), SL-Shoot Length (cm), RSR-Root-Shoot Ratio, DWR-Dry Weight of Root (g), FWR-Fresh Weight of Root (g), DWS-Dry Weight of Shoot(g), FWS-Fresh Weight of Shoot(g), DSI-Drought susceptibility index, TOL-Tolerance index, STI-Stress tolerance index, YI-Yield index, YSI-Yield stability index, PROLC.-Proline Content.

(1) Drought Susceptibility Index (DSI) =  $1 - Y_s / Y_p$  /  $1 - \text{Mean } Y_s / \text{Mean } Y_p$  (Fischer and Maurer 1978)

(2) Stress tolerance, TOL =  $Y_p - Y_s$  (Rosielle and Hamblin 1981)

(3) Stress tolerance index, STI =  $(Y_s) (Y_p) / (Y_p)^2$  (Fernandez, 1992 )

(4) Yield index, YI =  $Y_s / \text{Mean of } Y_s$  (Gavuzzi et al. 1997)

(5) Yield stability index, YSI =  $Y_s / Y_p$  (Bouslama and Schapaugh 1984) in which  $Y_s$  denote the mean yield of genotype under stress and  $Y_p$  the mean yield of genotype under non-stress (irrigated) conditions.

## Results and Discussion

The results related to analysis of variance for different quantitative and qualitative traits revealed that there was strong significant variation among the rice genotypes for all the traits studied under both stress and irrigated environmental condition (Table-1). This indicates that there was a good sufficient variability in the material under studied, which could be utilized in further crossing programme for generation of breeding materials. In other words, further analysis of water stress tolerance is meaningful as indicated by significant mean sum of squares under water stress condition. Interestingly, the magnitude of mean sum of square of almost all the traits

were found more under drought stress condition than irrigated, which indicated that the amount of variation for these traits was more desirable under water stress condition. More variation under water stress condition is expected as different genotypes respond differentially under water stress condition.

A previous study in accordance with the result of Chen *et al.*, (2001), Pantuwan *et al.*, (2002), Muthuswamy and Kumar (2006), Ouk *et al.*, (2006), Ganapathy *et al.*, (2007), Allah (2009), Mina *et al.*, (2011), Gomez *et al.*, (2003), they reported high variability for different traits in rice. Thus it indicates that there was sufficient variability in material used in experiment, which provides a good scope for selecting superior genotypes for further crop improvement. The phenotypic variances for most of the traits under study were higher than the genotypic variances (El-Kareem and El-Saidy, 2011). This may be due to the environmental factor which played an important role in the manifestation of these traits. Wide ranges of variance were observed in the experimental material for all the traits under investigation in both environments. The maximum phenotypic and genotypic variance was exhibited by the characters viz., days to 50 per cent flowering, days to physiological maturity, plant height, flag leaf area, proline content in leaves, relative water content, recovery per cent after stress, number of grains per panicle, harvest index. Drought susceptibility index, stress tolerance index, tolerance index, yield stability index, root traits like root length, root shoot ratio, seed vigour index and grain yield per plant under both irrigated and stress condition 2016. These findings were in accordance to Blum *et al.* (1988), Manickavelu *et al.* (2006b) and Mina *et al.* (2011), Chen *et al.* (2001), Pantuwan *et al.* (2002), Gomez *et al.* (2003), Ouk *et al.* (2006), Muthuswamy and Kumar (2006a), Ganapathy *et al.* (2007), Allah (2009) and Mina *et al.* (2011) reported high variability for various traits in rice. Thus, it is implied that there was reasonably sufficient variability in material used for the study, which provides ample scope for selecting superior genotypes by the plant breeder for further improvement. The heritable portion of the total variation can studying the components of variation such as GCV, PCV, along with heritability and genetic advance as per cent of mean. High to moderate estimate of PCV was observed for seed vigour index, root length, root shoot ratio, dry weight of root, plant height, relative water content, reduction percentage, seed yield per plant, seed vigour index, root shoot ratio, dry weight of root, dry weight of root, fresh weight root, fresh weight of shoot, DSI, TOL, YI, YSI and proline content. Similar results have been reported by Ganapathy *et al.*, (2007 and Mina *et al.* (2011). It indicates the least influence of environment when the minimum difference between PCV & GCV and preponderances of additive gene effects; indicating genotypes can be improved and

selected for these traits under water stress condition for improvement of drought tolerance.

In crop development programme, choosing/selection practiced direct or indirect. Selection parameters like the Heritability and genetic advance (direct selection) and indirect selection by correlation and path coefficient analysis. Under further study, we found that heritability in broad sense was found to be high for most of traits including days to 50% flowering, seed vigour index, root length, root shoot ratio, dry weight of root, plant height, relative water content, reduction percentage, seed yield per plant, seed vigour index, root shoot ratio, dry weight of root, dry weight of root, fresh weight root, fresh weight of shoot, DSI, TOL, YI, YSI and proline content. These findings are in agreement with the findings of Venkataramana and Shailaja (1999), Wu *et al.*, (2004), Muthuswamy *et al.*, (2006), Manickavelu *et al.*, (2006), Allah (2009).

In the present investigation, high heritability coupled with high genetic advance over mean was found for seed vigour index, root length, root shoot ratio, dry weight of root, plant height, relative water content, reduction percentage, seed yield per plant, seed vigour index, root shoot ratio, dry weight of root, dry weight of root, fresh weight root, fresh weight of shoot, DSI, TOL, YI, YSI and proline content in irrigated and water stress condition that suggested these traits can be used as for favourable attributes for improvement through selection and this may be due to additive genes effect and thus, could be improved upon by adopting selection without progeny testing. Hence, direct selection can be done through these characters for future improvement of genotypes under given environments for improvement of water tolerance and higher grain yield. Similar results also reported by earlier workers viz., Muthuswamy *et al.*, (2006), Manickavelu *et al.*, (2006) and Gomez *et al.*, (2003). The high heritability associated with high genetic advance indicated that the variation was mostly due to additive gene effects. It indicates that if these characters are subjected to any selection scheme for exploiting fixable genetic variance, a widely adapted genotype can be developed.

## Conclusion

Among all the traits, drought tolerance indices, flag leaf area, chlorophyll content, relative water content, root traits and proline content were considered to be the most effective for selection of drought tolerance, high yielding drought tolerance rice genotypes. The genotypes RAU-1428-6-7-3-6, RAU-1397-2-5-8-1-2-5-4, RAU-1417-2-1-5-7-7, RAU-1451-3-5-7-6-9-5-1, RAU-1428-31-5-4-3-2-2-2, RAU-1428-6-7-3-6, IR-36, RAU-1421-12-1-7-4-3, RAU-1415-3-5-7-6-9-5-3, RAU-1428-5-4-35-5-5, RAU-1451-6-6-1-1-5-2,

Sahbhagidhan were selected as superior rice genotypes for further breeding programme based on these drought tolerance attributes.

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## Impact of Loan Waiver Scheme on Farmers in Andhra Pradesh

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### Abstract

Now-a-days natural calamities like floods; other biological and management factors are having significant role in affecting the agriculture production prospects, thereby, making the farmers to end up in a debt trap. Several studies have been taken up regarding the performance of different financial institutions, assessing the credit needs of farmers, demand-supply gap of credit requirements of farmers *etc.* Present study taken up with the objective to study the impact of Loan Waiver Scheme on farmers. Andhra Pradesh state was selected purposively. The sampling framework consists of one district (Visakhapatnam), two institutions (DCCB and SBI representing cooperative and commercial sectors), four branches (two from each institution) and 120 farmer-borrowers constituting (15 each for beneficiaries and non-beneficiaries). Tabular analysis and Student t-test were employed to deduce the results from data. The impact of Loan waiver scheme on farmers shows that overdue was higher in debt relieved borrowers than debt waived borrowers. With reference to borrower wise; debt waived borrowers benefited more than debt relieved borrowers.

**Key words :** Farmers' indebtedness, loan waiver scheme, impact.

### Introduction

Borrowings and indebtedness are the two sides of the same coin, while borrowing is the cause, indebtedness is the result. It is important that, increase in borrowings need not increase the indebtedness on the part of farmers, unless persistent problems affect the agricultural prospects. Informal credit had certainly declined as a percentage of total debt and simultaneously the institutional credit flow of agriculture has increased over the years with the institutional agencies venturing into the rural areas (1).

Indebtedness has various facets. Out of 89.4 million farmer households at All India level, 48.6% were indebted (2). Among the states percentage of indebted farmer's households were highest in Andhra Pradesh (82%), followed by Tamil Nadu (74.5%), Punjab (65.4%), Kerala (64.4%), Karnataka (61.6%) and Maharashtra (54.8%) *etc.* States with very low proportion of indebted farmer households were Meghalaya, Arunachal Pradesh and Uttaranchal. So, debt is not problem itself, improper utilization of credit is the problem.

As the percentage of indebtedness among farmer's households were highest in Andhra Pradesh (82% of total indebted farmers) as reported (2), it took due attention on the part of the investigator to conduct a research study in the state of Andhra Pradesh on the causes and possible remedies of farmers' indebtedness. Visakhapatnam district is bestowed with different irrigation sources like

tanks, canals, wells *etc.*, for cultivating a wide range of crops under different agro-eco situations. However, erratic distribution of rainfall and sometimes prolonged droughts play major havoc with the farmers. This resulted in continuous failure of crops in the district, thereby, leading to mounting of debts to the farmers. On the other hand, the drastic increase in prices of inputs and services outweighs the price rise of output for many agricultural crops, thereby making the agribusiness less remunerative. This further aggravated the problem of indebtedness in the district. Considering the pathetic situation of the farmers in view of the mounting debts both in institutional and non- institutional sources, the Government has enacted Agricultural Debt Waiver and Debt Relief Scheme (ADWDRS) in the year 2008. The broad feature of the scheme includes marginal, small and other farmers. Marginal farmer, defined as cultivating agricultural land up to 1 hectare or 2.5 acres and small farmer is defined as cultivating between 1 hectare and 2 hectares *i.e.* less than 5 acres, will get full debt waiver of their short term crop loans as well as all the overdue installments on the investment credit. The other farmers, *i.e.* owing more than 5 acres or more than 2 hectares, will get One Time Settlement (OTS) relief.

Referring to the indebtedness of the farmers, the union finance minister Mr. P. Chindambharam pointed out in his budget speech (2008-09), that the government had appointed a committee under the chairmanship of R. Radhakrishnan to examine all aspects of this issue. The committee had made number of recommendation but

stopped sort of recommending waiver of agricultural loans. However, the finance minister sought to justify loan waiver of such a huge magnitude, maintaining that the government was conscious of the dimensions of the problem and was sensitive to the difficulties of the farming community, especially the small and marginal farmers. He also asserted that the government had carefully weighed the pros and cons of debt waiver and had taken in to account the resource position, the central finance Minister in his budget speech for 2008-09 announced the Agricultural Debt waiver and Debt Relief Scheme (ADWDRS). The scheme was called as Agriculture Debt Waiver and Debt Relief Scheme-2008 (3). Under the ADWDRS-2008 package, all the outstanding unpaid loans of small and marginal farmers have been totally written off while the other indebted farmers were required to repay only 75 per cent of the borrowed amount under OTS arrangement.

ADWDRS was estimated and benefit about three crores was to distributed to small and marginal farmers in the country whose debts total was around Rs. 50,000 crores would be waived and about one crore other farmers whose unpaid debts total was around Rs. 10,000 crores was entitled for a rebate of 25 per cent on the payment of 75 per cent of the borrowed amount under the OTS scheme.

In the economic context, several assessments have been taken up regarding the performance of different financial institutions, assessing the credit needs of farmers, demand- supply gap of credit requirements of farmers *etc.*, in different districts. There were many studies in vogue at macro level on agricultural finance by commercial banks but study at micro level about problems faced by farmers is out of vogue and is the need of the time for realistic approach (4). But, the economic analysis pertaining to the extent of indebtedness of farmers, factors responsible for farmers indebtedness, impact of Loan waiver scheme (ADWDRS) announced by different financial institutions *etc.*, is of immediate concern. Such analysis will help the researcher to formulate strategies to address the farmers' indebtedness in the study area. Many governmental studies and individual researchers have exposed that indebtedness among the rural households is very high and ever increasing in the country. The investigation has been conducted with the following specific objectives :

To assess the economic profile of debit-farmers in the district.

To study the impact of loan waiver scheme on farmers.

## Materials and Methods

Visakhapatnam district in Andhra Pradesh was

purposely selected for the study, as the district harbours a wide range of crops and allied enterprises. The District Credit Plan forms the basis for the selection of institutions. Major sources of institutional credit were cooperative and commercial banks. Hence, District Cooperative Central Bank (DCCB) for cooperative sector and State Bank of India (SBI) for commercial sector were selected. Further, based on the extent of indebtedness criteria, two branches were selected from the respective institutions. The selected DCCB branches were Kaspajagannadhapuram and Madugula located in Madugula mandal. The selected SBI branches were Kodavatipudi and Narsipatnam ADB located in Kotauratla and Rolugunta mandals respectively.

From each branch 15 farmer-borrowers were selected who benefited from ADWDRS; named as Beneficiaries, and equal numbers of farmer-borrowers from each branch who are not benefited from ADWDRS were selected; named as Non-beneficiaries. Hence, the sample size was 60 from beneficiaries and 60 from non-beneficiaries. Thus, in total, the sample size was 120 farmer-borrowers. The reference period for the study was 2018-19.

Primary data were collected through personal interview method with the help of pretested schedule specially designed for the study.

**Tools and Techniques of Analysis :** Both conventional and functional analyses were used in analysing the data and results were interpreted accordingly.

**Tabular analysis :** Tabular analysis was used to estimate the economic profile of farmers-borrowers by working out the simple averages and percentages.

**Significance test :** The following Student 't' test was used to know the existence of difference between the groups (debt waived, debt relieved and prompt paid borrowers) with respect to selected indicators by using the following formula :

$$t = \frac{|\bar{X}_1 - \bar{X}_2|}{\sqrt{S_p^2 \left( \frac{1}{N_1} + \frac{1}{N_2} \right)}}$$

$$S_p^2 = \frac{(n_1 - 1)s_1^2 + (n_2 - 1)s_2^2}{(n_1 + n_2 - 2)}$$

Where,

$\bar{X}_1$  = Mean of first group

$\bar{X}_2$  = Mean of second group

$N_1$  = No. of observations of first group

$N_2$  = No. of observations of second group

$S_p^2$  = Pooled variance of sample

$S_1^2$  = Variance of first group

$S_2^2$  = Variance of second group

Table-1 : Ownership pattern of assets by sample borrowers.

| S. No.     | Assets                  | Beneficiaries (n=60)         |                              |                                |                              | Non-beneficiaries (Prompt paid borrowers) (n=60) |                              |
|------------|-------------------------|------------------------------|------------------------------|--------------------------------|------------------------------|--------------------------------------------------|------------------------------|
|            |                         | Debt waived borrowers (n=30) |                              | Debt relieved borrowers (n=30) |                              |                                                  |                              |
|            |                         | No. of Farmers who owned     | Average purchase value (Rs.) | No. of Farmers who owned       | Average purchase value (Rs.) | No. of Farmers who owned                         | Average purchase value (Rs.) |
| <b>I</b>   | <b>Household Assets</b> |                              |                              |                                |                              |                                                  |                              |
|            | Fan                     | 21 (70.00)                   | 380.50                       | 25 (83.33)                     | 545.80                       | 43 (71.67)                                       | 412.00                       |
|            | Television              | 20 (66.67)                   | 4,525.00                     | 28 (93.33)                     | 8,545.00                     | 44 (73.33)                                       | 5,855.50                     |
|            | Transport Vehicles      | 13 (43.33)                   | 7,585.00                     | 18 (60.00)                     | 12,050.00                    | 30 (50.00)                                       | 31,520.00                    |
| <b>II</b>  | <b>Farm Assets</b>      |                              |                              |                                |                              |                                                  |                              |
|            | Tractor                 | 12 (40.00)                   | 70,500.00                    | 18 (60.00)                     | 1,25,000.00                  | 27 (45.00)                                       | 85,200.00                    |
|            | Bullock cart            | 15 (50.00)                   | 6,150.00                     | 22 (73.33)                     | 9,525.00                     | 34 (56.00)                                       | 9,550.00                     |
|            | Cultivator              | 12 (40.00)                   | 10,150.00                    | 18 (60.00)                     | 12,000.00                    | 25 (41.67)                                       | 11,500.00                    |
|            | Disc Plough             | 18 (60.00)                   | 8,500.00                     | 22 (73.33)                     | 10,500.00                    | 40 (66.67)                                       | 9,800.00                     |
|            | Rotovator               | 14 (46.67)                   | 8,700.00                     | 18 (60.00)                     | 9,000.00                     | 30 (50.00)                                       | 8,500.00                     |
|            | Pump sets               | 15 (50.00)                   | 9,500.00                     | 20 (66.67)                     | 12,200.00                    | 33 (55.00)                                       | 10,200.00                    |
|            | Sprayer                 | 17 (56.67)                   | 2,250.00                     | 22 (73.33)                     | 2,400.00                     | 40 (66.67)                                       | 2,350.00                     |
|            | Spades                  | 15 (50.00)                   | 350.00                       | 228 (93.33)                    | 380.00                       | 42 (70.00)                                       | 362.00                       |
|            | Sickles                 | 18 (60.00)                   | 100.00                       | 25 (83.33)                     | 150.00                       | 40 (66.67)                                       | 125.00                       |
|            | Hand hoe                | 18 (60.00)                   | 80.00                        | 22 (73.33)                     | 100.00                       | 38 (63.33)                                       | 80.00                        |
|            | Crowbar                 | 18 (60.00)                   | 500.00                       | 25 (83.33)                     | 550.00                       | 42 (70.00)                                       | 520.00                       |
| <b>III</b> | <b>Livestock</b>        |                              |                              |                                |                              |                                                  |                              |
|            | Cows                    | 18 (60.00)                   | 2,850.00                     | 22 (73.33)                     | 3,200.00                     | 40 (66.67)                                       | 3,00.00                      |
|            | Buffaloes               | 16 (53.33)                   | 8,500.00                     | 19 (63.33)                     | 9,500.00                     | 33 (55.00)                                       | 9,200.00                     |
|            | Bullock pair            | 17 (56.67)                   | 18,500.00                    | 21 (70.00)                     | 19,520.00                    | 35 (58.33)                                       | 19,200.00                    |
| <b>IV</b>  | <b>Farm buildings</b>   |                              |                              |                                |                              |                                                  |                              |
|            | Cattle shed             | 15 (50.00)                   | 12,500.00                    | 20 (66.67)                     | 13,200.00                    | 32 (53.33)                                       | 12,800.00                    |

**Note :** Figures in parentheses indicate percentage to total sample farmers in respective categories.

The resulting "t" values will be compared with table values at chosen (1% and 5%) level of significance.

## Results and Discussion

**Economic Profile of the sample farmers :** In general, the study of the farm assets, reveal the economic background of the farmer. Table-1 presents the asset position of the sample farmers of the study area. Among the farm assets, tractor was owned by all the categories of farmers. However, the proportion of farmers owned this asset was highest 60.00% among debt relieved borrowers with asset worth of Rs. 1, 25,000/- followed by 45.00% of non-beneficiary farmer's asset worth Rs. 85,200/- and 40.00 % among debt waived borrowers with asset value of Rs. 70,500/-. Similar trend was observed among the respondents with respect to Bullock cart; highest 73.33% among debt relieved borrowers with asset worth of Rs. 9,525/- followed by 56.00% of non-beneficiary farmers asset worth of Rs. 9,550/- and 50.00% among debt waived borrowers with asset value of Rs. 61,500/-. Similar trend was observed with respect to farm building; highest (66.67%) among debt relieved borrowers with asset worth of Rs. 13,200/- followed by of non-beneficiary farmers (53.33%) with asset worth of Rs. 12,800/- and (50.00%)

among debt waived borrowers with asset value of Rs. 12,500/-.

## Impact of Loan Waiver Scheme on Farmers

**Family expenditure pattern on necessities, comforts and luxuries :** The expenditure patterns of selected farm families viz., Debt waived, Debt Relieved and Prompt paid, were studied and details were presented in Table-2. In the debt waived borrowers (Fig.-1), out of the average house hold expenses Rs. 53,845.67, highest amount was spent for food Rs. 15,511.67 (28.81%), followed by fuel and lighting Rs. 13, 023.67 (24.19%), clothing and foot wear Rs.9,676.67 (17.97%), education Rs. 5,086.67 (9.45%), recreation and functions Rs. 3,020.00 (5.61%), medicines Rs. 2,734.00 (5.08%), maintenance of house Rs. 2,486.67 (4.62%) and Rs. 2,306.33 (4.28%) was used for comforts and luxuries. With regards to debt relieved borrowers (Fig.2), out of the average house hold expenses Rs. 76, 969.71, highest amount was spent for education of children Rs.16,116.04 (20.94%), followed by food Rs.15,877.33 (20.63%), fuel and lighting Rs. 13,207.00 (17.16%), clothing and foot wear Rs. 9,925.00 (12.89%), recreation and functions Rs. 8,175.67(10.62%), medicines Rs. 6,072.67(7.89%). About Rs. 4,286.67

Table-2 : Annual family expenditure of sample borrowers.

| S.No. | Particulars              | Beneficiaries (n=60)         |            |                                |            | Non-Beneficiaries (Prompt paid borrowers) (n=60) |            | A v/s B | B v/s C | A v/s C |
|-------|--------------------------|------------------------------|------------|--------------------------------|------------|--------------------------------------------------|------------|---------|---------|---------|
|       |                          | Debt waived borrowers (n=30) |            | Debt relieved borrowers (n=30) |            | Rs.                                              | Percentage | t-value | t-value | t-value |
|       |                          | Rs.                          | Percentage | Rs.                            | Percentage |                                                  |            |         |         |         |
| 1.    | Food                     | 15,511.67                    | 28.81      | 15,877.33                      | 20.63      | 17,431.50                                        | 27.60      | 1.16    | 0.50    | 0.62    |
| 2.    | Clothing and foot wear   | 9,676.67                     | 17.97      | 9,925.00                       | 12.89      | 8,765.00                                         | 13.88      | 0.31    | 2.24*   | 1.63    |
| 3.    | Fuel and lighting        | 13,023.67                    | 24.19      | 13,207.00                      | 17.16      | 13,246.83                                        | 20.97      | 0.81    | 0.21    | 1.13    |
| 4.    | House rent and repairs   | 2,486.67                     | 4.62       | 3,309.33                       | 4.30       | 2,467.50                                         | 3.91       | 12.10** | 12.89** | 0.25    |
| 5.    | Medicine                 | 2,734.00                     | 5.08       | 6,072.67                       | 7.89       | 3,528.75                                         | 5.59       | 23.57** | 26.11** | 13.54** |
| 6.    | Education                | 5,086.67                     | 9.45       | 16,116.04                      | 20.94      | 9,333.45                                         | 14.78      | 7.17**  | 5.40**  | 3.46**  |
| 7.    | Recreation and Functions | 3,020.00                     | 5.61       | 8,175.67                       | 10.62      | 6,045.17                                         | 9.57       | 44.69** | 1.88    | 2.67**  |
| 8.    | Comforts and Luxuries    | 2,306.33                     | 4.28       | 4,286.67                       | 5.57       | 2,338.33                                         | 3.70       | 19.26** | 29.13** | 0.43    |
|       | Total expenditure        | 53,845.67                    | 100.00     | 76,969.71                      | 100.00     | 63,156.54                                        | 100.00     | 10.62** | 3.80**  | 2.36**  |

Note : A = Debt waived borrowers, B = Debt relieved borrowers and C = Prompt paid borrowers

\*Significant at 5% level and \*\*Significant at 1% level

Table-3 : Annual income from different sources for sample borrowers.

| S. No. | Particulars | Beneficiaries (n=60)          |         |                                |         | Non-Beneficiaries (Prompt paid borrowers) (n=60) |         | A v/s B | B v/s C | A v/s C |
|--------|-------------|-------------------------------|---------|--------------------------------|---------|--------------------------------------------------|---------|---------|---------|---------|
|        |             | Debt waived borrowers (n= 30) |         | Debt relieved borrowers (n=30) |         | Rs.                                              | Percent | t-value | t-value | t-value |
|        |             | Rs.                           | Percent | Rs.                            | Percent |                                                  |         |         |         |         |
| 1.     | Agriculture | 31,486.50                     | 73.22   | 35,581.20                      | 49.20   | 44,245.98                                        | 64.50   | 6.70**  | 9.58**  | 0.16    |
| 2.     | Livestock   | 3,603.77                      | 8.44    | 24,932.50                      | 34.47   | 8,125.67                                         | 11.85   | 12.26** | 14.89** | 29.08** |
| 3.     | Wages       | 1,585.97                      | 3.69    | 3,414.23                       | 4.72    | 6,053.62                                         | 8.83    | 4.47**  | 11.01** | 5.00**  |
| 4.     | Salary      | 4,883.23                      | 11.36   | 4,045.70                       | 5.59    | 5,808.32                                         | 8.47    | 15.70** | 20.08** | 42.67** |
| 5.     | Business    | 1,414.93                      | 3.29    | 4,351.87                       | 6.02    | 4,361.63                                         | 6.36    | 22.84** | 0.08    | 29.61** |
| 6.     | Total       | 43,001.40                     | 100.00  | 72,325.50                      | 100.00  | 68,595.22                                        | 100.00  | 10.31** | 12.50** | 4.69**  |

Note : A = Debt waived borrowers, B = Debt relieved borrowers and C = Prompt paid borrowers.

(5.57%) was for comforts and luxuries and Rs. 3,309.33(4.30%) was used for maintenances of house.

In the case of non- beneficiary farmers (prompt paid borrowers) (Fig.3), out of Rs. 63,156.54, the average household expenses, highest amount was spent for food Rs. 17,431.50 (27.60%), followed by fuel and lighting Rs. 13,246.83 (20.97%), Education of children Rs. 9,333.45 (14.78%), clothing and foot wear Rs. 8,765.00 (13.88%), recreation and functions Rs. 6,045.17 (9.57%), medicines Rs. 3,528.75 (5.59%). About Rs. 2,467.50 (3.91%) was for maintenance of house and Rs. 2,338.33 (3.70%) was used for comforts and luxuries.

Total annual expenditure incurred by debt relieved borrowers (Rs. 76, 969.71) was higher than prompt paid (Rs. 63, 156.54) and debt waived borrowers (Rs. 53, 845.67). Interestingly, among the debt relieved and prompt paid borrowers, expenditure on children's education was two and half times more than that observed in case of debt waived borrowers. It could be inferred that with increase in income, families tend to spend more on their children's education.

Thus, House hold expenditure among the borrowers revealed that total annual expenditure incurred by beneficiary farmers was higher than non-beneficiary farmers. Among the house hold expenditure, clothing and

foot wear, house rent and repairs, medicine and comforts and luxuries are showing significant difference at one per cent level of significance. It could be inferred that with increase in income of families tend to spend more on their standard of living rather on spending on recreation and functions.

To know, whether these results of different categories of farmers are significantly differ or not, student 't-test' was employed and results were presented. As a whole, there is not much difference between beneficiaries and non-beneficiaries. But, total annual expenditure of prompt paid borrowers was significantly higher than debt waived borrowers. Further, there existed a significant difference between prompt paid borrowers and debt relieved borrowers; as well as between debt waived and debt relieved borrowers. But, at micro level there is significant difference between all categories of borrowers. This seems to be much adherence between the family expenditure and extent of debt, which in turn, plays role in repayment of the debt.

Increasing the educational level of the head of the family and reduction in the unproductive expenditure results in reducing the magnitude of indebtedness (5). In tune with the reference results from the present study shows more expenditure was born on education by

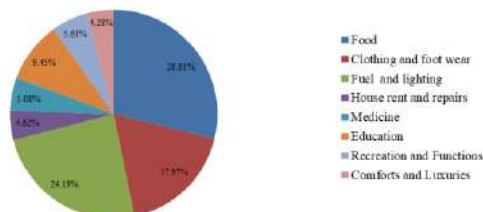


Fig.-1 : Component-wise shares of total family expenditure of debt waived borrowers.

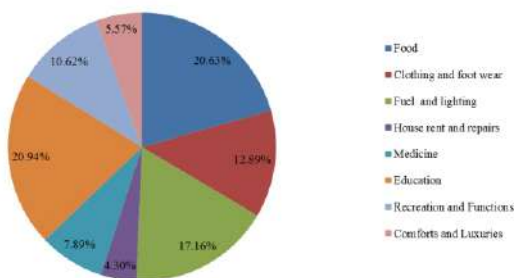


Fig.-2 : Component-wise shares of total family expenditure of debt relieved borrowers.

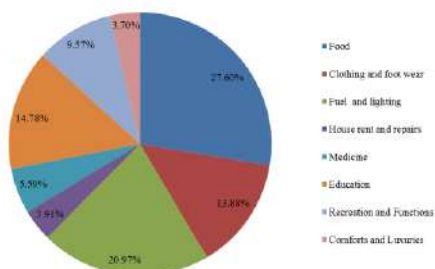


Fig.-3 : Component-wise shares of total family expenditure of prompt paid borrowers.

prompt paid borrowers where percentage of literates were more than debt waived borrowers and debt relieved borrowers.

**Annual income of sample borrowers :** A perusal of Table-4 shows that the annual income obtained from different categories of selected farmers. Among the debt waived borrowers; out of the total annual income of (Rs. 43,001.40), highest (Rs. 31,486.50) was obtained from agriculture (73.22%), followed by salary with 11.36% (Rs. 4,883.23), livestock with 8.44% (Rs. 3,603.77), wages with 3.69% (Rs. 1,585.97) and business with 3.29% (Rs. 1,414.93). With regard to debt relieved borrowers, highest contribution is from agriculture 49.20% (Rs. 35,581.20), followed by livestock with 34.47% (Rs. 24,932.50), business with 6.02% (Rs. 4,351.87), salary with 5.59% (Rs. 4,045.70) and wages with 4.72% (Rs. 3,414.23) as depicted in Fig. 5.15.

In case of non-beneficiary farmers, out of total annual income of Rs. 68,595.22 highest Rs. 44,245.98, was obtained from agriculture (64.50%), while, livestock, wages, salary and business contributed 11.85, 8.83, 8.47

and 6.36 per cent respectively with a magnitude of Rs. 8,125.67, Rs. 6,053.62, Rs. 5,808.32 and Rs. 4,361.63 respectively. Average annual income of debt relieved borrowers (Rs. 72,325.50) were more than prompt paid (Rs. 68,595.22) and debt waived borrowers (Rs. 43,001.40). Thus, in both expenditure and income, debt relieved borrowers are higher in comparison with other categories of borrowers. This shows that there is stickiness between income pattern and expenditure pattern.

To know, whether these results of different categories of farmers are significantly different or not student 't-test' was employed and results show that there existed a significant difference in incomes of all categories of borrowers viz., debt waived, debt relieved and prompt paid borrowers. Whereas, in case of debt waived and prompt paid borrowers there exist a significant difference in incomes from livestock, wages, salary and business. There existed a highly significant difference in incomes from agriculture, livestock, wages and salary in between prompt paid borrowers and debt relieved borrowers.

### Conclusions and Policy Implications :

There is not much difference between beneficiaries and non-beneficiaries in the impact of Loan waiver scheme on farmers' house hold expenditure. Whereas, there existed a significant difference among all categories of borrowers in their annual income.

The impact of Loan waiver scheme on Borrower wise-benefit of the Agricultural Debt waiver and Debt Relief Scheme-(2014) was extended higher by debt waived borrowers higher than debt relieved borrowers.

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## Estimation of Water Requirement of Drip Irrigated Bell Pepper (*Capsicum annuum* L.) Under Polyhouse

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### Abstract

Bell pepper crop is widely cultivated in all the States throughout India. Bell pepper requires favorable climate for good growth and production. To determine the water requirement of Bell pepper, a study was conducted in the department of Soil and Water Conservation Engineering, AEC&RI, TNAU, Trichy during the year 2019. Bell pepper variety Indra was raised inside Naturally ventilated polyhouse. Raised beds were made inside polyhouse and drip irrigation systems were laid out. The uniformity coefficient of drip irrigation was worked out. The soil water content was assessed through soil moisture sensors were installed at the depth of 20 cm. From the soil water depletion rate on daily basis the water requirement of Bell pepper was assessed.

**Key words :** Bell pepper, naturally ventilated polyhouse, soil moisture sensor, uniformity coefficient, water requirement.

### Introduction

Bell pepper belongs to the family *solanaceae*. The species belongs to America. India ranks fourth in the production of Bell pepper. Growing Bell pepper under naturally ventilated polyhouse produces good quality product as well as maximum yield. Raising of Bell pepper under drip irrigation will conserve moisture as well as lead to better absorbance of water in the crop root zone. The controlled environment inside polyhouse provides suitable weather condition for better crop productivity. Hence off season cultivation is possible to raise Bell pepper inside Naturally ventilated polyhouse. Bell pepper is being grown in many States like Tamil Nadu, Uttar Pradesh, Karnataka and Maharashtra. Erratic weather like high precipitation and water scarcity led to low production of Bell pepper in case of open field cultivation in North Eastern Himalayan region. Vegetable cultivation inside polyhouse increased production and productivity of crops in NEH region (9).

The impact of different moisture regime for the effective growth of Bell pepper was studied. They reported that irrigating Bell pepper at 1.0 ETc produced higher yield and good quality produce with the water consumption of 348 mm throughout the crop season (4). Decreasing irrigation rate decreased the yield components of Bell pepper and larger irrigation interval reduced the bell pepper yield (10). Higher yield (4 t/ha) of bell pepper was obtained when irrigating with 1.0 ETc compared to the yield (2.1 t/ha) obtained with irrigation with 0.5 ETc. They calculated the seasonal irrigation water requirement with Aqua crop model (8). The water requirement of bell pepper was calculated by deducting the effective rainfall from the actual crop

evapotranspiration (7). Hence calculation of actual evapotranspiration is very important in order to know the crop water requirement of Bell pepper. Drip irrigation methods gave maximum yield of bell pepper compared to other irrigation methods with water saving of 19% than the sprinkler irrigation system (1). Irrigation requirement was less (7.3% to 13%) in sub surface drip irrigation than the surface drip irrigation system for bell pepper cultivation and also reported 150 Kg/ha N fertilizer increased the bell pepper yield (5). Maximum yield and water use efficiency of cucumber were recorded in polyhouse compared to open field cultivation (2). They worked out actual evapotranspiration of the crop based on soil water balance method. In polyhouse, 100 % of the ETc produced good quality, yield and maximum water use efficiency of bell pepper (11). Cultivation of crops inside polyhouse would fetch better benefits than the crop growing outside condition and the pay back period would be within 3 to 5 years depends on the crop cultivation inside polyhouse (6)

### Materials and Methods

Soil samples were collected from the depth of 0 to 15 cm using screw auger and soil sample is dried, pulverized, sieved through 2 mm sieve. Then physical and chemical properties were estimated. The type of soil in the experimental field was sandy loam. It was identified through international pipette method. The pH of the soil was between 7 and 8. The electrical conductivity of the soil was less than 0.5 ds/m.

The textural triangle was found out by using Textural triangle method. Bulk density of the soil was calculated by core sample method. Particle density and porosity were calculated by cylinder method. Soil pH and Ec were

assessed by pH meter and Electrical conductivity digital meter respectively. Available Calcium, Magnesium, Nitrogen and Phosphorous also found out for the experimental soil.

Drip irrigation system was laid out. The seedling of bell pepper variety Indra was planted in paired row system. The raised bed size was 1.2 m width. Each lateral catered the needs of water for two rows of plants. The plant to plant spacing was 60 cm and row to row spacing was 45 cm. The Bell pepper seedlings were transplanted on July 2019 inside naturally ventilated polyhouse. The dripper capacity of 4 lph was used. The required population was maintained in the experimental field. Thinning and gap filling were done after 10 days of sowing. The recommended N:P:K dosage to Bell pepper was 250:150:150 kg/ha. 100% of phosphorous fertilizers were given as basal dose. N and K were applied through fertigation at fortnightly interval. Panchakavya was sprayed once in 15 days. Pest and disease management practices were also carried out.

The relative humidity, temperature, light intensity of the naturally ventilated polyhouse were recorded by PCE-THB 38 air humidity meter and lux meter. The readings at different time intervals 7.30 - 8.30 am, 12.30 – 1.30 pm and 4.00 – 5.00 pm were recorded. The average of the readings was noted on daily basis from transplanting to harvesting.

Water distribution uniformity of drippers was determined by placing the cans at randomly selected emitters of selected laterals. For particular time, the amount of water collected in the can at each drippers were recorded. The uniformity coefficient was determined by using variation discharge formula,

$$V_q = 0.667 \frac{t_{us} - t_{ls}}{t_{us} + t_{ls}} \times 100$$

Where,  $V_q$  = variation of discharge;  $t_{us}$  = sum of upper three readings;  $t_{ls}$  = sum of lower three readings

The soil moisture sensors were installed at the soil depth of 20 cm. The daily moisture content level was read from the digital meter. The daily variation of soil moisture depletion was calculated. Then based on soil moisture balance the actual crop water requirement was calculated. The bell pepper plant height, number of branches per plant and number of leaves per plant were observed at all plant growth stages. The yield per plant was recorded at each harvest and the total yield was calculated.

## Results and Discussion

The efficiency of drip irrigation system depends on uniformity of distribution of water. The uniformity coefficient of 93 % was obtained. There was good crop

growth and yield was found inside naturally ventilated polyhouse. The root length and distribution was found maximum as the crop was grown under controlled environment as well as under drip irrigation system. The average diameter of bell pepper fruit was 7.8 cm, the average length of fruit was 10 cm.

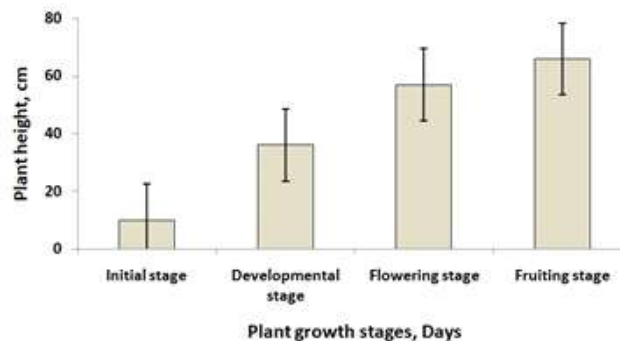


Fig-1 : Plant height throughout the crop season.

In naturally ventilated polyhouse the minimum temperature varied from 21.2 to 27.4°C; maximum temperature varied from 32.3 to 37.3°C. The relative humidity was ranged from 55 to 81.7%. The reference evapotranspiration value ranged from 3 to 6 mm throughout the crop season. The actual crop evapotranspiration value ranged from 0.5 mm to 9 mm for the entire crop growth period.

Table-1 : Monthly average maximum and minimum temperature, Relative Humidity and Light intensity in Naturally ventilated polyhouse.

| Month (Year 2019) | Maximum Temperature (°C) | Minimum Temperature (°C) | Relative Humidity (%) | Light Intensity (lux) |
|-------------------|--------------------------|--------------------------|-----------------------|-----------------------|
| June              | 37.3                     | 26.3                     | 55.0                  | 30303.0               |
| July              | 36.9                     | 26.8                     | 73.5                  | 27262.0               |
| August            | 35.8                     | 27.1                     | 76.5                  | 29566.0               |
| September         | 35.6                     | 27.4                     | 77.4                  | 22909.0               |
| October           | 35.0                     | 26.5                     | 79.5                  | 19362.0               |
| November          | 32.5                     | 22.4                     | 81.7                  | 21557.0               |
| December          | 32.3                     | 21.2                     | 80.4                  | 24096.0               |

The highest temperature was recorded during June month during the crop duration. The lowest minimum temperature was observed during December 2019. The relative humidity was found maximum during December and less during June 2019. It was due to the higher temperature inside naturally ventilated polyhouse. The light intensity was also found maximum during June 2019 that was the initial growth time of plants inside polyhouse.

Fig-2 shows the comparison between Potential evapotranspiration and actual crop evapotranspiration recorded by soil moisture sensors. The total crop water requirement of bell pepper was 503.9 mm throughout the crop season. Crop evapotranspiration of bell pepper was calculated by multiplying reference evapotranspiration

and crop coefficient. They had calculated the water requirement of bell pepper was 380 mm for the entire crop growth period (3).

## Conclusion

A study was conducted to determine the water requirement of Bell pepper. Bell pepper variety Indra was raised inside Naturally ventilated polyhouse. Raised beds were made inside polyhouse and drip irrigation systems were laid out. The uniformity coefficient of drip irrigation (93%) was worked out. The soil water content was assessed through soil moisture sensors. The total water requirement of bell pepper was calculated as 503.9 mm for the cultivation of bell pepper inside naturally ventilated polyhouse.

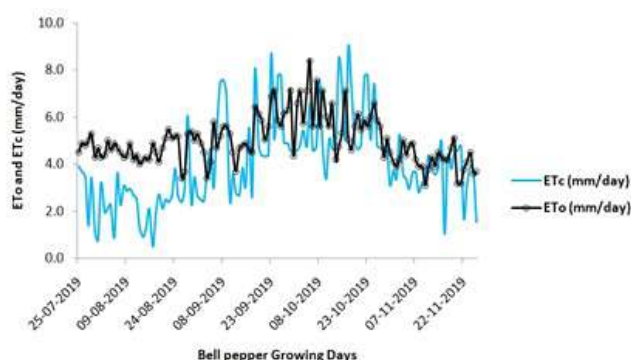


**Fig.-2 : Potential Evapotranspiration and Actual crop evapotranspiration.**

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## Effect of Sowing Dates on Fall Army Worm (*Spodoptera frugiperda*) Infestation and Yield in Maize

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### Abstract

Studies were conducted during the *Kharif* season of 2018 at Maize Research Centre, Agricultural Research Station, Vijayarai, West Godavari District with an objective of determining the effect of sowing dates on fall armyworm (FAW) infestation to minimize yield losses in maize. Popular maize hybrid Kaveri 50 was used in this study. Five dates of maize sowings starting from June 2<sup>nd</sup> fortnight to August 2<sup>nd</sup> fortnight were taken up at fortnightly intervals in a Randomized Complete Block Design (RCBD). The mean percent plant infestation of fall army worm was severe in late sown crop i.e, 2<sup>nd</sup> fortnight of August (50.06) as compared to early sown crop i.e, 1<sup>st</sup> fortnight of July (16.94). Leaf damage was scored by visual observation using the scale of 0–9 reported by Davis and Williams (1992). The crop sown during 2<sup>nd</sup> fortnight of August under natural infestation recorded more leaf damage with a mean score of 6.55 as compared to 1<sup>st</sup> fortnight of July (4.22). The per cent cob damage was lowest in early sown crop 1<sup>st</sup> fortnight of July (32.60) followed by 2<sup>nd</sup> fortnight of July (38.52) than in late sown crop i.e., 2<sup>nd</sup> fortnight of August (78.61). Highest yields were recorded in crop sown in 1<sup>st</sup> fortnight of July (5960 Kg ha<sup>-1</sup>) followed by 2<sup>nd</sup> fortnight of July (5688 Kg ha<sup>-1</sup>). Therefore, considering all facts, 1<sup>st</sup> fortnight of July and 2<sup>nd</sup> fortnight of July as sowing dates could be recommended in realizing higher yields.

**Key words :** fall army worm, *Spodoptera frugiperda*, maize, dates of sowing, cultural practices

### Introduction

Maize is called 'queen of cereals' due to its demand and wider adaptability. Maize is grown throughout the year due to its photo-thermo insensitive character and highest genetic yield potential among the cereals. In India, maize is cultivated throughout the year in most of states of the country for various purposes including grain, feed, fodder, green cobs, sweet corn, baby corn, pop corn and industrial products. In India, current consumption pattern of maize is poultry, pig, fish feed 52%, human consumption 24%, cattle feed and starch 11% and seed and brewery industry 1%. There are three distinct seasons for the cultivation of maize in India: *Kharif*, *Rabi* in Peninsular India and Bihar, and Spring in northern India. Maize is predominantly a *Kharif* season crop but in past few years *Rabi* maize has gained a significant place in total maize production in India.

Fall armyworm, *Spodoptera frugiperda* (J.E. Smith) (Noctuidae, Lepidoptera), is the major and notorious pest of maize. This pest is native to tropical and sub-tropical part of USA (CABI, 2017). The incursion of fall armyworm as an invasive pest into Asia was reported for the first time on maize crop in India during May 2018 (Sharanabasappa *et al.*, 2018a). Since then, it has spread to different states of India on maize (Mahadevaswamy *et al.*, 2018; Sharanabasappa *et al.*, 2018b) subsequently appearing

in Thailand (2018), Bangladesh (2019), China (2019), Myanmar (2019) and Sri Lanka (2019). Though it is major pest of maize but it also attacks more than 80 additional species of crop such as rice, millets, cotton (FAO, 2020) because of its polyphagous nature.

Fall armyworm (FAW) can be managed by adopting different approaches with varying degree of success. These include cultural methods (Prasanna *et al.*, 2018) and use of pheromone traps, biological controls, natural enemies, 'Push-Pull' strategy in which *Desmodium* spp. is used as push crop and Napier grass are used as pull crop (Midega, 2018) and chemical pesticides. Though the effectiveness of various control options is being evaluated, it is important to develop effective interventions that are ecofriendly for controlling Fall army worm. Although synthetic insecticides are commonly used to control field pests, their continuous use can result in pest resistance and increased reliance on chemical controls that may lead to high production cost and severe environmental effects (Perez *et al.*, 2000, Xu *et al.*, 2010).

The most important technique under cultural method is adjustment of planting time. Late planting of maize is more prone to infestation of fall armyworm. Farmer Field School (FFS) farmers in Kenya reported significant yield losses to FAW on late-planted maize plots, compared to adjacent earlier planted crops (FAO 2018). The experiment conducted in the study were aimed at

determining the effect of sowing time on fall armyworm (FAW) damage/infestation in a bid to minimize yield losses and concomitantly ensure food security.

## Materials and Methods

The experiment was conducted at Agricultural Research station, during *Kharif* season 2018. Maize hybrid Kaveri-50 was sown on five dates at fortnightly intervals starting from June 2<sup>nd</sup> Fortnight to August 2<sup>nd</sup> fortnight. (June 2<sup>nd</sup> fortnight, July 1<sup>st</sup> fortnight, July 2<sup>nd</sup> fortnight, August 1<sup>st</sup> fortnight and August 2<sup>nd</sup> fortnight.) The experiment was laid out in Randomized Complete Block Design (RCBD) with 5 treatments and four replications. Plot size was 5x4.5 m<sup>2</sup> with row and plant spacing of 75 and 20 cm, respectively. The plots were thoroughly prepared and all agronomic practices were uniformly applied to all treatments. Insecticides were sprayed in all the treatments but fungicides were sprayed as and when necessary. All the treatments were allowed for natural infestation of fall army worm. Fall army worm infestation (number of infested maize plants per plot) was regularly recorded in all un-protected plots at 10 days intervals starting from 20 days after sowings to 50 after sowings. Thus the data regarding percent plant infestation at 20, 30, 40 and 50 after sowings during vegetative stage. All the plants on each plot except border rows were visually observed for symptoms of FAW larval damage on leaves and leaf whorls (small holes, scratches, or skeleton damage of leaves with partially damaged epidermis giving a windowpane appearance). Leaf damage was also measured after 50 DAS in terms of scores based on Mean whorl feeding injury as visual score (1-9 scale) (Davis and Williams, 1992). Percent cob damage (number of cobs harvested and number of damaged cobs in each plot was recorded as the yield affecting factor) was recorded at the time of harvest. The yield of maize grains were assessed based on the weight obtained from all plots. The cobs in all treatments were harvested, shelled and cleaned. Grain yield from the net plot of each treatment was taken, dried, weighed and was converted to kg ha<sup>-1</sup> and are subjected to statistical analysis.

Maize infestation by fall armyworm (%)

$$= \frac{\text{Number of infested plants per plot}}{\text{Total number of plants per plot}} \times 100$$

Number of infested plants per plot

$$= \frac{\text{Number of infested cobs per plot}}{\text{Total number of cobs per plot}} \times 100$$

## Results and Discussion

The results showed that fall armyworm (FAW) incidence, damage varied with maize sowing dates. The highest

percent plant infestation by FAW was up to 62 % followed by 56% in August 2<sup>nd</sup> Fortnight sowings at 50 and 40 days after sowings (DAS) respectively.

**Percent infestation by Fall Army Worm :** Highest percent infestation by FAW was noticed in 2<sup>nd</sup> fortnight of August sowings (36.50) which is significantly different from other treatments at 20 days after sowing.

**At 30 days after sowing :** Lowest percent infestation by Fall Army Worm (8.25) was observed in 2<sup>nd</sup> fortnight of June sowings followed by 1<sup>st</sup> fortnight of July sowings (11.00) and both were at par. Percent infestation of FAW was significantly differed among remaining dates of sowing. Highest percent infestation by FAW was noticed in 2<sup>nd</sup> fortnight of August sowings (45.75) which is significantly different from all other treatments.

**At 40 Days after sowing :** Lowest percent infestation of FAW was noticed in first fortnight of July sowings (21.75) followed by 2<sup>nd</sup> fortnight of July sowings (29.50) and both were at par and significantly different from other dates of sowing viz., 1<sup>st</sup> fortnight of August sowings (41.25) and August 2<sup>nd</sup> fortnight sowings (56.00). Highest percent infestation by FAW was noticed in 2<sup>nd</sup> fortnight of August sowings (56.00) which is significantly different from all other treatments. Similar trend was followed even at 50 days after sowing also. Lowest percent infestation of FAW (27.75) was noticed in 1<sup>st</sup> fortnight of July sowings followed by 2<sup>nd</sup> fortnight of July sowings (34.35) and both were at par and significantly different from other dates of sowings. Highest percent infestation of FAW was noticed in 2<sup>nd</sup> fortnight of August sowings (62.00)

Cumulative data on percent plant infestation by FAW incidence after 50 days after sowing revealed that lowest infestation of FAW was noticed in 1<sup>st</sup> fortnight of July sowings (16.94), 2<sup>nd</sup> fortnight of July (22.68) and 2<sup>nd</sup> fortnight of June (27.62) all were at par with each other (Table-1).

**Leaf damage (Score) :** Leaf damage was taken in terms of Score given by (Davis and Williams, 1992). Data on leaf damage made by fall army worm in maize was influenced by different dates of sowings. This study revealed that mean leaf damage with a score (mean whorl feeding injury) ranged from 4.22 to 6.55 at 50 days after sowings. Significantly higher percentage of foliar damage was recorded in August 2<sup>nd</sup> Fortnight sowings followed by August 1<sup>st</sup> Fortnight sowings with scores of 6.55 and 6.30 respectively. Among all the five Fortnight sowings, the lowest leaf damage with a score of 4.22 when the crop was sown during 1<sup>st</sup> fortnight of July followed by July 2<sup>nd</sup> fortnight (4.72) and June 2<sup>nd</sup> Fortnight (4.85) sowings (Table. No 1).

**Percent cob damage :** The results of cob damage (%)

**Table-1 : Effect of sowing dates on percent plant infestation and Leaf damage by Fall Army Worm in Maize during Kharif, 2018.**

| Treatments                           | % plant infestation by fall army worm |                  |                  |                  |                  | Leaf damage (mean of whorl feeding injury) Score1-9 |
|--------------------------------------|---------------------------------------|------------------|------------------|------------------|------------------|-----------------------------------------------------|
|                                      | 20 DAS                                | 30 DAS           | 40 DAS           | 50 DAS           | Mean             | Score                                               |
| D1 2 <sup>nd</sup> Fortnight of June | 0.0                                   | 8.25<br>(16.60)  | 48.00<br>(43.80) | 54.25<br>(47.50) | 27.62<br>(28.42) | 4.85                                                |
| D2 1 <sup>st</sup> Fortnight of July | 7.25<br>(15.54)                       | 11.00<br>(19.30) | 21.75<br>(27.80) | 27.75<br>(31.70) | 16.94<br>(23.63) | 4.22                                                |
| D3 2 <sup>nd</sup> Fortnight of July | 10.00<br>(18.4)                       | 16.50<br>(23.80) | 29.50<br>(32.80) | 34.35<br>(26.10) | 22.68<br>(27.78) | 4.72                                                |
| D4 1 <sup>st</sup> Fortnight of Aug  | 14.25<br>(22.2)                       | 24.25<br>(29.50) | 41.25<br>(40.00) | 48.25<br>(44.00) | 32.00<br>(33.9)  | 6.30                                                |
| D5 2 <sup>nd</sup> Fortnight of Aug  | 36.50<br>(37.1)                       | 45.75<br>(42.50) | 56.00<br>(48.50) | 62.00<br>(52.00) | 50.06<br>(45.01) | 6.55                                                |
| Mean of fall army worm infestation   | 17.0                                  | 21.15            | 39.3             | 45.32            |                  |                                                     |
| F-test                               | Sig                                   | Sig              | Sig              | Sig              | Sig              | Sig                                                 |
| CD (P = 0.05)                        | 4.03                                  | 4.98             | 6.39             | 6.57             | 9.0              | 0.81                                                |
| CV (%)                               | 12.50                                 | 10.63            | 9.30             | 8.74             | 18.19            | 9.74                                                |

\*Arc-sine transformation; DAS = Days after Sowing

**Table-2 : Effect of sowing dates on cob damage by fall army worm and yield in maize during Kharif, 2018.**

| Treatments                           | % cob damage  | Yield (kg/ha) |
|--------------------------------------|---------------|---------------|
| D1 2 <sup>nd</sup> Fortnight of June | 53.08 (46.78) | 4202          |
| D2 1 <sup>st</sup> Fortnight of July | 32.60 (34.66) | 5960          |
| D3 2 <sup>nd</sup> Fortnight of July | 38.52 (38.14) | 5688          |
| D4 1 <sup>st</sup> Fortnight of Aug  | 64.74 (53.69) | 4927          |
| D5 2 <sup>nd</sup> Fortnight of Aug  | 78.61 (64.01) | 3913          |
| F-test                               | Sig           | Sig           |
| CD                                   | 11.76         | 592           |
| ICV                                  | 15.91         | 7.78          |

revealed percent cob damage differed with different dates of sowings. 1<sup>st</sup> fort night of July sowings having the lowest percent cob damage (32.60) followed by 2<sup>nd</sup> fort night of July sowings (38.52) and both were at par and later treatment were at par with 2<sup>nd</sup> fort night of June sowings (53.08). Highest percent of cob damage (78.61) was recorded in 2<sup>nd</sup> fortnight of August sowings significantly differed from other dates of sowings except August 1<sup>st</sup> fortnight sowings (64.74) (Table 2).

**Impact of Treatments on Maize Yield :** Maize grain yield ranged from 3913 kg ha<sup>-1</sup> to 5960 kg ha<sup>-1</sup> with the highest yield (5960 kg ha<sup>-1</sup>) in the 1<sup>st</sup> fortnight of July sowings followed by 2<sup>nd</sup> Fortnight of July sowings (5688 kg ha<sup>-1</sup>) and are on par with each other and differed significantly from other dates of sowings. Lowest yield occurred in the 2<sup>nd</sup> fort night of August sowings (3913 Kg ha<sup>-1</sup>).

High percent plant infestation, high leaf damage especially high cob damage resulted in lower yields in 2<sup>nd</sup> fortnight of August followed by 1<sup>st</sup> fortnight of August sowings. Further high foliar damage and high percent infestation likely decreases photosynthetic area thereby

reduced carbon fixation and consequently reduced plant growth and production (Dyer *et al.*, 2003; Silva *et al.*, 2015). Significant 40% increase in the incidence of FAW was observed in late planted crop compared to early and medium planted maize crops. Consequently, early planting gave a significantly higher yield by 122% compared to late planting (Nyabanga *et al.*, 2021). Our results indicated that mean percent infestation by fall army worm increased with age of the plant irrespective of date of sowings. Irrespective of dates of sowing, mean percent plant infestation by fall army worm is 17.0, 21.15, 39.3 and 45.32 at 20, 30, 40 and 50 days after sowings respectively (Table 2). Our results closely followed the results of Hruska and Gould (1997) who demonstrated that maize is more tolerant of lepidopteran infestation during early growth stages than at later stages. Fall army worm infestation was less at earlier stages of crop growth compared to later stage (Marenco, 1992).

Maize yield was negatively correlated to FAW severity (leaf damage) or rate of infestation and percentage cob damage as the maize yield decreased significantly with increased FAW severity or infestation and cob damage. Our results closely follows the findings of Alam *et al.* (2020) who reported that sowing dates (early, late or very late) was strongly negatively correlated decrease with the grain yield of maize. Further Farmer Field School (FFS) farmers in Kenya reported significant yield losses to FAW on late-planted maize plots, compared to adjacent earlier planted crops (FAO, 2018). Early harvest allows many corn ears to escape the higher armyworm densities that develop later in the season (Mitchell, 1978).

Overall, the maize yield is consistent with the infestation rate and increased as the rate of infestation decreased and vice versa, which strongly support the

hypothesis of this study that early dates of sowings were better in realizing higher yields by minimizing fall army worm damage compared to the later sowings.

## Conclusion

Our study suggests that percent infestation by fall army worm at both vegetative and reproductive stages can be minimized by sowing the maize seed during 1<sup>st</sup> and 2<sup>nd</sup> fortnight of July during *Kharif* season in realizing higher yields. This experiment is providing good database for assessing the level of damage done by fall army worm when sown at different fortnightly intervals during *Kharif* season. This could be used as cultural methods under IPM to reduce the insecticidal sprays and to avoid harmful effects to environment.

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## Training Need of Non-Beneficiaries' Farmers Regarding Improved Pomology and Olericulture Practices in Gwalior and Chambal Division

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### Abstract

The present study was conducted in Gwalior and Chamal division of Madhya Pradesh. The study was conducted in Ex-post facto research design. A total of 184 non-beneficiary farmers from each practice 50 per cent were selected from pomology and olericulture farming by simple random sampling method. Results indicated that the optimum number of the non-beneficiaries 57.61 per cent obsessed needed pomology training practices, most needed (41.3%), and not needed (1.09%) in pomology practice category. Conversely, olericulture practice category, optimum number of the non beneficiaries (64.13%) obsessed needed afterward most needed (32.61%), and not needed (3.26%).

**Key words :** *Training need, non-beneficiaries farmers, pomology practice, olericulture practice.*

### Introduction

Agriculture needs technology transfer to accelerate the production so that food is accessible to the common man. The large number of appropriate technologies has been generated at research stations, but only a few of them have been adopted at farm level. It is essential to see that the developed technology should reach grass root level farmers for whom it was developed. The agriculture science center is an innovative science support institution, which undertakes vocational training of rural youth, farm women, and farmers conducts on farm research for technology enhancement and FLDs to promptly demonstrate the latest agriculture technologies to the farmers in addition to the extension agents. The functions of KVK are mutual participation of farmers, subject matter specialist, scientists, extension workers, rural youth, and farm women. KVKs are grass root level vocational training Institutions considered for bridging the gap amid available technology at one end allied area as both at non-institutional level (off-campus) and institutional (on-campus) training conducting result and method demonstration at institutional farms in addition to the farmers field and also organizing a huge number of extension activities for quick adoption of latest agricultural technology among the farm women, farmers, rural youth, and fishermen. The KVKs arrange composite training programme of long and short duration based on logical study of the training needs and technology gaps by each KVKs through a scientific and systematic survey of villages.

Training is one of the crucial aspects of human resource development. This is a mean to reduce the obsolescence among people and organization in the face of relents less technological innovation. This plays a vital

role in making the farmers more receptive and equipping them with new technologies. This is the function of helping farmers in order to increase productivities. The Krishi Vigyan Kendra have got clear cut mandates for upgrading of farmers in terms of capacity building through training, demonstrated campaign and various sensitization programme. The KVKs are organizing different training for the farmers so that they can earn and sustain their family through remunerative enterprise. Therefore, the study conducted to explore the "Analytical study of KVK training programme on the farmers in Chambal and Gwalior division." with the following specific objective 'To study the training need of farmers regarding improved pomology and olericulture practices'.

### Materials and Methods

The study was conducted in Ex-post facto research design. Madhya Pradesh comprises of ten divisions viz. Ujjain, Indore, Gwalior, Bhopal, Sagar, Jabalpur, Chambal, Rewa, Hosangabad and shahdol out of 10 division, Gwalior and Chambal divisions were selected purposively. Gwalior division consists of 5 districts viz. (Gwalior, Ashoknagar, Shivpuri, Datia and Guna) and Chambal division consists of 3 districts (Morena, Bhind and Sheopur). All KVKs are arranged in the form of dictionary manner and 50 per cent KVKs (Ashoknagar, Datia, Gwalior, and Sheopur) were selected on the basis of systematic random sampling method.

Non-beneficiary farmers were selected according to a list of pomology and olericulture practices with the help of KVK scientists and a total of 184 non-beneficiary farmers from each practice 50 per cent was selected from pomology and olericulture farming by simple random sampling method. With this method 23 pomology and 23 olericulture non-beneficiaries were selected from each

**Table-1 : Practice wise distribution of the non-beneficiaries' farmers regarding improved pomology and olericulture practices.**

| S. No.    | Practices                            | Non-beneficiaries |            |          |     |      |      |
|-----------|--------------------------------------|-------------------|------------|----------|-----|------|------|
|           |                                      | MN                | N          | NN       | TS  | M    | R    |
| <b>A.</b> | <b>Pomology Practices (n=92)</b>     |                   |            |          |     |      |      |
| 1.        | Improved variety                     | 27 (29.34)        | 64 (69.57) | 1 (1.09) | 210 | 2.28 | V    |
| 2.        | Seed & seedling treatment            | 38 (41.30)        | 54 (58.70) | 0 (0.00) | 222 | 2.41 | III  |
| 3.        | Irrigation management                | 26 (28.26)        | 65 (70.65) | 1 (1.09) | 209 | 2.27 | VI   |
| 4.        | Balanced fertilizer                  | 48 (52.17)        | 44 (47.83) | 0 (0.00) | 232 | 2.52 | II   |
| 5.        | Training and pruning                 | 28 (30.44)        | 61 (66.30) | 3 (3.26) | 209 | 2.27 | VI   |
| 6.        | IPM/ IDM                             | 64 (69.57)        | 27 (29.35) | 1 (1.09) | 247 | 2.68 | I    |
| 7.        | Storage                              | 35 (38.04)        | 56 (60.87) | 1 (1.09) | 218 | 2.37 | IV   |
| <b>B.</b> | <b>Olericulture Practices (n=92)</b> |                   |            |          |     |      |      |
| 1.        | Improved variety                     | 16 (17.39)        | 74 (80.44) | 2 (2.17) | 198 | 2.15 | VIII |
| 2.        | Seed and plant treatment             | 32 (34.78)        | 56 (60.87) | 4 (4.35) | 212 | 2.30 | V    |
| 3.        | Weed control                         | 35 (38.04)        | 56 (60.87) | 1 (1.09) | 218 | 2.37 | IV   |
| 4.        | Method of sowing                     | 26 (28.26)        | 61 (66.30) | 5 (5.44) | 205 | 2.23 | VI   |
| 5.        | Irrigation method                    | 21 (22.83)        | 67 (72.83) | 4 (4.34) | 201 | 2.18 | VII  |
| 6.        | Stalking                             | 10 (10.87)        | 75 (81.52) | 7 (7.61) | 187 | 2.03 | IX   |
| 7.        | Balanced fertilizer                  | 45 (48.91)        | 44 (47.83) | 3 (3.26) | 226 | 2.46 | II   |
| 8.        | IPM/ IDM                             | 48 (52.17)        | 44 (47.83) | 0 (0.00) | 232 | 2.52 | I    |
| 9.        | Storage                              | 37 (40.22)        | 54 (58.69) | 1 (1.09) | 220 | 2.39 | III  |

MN = Most needed, N = Needed, NN = Not needed, TS = Total score, M = Mean, R = Rank

**Table-2 : Distribution of the non-beneficiaries according to their training need regarding improved pomology and olericulture practices.**

| S. No.    | Categories                    | Non-beneficiaries (n=92) | Percentage |
|-----------|-------------------------------|--------------------------|------------|
| <b>A.</b> | <b>Pomology practices</b>     |                          |            |
| 1.        | Not needed (8-13 Score)       | 01                       | 1.09       |
| 2.        | Needed (14-18 Score)          | 53                       | 57.61      |
| 3.        | Most needed (19-24 Score)     | 38                       | 41.30      |
| <b>B.</b> | <b>Olericulture practices</b> |                          |            |
| 1.        | Not needed (7-11 Score)       | 03                       | 3.26       |
| 2.        | Needed (12-15 Score)          | 59                       | 64.13      |
| 3.        | Most needed (16-21 Score)     | 30                       | 32.61      |

KVK. Thus the number of pomology and olericulture non-beneficiaries each was 92.

## Results and Discussion

### Practice wise training need of non-beneficiaries' farmers regarding improved pomology practices :

As obsessed improved variety, optimum number of the non beneficiaries (69.57%) had needed even as, most needed (29.34%) and not needed (1.09%).

As pragmatic seed and seedling treatment optimum number of the non beneficiaries (58.7%) had needed and most needed (41.3%).

As obsessed irrigation management, optimum number of the non beneficiaries (70.65%) had needed even as, most needed (28.26%) and not needed (1.09%).

As pragmatic balanced fertilizer, optimum number of the non beneficiaries (52.17%) had most needed and needed (47.83%).

As obsessed training and pruning, optimum number of the non beneficiaries (66.3%) had needed even as, most needed (30.44%) and not needed (3.26%).

As pragmatic IPM/ IDM, optimum number of the non beneficiaries (69.57%) had most needed even as, needed (29.35%) and not needed (1.09%).

As obsessed storage, optimum number of the non beneficiaries (60.87%) had needed even as, most needed (38.04%) and not needed (1.09%). (Table-1)

### Practice wise training need of non-beneficiaries' farmers regarding improved olericulture practices :

As pragmatic improved variety, optimum number of the non beneficiaries (80.44%) had needed even as, not needed (22.83%) and most needed (2.17%).

As obsessed seed and plant treatment, optimum number of the non beneficiaries (60.87%) had needed even as, most needed (34.78%) and not needed (4.35%).

As pragmatic weed control, optimum number of the non beneficiaries (60.87%) had needed even as, most needed (38.04%) and not needed (1.09%).

As obsessed method of sowing, optimum number of the non beneficiaries (66.3%) had needed even as, most needed (28.26%) and not needed (5.44%).

As pragmatic irrigation method, optimum number of

the non beneficiaries (72.83%) had needed even as, most needed (22.83%) and most needed (4.34%).

As obsessed stalking, optimum number of the non beneficiaries (81.52%) had needed even as, most needed (10.87%) and not needed (7.61%).

As pragmatic balanced fertilizer, optimum number of the non beneficiaries (48.91%) had most needed even as, needed (48.91%) and not needed (3.26%).

As obsessed IPM/ IDM, optimum number of the non beneficiaries (52.17%) had needed and most needed (47.83%).

As pragmatic storage, optimum number of the non beneficiaries (58.69%) had needed even as, most needed (40.22%) and not needed (1.09%). (Table-1)

**Extent of training need of non-beneficiaries farmers regarding improved pomology and olericulture practices :** Table-2 disclosed that the optimum number of the non-beneficiaries 57.61 per cent obsessed needed pomology training practices, most needed (41.3%), and not needed (1.09%) in pomology practice category. Conversely, olericulture practice category, optimum number of the non beneficiaries (64.13%) obsessed needed afterward most needed (32.61%), and not needed (3.26%).

## Conclusion

Training is a vital role play for quantitative and qualitative-based pomology production. If the government and

pomology-related agency focused on IPM/IDM, balanced fertilizer, seed and seedling treatment, and storage-related training then we can do doubling the income of the farmers. It can also play a vital role in the policy being framed by the government. If the training is provided to the farmers in a timely, monitoring and evaluation is done then there is a desirable change in the skill, performance, and overall development.

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## Bioefficacy and Phytotoxicity of Pyriproxyfen 10% + Bifenthrin 10% EC against Whitefly and Moong Bean Yellow Mosaic Virus (MBYMV) on Greengram

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### Abstract

Greengram [*Vigna radiata* (L.) Wilczek] is one of important pulse crops for diversifying cereal-based cropping systems worldwide. But various insect pests were attacking among these whitefly and MBYMV incidence resulting low yield in greengram. Based on ETL the spray foliar treatments were imposed and at KVK, Dharwad. Pyriproxyfen 10% + Bifenthrin 10% EC @ 1250 ml/ha (2.93/trifoliate leaf) was excellent in controlling Whitefly and Moong Bean Yellow Mosaic Virus (MBMV) which was at par with Pyriproxyfen 10% + Bifenthrin 10% EC @ 1000 ml/ha (3.10/trifoliate leaf), recorded 86.29 & 85.81 percent reduction after second application in both the season. The plot treated with Pyriproxyfen 10% + Bifenthrin 10% EC has no adverse effects or mortality of natural enemies thereby confirms the eco-safety. Looking at cost effectiveness and benefit cost ratio along with other parameters, Pyriproxyfen 10% + Bifenthrin 10% EC @ 1000 ml/ha can be recommended as the best dose for the control of Whitefly menace in the field.

**Key words :** Greengram, pyriproxyfen, bifenthrin, ec, whitefly and moong bean yellow mosaic virus.

### Introduction

Greengram [*Vigna radiata* (L.) Wilczek], (synonyms, *Phaseolus aurius* Roxb., *Phaseolus radiatus* L.) It is one of important pulse crops for diversifying cereal-based cropping systems worldwide. In India pulses have been considered poor men meat, also play major role in sustainable agriculture because pulses improve soil fertility through nitrogen fixation. It is estimated that, in India pulses are grown in 25.22 million ha, area yielding 19.27 million tones with an average yield of 764 kg/ha (Anonymous 2013-14 a).

In India during 2013-14 Green gram was cultivated on 3.28 million ha area and its production and productivity was 1.55 million tones and 317 kg/ha, respectively (Anonymous 2013-14a). It enhances the soil fertility by absorbing the atmospheric nitrogen, so it is used as a green manure crop. It is also used as cattle feed along with roughtage crops.

The most serious insect pests attacking on green gram includes white fly (*Bemisia tabaci*). Although there are various risk associated with Insecticide application but, still is has been considered as one of the most effective and quickest method of reducing insect pest population in the field. More often it forms the only solution to manage the out breaks of insect pests. Keeping this view present study was conducted to find out the efficacy of certain parameters as yellow mosaic virus (YMV) is a major observed disease in pulses during recent years. It results in heavy crop loss from 50 to 70 percent, especially if the disease occurs in the early stages of crop growth.

Keeping the present scenario into notice, trial was initiated for the evaluation of product Pyriproxyfen 10% + Bifenthrin 10% EC against Whitefly and Moong Bean Yellow Mosaic Virus (MBMV) in KVK, Dharwad. Based on ETL the spray foliar treatments were imposed. Two sprays were imposed on 15 days interval. Observations on whiteflies and YVMV were recorded one day before and 3, 7, 10 days after spraying, on five randomly selected plants covering three leaves, one each from top, middle and bottom portion of the plant. Seed yield was also recorded. The data were subjected to statistical analysis.

### Materials and Methods

A field experiment for evaluation of Pyriproxyfen 10% + Bifenthrin 10% EC against sucking pest Whitefly was conducted at ICAR-Krishi Vigyan Kendra, Dharwad. The field trial was laid out during Kharif 2018 (First season) & Rabi 2018-2019 (Second season).

The field experiment was laid out in a randomized block design (RBD) with 7 treatments and three replications. Sowing was taken up on 18.06.2018 (First season) and 14.01.2019.(Second season). Recommended doses of major fertilizers (nitrogen, phosphorus and potassium) were applied in the field along with well rotten FYM (Before sowing). Inter row spacing of 30cm and intra row spacing of 10 cm was maintained with the help of marked rope. The plot size for each treatment was 6x6mt. Weed management and other agronomic practices were followed properly in the experimental plots to ensure the uniformity in all the treatments.

**Table-1 : Bio-efficacy of Pyriproxyfen 10% + Bifenthrin 10% EC against Whitefly on Green gram – during, kharif season, 2018 (First Season) (Mean of three replications).**

| Treat-ments    | APT count/3 leaves | 1 <sup>st</sup> spray |                 |                 |       | 2 <sup>nd</sup> spray |                 |                 |       | Corrected % whitefly population reduction |                       |
|----------------|--------------------|-----------------------|-----------------|-----------------|-------|-----------------------|-----------------|-----------------|-------|-------------------------------------------|-----------------------|
|                |                    | 3DAS                  | 7DAS            | 10DAS           | Mean  | 3DAS                  | 7DAS            | 10DAS           | Mean  | 1 <sup>st</sup> Spray                     | 2 <sup>nd</sup> Spray |
| T <sub>1</sub> | 10.33              | 6.05<br>(2.55)        | 5.52<br>(2.45)  | 6.00<br>(2.54)  | 5.86  | 5.17<br>(2.38)        | 4.02<br>(2.12)  | 5.11<br>(2.36)  | 4.77  | 65.53                                     | 77.90                 |
| T <sub>2</sub> | 10.45              | 4.24<br>(2.17)        | 3.24<br>(1.93)  | 4.06<br>(2.13)  | 3.85  | 3.25<br>(1.93)        | 2.74<br>(1.8)   | 3.3<br>(1.94)   | 3.10  | 77.62                                     | 85.81                 |
| T <sub>3</sub> | 10.22              | 4.07<br>(2.13)        | 3.21<br>(1.92)  | 3.56<br>(2.01)  | 3.61  | 3.24<br>(1.93)        | 2.42<br>(1.70)  | 3.12<br>(1.90)  | 2.93  | 78.50                                     | 86.29                 |
| T <sub>4</sub> | 10.32              | 7.54<br>(2.83)        | 6.34<br>(2.61)  | 5.67<br>(2.48)  | 6.52  | 5.45<br>(2.43)        | 4.55<br>(2.24)  | 5.15<br>(2.37)  | 5.05  | 61.61                                     | 76.56                 |
| T <sub>5</sub> | 10.04              | 8.34<br>(2.97)        | 7.02<br>(2.74)  | 7.88<br>(2.89)  | 7.75  | 7.32<br>(2.79)        | 7.02<br>(2.74)  | 7.15<br>(2.76)  | 7.16  | 53.09                                     | 65.83                 |
| T <sub>6</sub> | 10.67              | 9.55<br>(3.17)        | 8.34<br>(2.83)  | 8.22<br>(2.95)  | 8.70  | 7.56<br>(2.83)        | 7.55<br>(2.83)  | 7.77<br>(2.87)  | 7.63  | 50.40                                     | 65.77                 |
| T <sub>7</sub> | 10.45              | 14.56<br>(3.88)       | 17.45<br>(4.72) | 19.55<br>(4.77) | 17.19 | 20.45<br>(4.57)       | 21.78<br>(4.72) | 23.23<br>(4.87) | 21.82 | 0.00                                      | 0.00                  |
| CD at 5%       | NS                 | 1.94                  | 2.15            | 0.20            |       | 2.55                  | 1.77            | 1.51            | -     | -                                         | -                     |
| SEm ±          | 0.09               | 0.67                  | 0.74            | 0.69            | -     | 0.88                  | 0.61            | 0.52            | -     | -                                         | -                     |

PTC – Pre-treatment count, Figures in parentheses are  $\sqrt{x} \ 0.5$  transformed values

In a column, means followed by a common letter(s) are not significantly different by DMRT ( $p=0.05$ )

**Table-2 : Bio-efficacy of Pyriproxyfen 10% + Bifenthrin 10% EC against Whitefly on Green gram – during, rabi season, 2018-19 (Second Season) (Mean of three replications).**

| Treat-ments    | APT count/3 leaves | 1 <sup>st</sup> spray |                 |                 |       | 2 <sup>nd</sup> spray |                 |                 |       | Corrected % whitefly population reduction |                       |
|----------------|--------------------|-----------------------|-----------------|-----------------|-------|-----------------------|-----------------|-----------------|-------|-------------------------------------------|-----------------------|
|                |                    | 3DAS                  | 7DAS            | 10DAS           | Mean  | 3DAS                  | 7DAS            | 10DAS           | Mean  | 1 <sup>st</sup> Spray                     | 2 <sup>nd</sup> Spray |
| T <sub>1</sub> | 11.45              | 5.02<br>(2.34)        | 4.89<br>(2.32)  | 4.96<br>(2.33)  | 11.45 | 4.03<br>(2.12)        | 3.78<br>(2.06)  | 3.76<br>(2.06)  | 3.86  | 70.93                                     | 83.61                 |
| T <sub>2</sub> | 10.76              | 4.76<br>(2.29)        | 3.45<br>(1.98)  | 3.98<br>(2.11)  | 10.76 | 3.45<br>(1.98)        | 2.33<br>(1.68)  | 3.01<br>(1.87)  | 2.93  | 74.64                                     | 86.75                 |
| T <sub>3</sub> | 11.44              | 4<br>(2.12)           | 3.43<br>(1.98)  | 3.95<br>(2.10)  | 11.44 | 3.77<br>(2.06)        | 2.55<br>(1.74)  | 2.98<br>(1.86)  | 3.10  | 77.73                                     | 86.81                 |
| T <sub>4</sub> | 11.86              | 8.45<br>(2.99)        | 7.02<br>(2.74)  | 7.02<br>(2.74)  | 11.86 | 6.78<br>(2.69)        | 5.52<br>(2.45)  | 6.71<br>(2.68)  | 6.34  | 57.55                                     | 74.00                 |
| T <sub>5</sub> | 11.9               | 7.77<br>(2.87)        | 6.09<br>(2.56)  | 7.01<br>(2.74)  | 11.9  | 6.09<br>(2.56)        | 5.01<br>(2.34)  | 6.01<br>(2.55)  | 5.70  | 60.74                                     | 76.68                 |
| T <sub>6</sub> | 11.45              | 8.04<br>(2.92)        | 7.05<br>(2.74)  | 6.67<br>(2.67)  | 11.45 | 7.98<br>(2.91)        | 6.34<br>(2.61)  | 6.65<br>(2.67)  | 6.99  | 57.46                                     | 70.29                 |
| T <sub>7</sub> | 11.89              | 15.67<br>(4.02)       | 17.67<br>(4.26) | 19.78<br>(4.50) | 11.89 | 22.43<br>(4.78)       | 24.09<br>(4.95) | 26.78<br>(5.22) | 24.43 | 0.00                                      | 0.00                  |
| CD at 5%       | NS                 | 1.71                  | 1.83            | 1.91            | -     | 2.06                  | 2.26            | 2.00            | -     | -                                         | -                     |
| SEm ±          | 0.12               | 0.59                  | 0.63            | 0.66            | -     | 0.71                  | 0.78            | 0.69            | -     | -                                         | -                     |

PTC – Pre-treatment count, Figures in parentheses are  $\sqrt{x} \ 0.5$  transformed values

In a column, means followed by a common letter(s) are not significantly different by DMRT ( $p=0.05$ )

The observations on population of white fly was recorded during morning hrs from randomly selected five plants from each plot by observing three leaves (top, middle & bottom) of each plant. The observations on the whitefly population was recorded one day before application (pre-treatment population) and three, five and ten days after application of insecticides. The second spray was done after rebuild up of pest population and again the observations were recorded at one day before and one, three, seven and fifteen days after the application of treatments. The plot yield in each treatment was recorded and expressed in yield/ha.

**Application of Treatments :** The test chemical, Pyriproxyfen 10% + Bifenthrin 10% EC was evaluated at three different doses of 600,1000,1250 ml/ha and compared with standard checks and untreated check. The Pyriproxyfen 10% + Bifenthrin 10% EC formulation was diluted in water before application as per the doses shown in treatments. Pyriproxyfen 10% EC @ 500 ml/ha, Bifenthrin 10% EC @800 ml/ha and Dimethoate 30% EC @500 ml/ha were used as standard comparative checks respectively. There was one untreated control treatment for the comparison of all spray treatments. Pyriproxyfen 10% + Bifenthrin 10% EC was applied as spray with the

**Table 3 : Effect of Pyriproxyfen 10% + Bifenthrin 10% EC on MBMV incidence on Green gram kharif season, 2018 (First Season)**

| Treatments     | Before Spray | 20 days after 1st spray | 20 days after 2nd spray | Mean  | Percent Protection |
|----------------|--------------|-------------------------|-------------------------|-------|--------------------|
| T <sub>1</sub> | 17.11        | 18.09 (25.17)           | 21.56 (27.67)           | 19.82 | 51.72              |
| T <sub>2</sub> | 15.33        | 16.43 (23.91)           | 17.78 (24.94)           | 17.10 | 58.35              |
| T <sub>3</sub> | 12.22        | 13.67 (21.70)           | 15.67 (23.32)           | 14.67 | 64.27              |
| T <sub>4</sub> | 16.21        | 17.78 (24.94)           | 18.67 (25.60)           | 18.22 | 55.62              |
| T <sub>5</sub> | 18.44        | 19.67 (26.33)           | 20.12 (26.65)           | 19.89 | 51.55              |
| T <sub>6</sub> | 20.22        | 22.78 (28.51)           | 24.09 (29.39)           | 23.43 | 42.93              |
| T <sub>7</sub> | 22.45        | 40.02 (39.24)           | 42.11 (40.46)           | 41.06 | -                  |
| CD at 5%       | NS           | 2.75                    | 2.63                    | -     | -                  |
| SEm ±          | 0.56         | 0.93                    | 0.89                    | -     | -                  |

Figures in parentheses are arc sine transformed values

**Table-4 : Effect of Pyriproxyfen 10% + Bifenthrin 10% EC on MBMV incidence on Green gram kharif season, 2018-19 (First Season).**

| Treatments | Before Spray | 20 days after 1 <sup>st</sup> spray | 20 days after 2 <sup>nd</sup> spray | Mean  | Percent Protection |
|------------|--------------|-------------------------------------|-------------------------------------|-------|--------------------|
| T1         | 16.76        | 17.21 (24.51)                       | 19.32 (26.07)                       | 18.26 | 44.80              |
| T2         | 14.21        | 15.33 (23.05)                       | 16.29 (23.80)                       | 15.81 | 52.20              |
| T3         | 10.25        | 11.61 (19.92)                       | 13.67 (21.70)                       | 12.64 | 61.78              |
| T4         | 16.22        | 17.78 (24.94)                       | 18.64 (25.58)                       | 18.21 | 44.95              |
| T5         | 18.44        | 19.45 (26.17)                       | 20.11 (26.64)                       | 19.78 | 40.20              |
| T6         | 20.22        | 21.90 (27.90)                       | 22.9 (28.59)                        | 22.4  | 32.28              |
| T7         | 25.91        | 32.02 (34.46)                       | 34.14 (35.75)                       | 33.08 | -                  |
| CD at 5%   | NS           | 2.41                                | 2.60                                | -     | -                  |
| SEm ±      | 0.64         | 0.81                                | 0.87                                | -     | -                  |

Figures in parentheses are arc sine transformed values

**Table-5 : Effect of Different dose of Pyriproxyfen 10% + Bifenthrin 10% EC on Natural Enemies population in Green gram during Kharif 2018 (Season-I).**

| Treatments                                                        | Coccinellids/5 plants |             |             |             |             |             | Spiders /5 plants |             |             |             |
|-------------------------------------------------------------------|-----------------------|-------------|-------------|-------------|-------------|-------------|-------------------|-------------|-------------|-------------|
|                                                                   | 1DBT                  | 3 DAS       | 7 DAS       | 10 DAS      | 14 DAS      | B.S.        | 3 DAS             | 7 DAS       | 10 DAS      | 14 DAS      |
| T <sub>1</sub> : Pyriproxyfen 10% + Bifenthrin 10% EC @600 ml/ha  | 4.00                  | 3.67 (2.04) | 2.98 (1.95) | 3.47 (1.99) | 3.29 (1.95) | 4.23 (2.25) | 3.12 (1.96)       | 5.67 (2.48) | 4.13 (2.14) | 4.00 (2.12) |
| T <sub>2</sub> : Pyriproxyfen 10% + Bifenthrin 10% EC @1000 ml/ha | 4.23                  | 3.23 (1.93) | 2.56 (1.87) | 3.17 (1.92) | 3.00 (1.87) | 4.11 (2.19) | 3.71 (1.94)       | 6.33 (2.61) | 3.64 (2.02) | 5.33 (2.41) |
| T <sub>3</sub> : Pyriproxyfen 10% + Bifenthrin 10% EC @1250 ml/ha | 4.50                  | 2.59 (1.76) | 3.65 (1.65) | 2.67 (1.78) | 2.23 (1.65) | 5.32 (2.47) | 4.11 (2.14)       | 4.33 (2.19) | 4.23 (2.19) | 3.33 (1.95) |
| T <sub>4</sub> : Pyriproxyfen 10% EC @ 500 ml/ha                  | 4.37                  | 2.37 (1.69) | 2.12 (1.57) | 2.00 (1.58) | 1.97 (1.57) | 5.21 (2.36) | 5.05 (2.14)       | 6.00 (2.54) | 5.26 (2.38) | 5.00 (2.34) |
| T <sub>5</sub> : Bifenthrin 10% EC @800 ml/ha                     | 4.00                  | 2.93 (1.85) | 2.01 (1.74) | 2.97 (1.86) | 2.53 (1.74) | 6.45 (2.57) | 5.28 (2.38)       | 4.67 (2.27) | 5.21 (2.46) | 3.67 (2.04) |
| T <sub>6</sub> : Dimethoate 30% EC @500 ml/ha                     | 4.20                  | 1.67 (1.47) | 2.11 (1.64) | 2.47 (1.72) | 2.19 (1.64) | 5.67 (2.34) | 5.93 (2.40)       | 5.00 (2.34) | 5.70 (2.50) | 5.20 (2.36) |
| T <sub>7</sub> : = Untreated Control                              | 4.67                  | 6.59 (2.66) | 5.15 (2.39) | 4.93 (2.33) | 5.23 (2.39) | 5.43 (2.36) | 5.04 (2.34)       | 5.00 (2.34) | 5.03 (2.34) | 5.20 (2.36) |
| CD at 5%                                                          | NS                    | NS          | NS          | NS          | NS          | NS          | NS                | NS          | NS          | NS          |

Figures in parentheses are  $\sqrt{x} - 0.5$  transformed values.

help of a knapsack sprayer fitted with hollow cone nozzle targeted against all vegetative parts of Green gram crop up to the point of runoff at 10 -15 days intervals. Totally three treatment applications were taken up during the experimental period.

#### Weather data :

**Observations recorded :** The data of target pests was recorded from randomly selected five plants in each

treatment and each replication. Observation of total number of Whitefly population was recorded from five top young leaves of each plant per plot.

The data were subject to analysis after making necessary transformation and express on the basis of percent reduction of pests population. The Green-gram yield (q/ha) from each plot was recorded and analyzed statistically.

**Table-6 : Effect of Different dose of Pyriproxyfen 10% + Bifenthrin 10% EC on Natural Enemies population in Green gram during Rabi 2018-2019 (Sesaon-II).**

| Treatments                                                        | Coccinelids/5 plants |                |                |                |                | Spiders/5 plants |                |                |                |                |
|-------------------------------------------------------------------|----------------------|----------------|----------------|----------------|----------------|------------------|----------------|----------------|----------------|----------------|
|                                                                   | B.S.                 | 3 DAS          | 7 DAS          | 10 DAS         | 14 DAS         | B.S.             | 3 DAS          | 7 DAS          | 10 DAS         | 14 DAS         |
| T <sub>1</sub> : Pyriproxyfen 10% + Bifenthrin 10% EC @600 ml/ha  | 3.89                 | 2.36<br>(2.04) | 3.79<br>(2.07) | 3.23<br>(2.04) | 3.29<br>(1.95) | 5.01<br>(2.34)   | 4.65<br>(2.48) | 3.12<br>(1.96) | 4.76<br>(2.19) | 3.89<br>(2.10) |
| T <sub>2</sub> : Pyriproxyfen 10% + Bifenthrin 10% EC @1000 ml/ha | 3.67                 | 3.32<br>(1.93) | 3.47<br>(1.99) | 2.65<br>(1.93) | 3.00<br>(1.87) | 6.22<br>(2.54)   | 7.25<br>(2.61) | 3.71<br>(1.94) | 5.82<br>(2.48) | 3.67<br>(2.04) |
| T <sub>3</sub> : Pyriproxyfen 10% + Bifenthrin 10% EC @1250 ml/ha | 3.00                 | 3.02<br>(1.76) | 2.67<br>(1.78) | 2.66<br>(1.76) | 2.23<br>(1.65) | 4.11<br>(2.12)   | 4.33<br>(2.19) | 4.11<br>(2.14) | 3.54<br>(2.04) | 3.00<br>(1.87) |
| T <sub>4</sub> : Pyriproxyfen 10% EC @ 500 ml/ha                  | 2.79                 | 3.12<br>(1.69) | 2.43<br>(1.71) | 2.39<br>(1.69) | 1.97<br>(1.57) | 5.67<br>(2.48)   | 6.00<br>(2.54) | 5.05<br>(2.14) | 5.65<br>(2.41) | 2.79<br>(1.81) |
| T <sub>5</sub> : Bifenthrin 10% EC @800 ml/ha                     | 3.23                 | 2.89<br>(1.85) | 3.17<br>(1.92) | 2.96<br>(1.85) | 2.53<br>(1.74) | 4.33<br>(2.19)   | 4.67<br>(2.27) | 5.28<br>(2.38) | 4.78<br>(2.12) | 2.43<br>(1.71) |
| T <sub>6</sub> : Dimethoate 30% EC @500 ml/ha                     | 2.43                 | 1.65<br>(1.47) | 1.89<br>(1.55) | 1.69<br>(1.47) | 2.19<br>(1.64) | 5.05<br>(2.35)   | 5.00<br>(2.34) | 5.93<br>(2.40) | 5.52<br>(2.37) | 2.37<br>(1.69) |
| T <sub>7</sub> : = Untreated Control                              | 6.00                 | 6.60<br>(2.66) | 6.79<br>(2.70) | 6.12<br>(2.66) | 5.23<br>(2.39) | 6.67<br>(2.67)   | 5.00<br>(2.34) | 5.04<br>(2.34) | 6.60<br>(2.54) | 6.00<br>(2.55) |
| CD at 5%                                                          | NS                   | NS             | NS             | NS             | NS             | NS               | NS             | NS             | NS             | NS             |

Figures in parentheses are  $\sqrt{x} - 0.5$  transformed values.

**Table-7 : Yield of green gram recorded in kharif season, 2018 and Rabi 2018-2019.**

| Treatments                                                        | Yield (q/ha) |              | Mean yield (q/ha) | % increase in yield over control |
|-------------------------------------------------------------------|--------------|--------------|-------------------|----------------------------------|
|                                                                   | Kharif 2018  | Rabi 2018-19 |                   |                                  |
| T <sub>1</sub> : Pyriproxyfen 10% + Bifenthrin 10% EC @600 ml/ha  | 12.45        | 12.11        | 12.28             | 33.06                            |
| T <sub>2</sub> : Pyriproxyfen 10% + Bifenthrin 10% EC @1000 ml/ha | 13.04        | 13.21        | 13.12             | 59.61                            |
| T <sub>3</sub> : Pyriproxyfen 10% + Bifenthrin 10% EC @1250 ml/ha | 13.11        | 13.24        | 13.17             | 60.21                            |
| T <sub>4</sub> : Pyriproxyfen 10% EC @ 500 ml/ha                  | 10.78        | 10.57        | 10.67             | 29.80                            |
| T <sub>5</sub> : Bifenthrin 10% EC @800 ml/ha                     | 9.4          | 9.33         | 9.39              | 14.23                            |
| T <sub>6</sub> : Dimethoate 30% EC @500 ml/ha                     | 9.65         | 9.02         | 9.33              | 13.50                            |
| T <sub>7</sub> : = Untreated Control                              | 8.00         | 8.45         | 8.22              | -                                |
| CD (p=0.05)                                                       | 1.65         | 2.11         | -                 | -                                |
| SEm ±                                                             | 0.56         | 0.72         | -                 | -                                |

Figures in parentheses are  $\sqrt{x} - 0.5$  transformed values.

**Table-8 : Benefit : Cost Ratio of Pyriproxyfen 10% + Bifenthrin 10% EC on green gram crop (kharif season, 2018 & Rabi 2018-2019).**

| Sr. No. | Treatments                                                        | Dose (ml/ha) (1) | Cost of Chemical/ kg/l (₹) & (2) | Cost of Chemical/ha For 2 spray (₹) (3) | Cost of Cultivation /ha (₹) (4) | Total Cost (₹) (5=3+4) | Total yield (Kg/ha) (6) | Gross Return @ 70/ Kg (7) | Net Returns (₹) (8=7-5) | BC Ratio (9=8/5) |
|---------|-------------------------------------------------------------------|------------------|----------------------------------|-----------------------------------------|---------------------------------|------------------------|-------------------------|---------------------------|-------------------------|------------------|
| 1.      | T <sub>1</sub> : Pyriproxyfen 10% + Bifenthrin 10% EC @600 ml/ha  | 600              | 1900                             | 2280                                    | 38000                           | 40280                  | 1228                    | 85960                     | 45680                   | 1.13             |
| 2.      | T <sub>2</sub> : Pyriproxyfen 10% + Bifenthrin 10% EC @1000 ml/ha | 1000             | 1900                             | 3800                                    | 38000                           | 41800                  | 1312                    | 91840                     | 50040                   | 1.20             |
| 3.      | T <sub>3</sub> : Pyriproxyfen 10% + Bifenthrin 10% EC @1250 ml/ha | 1250             | 1900                             | 4750                                    | 38000                           | 42750                  | 1317                    | 92190                     | 49440                   | 1.16             |
| 4.      | T <sub>4</sub> : Pyriproxyfen 10% EC @ 500 ml/ha                  | 500              | 1200                             | 1200                                    | 38000                           | 39200                  | 1067                    | 74690                     | 35490                   | 0.91             |
| 5.      | T <sub>5</sub> : Bifenthrin 10% EC @800 ml/ha                     | 800              | 1270                             | 2032                                    | 38000                           | 40032                  | 939                     | 65730                     | 25698                   | 0.64             |
| 6.      | T <sub>6</sub> : Dimethoate 30% EC @500 ml/ha                     | 500              | 550                              | 550                                     | 38000                           | 38550                  | 933                     | 65310                     | 26760                   | 0.69             |
| 7.      | T <sub>7</sub> : = Untreated Control                              | -                | 0                                | 0                                       | 38000                           | 38000                  | 822                     | 57540                     | 19540                   | 0.51             |

Based on these observations, mean insect population was worked out and statistically analyzed after transforming them. The per cent reduction in insect population over untreated control was worked out

treatment-wise using the formula of Henderson & Tilton Formula (1955).

**Observations on Phyto-toxicity :** The phytotoxicity test was carried out with test chemical Pyriproxyfen 10% +

Bifenthrin 10% EC at different doses such as 1000 and 1250 ml/ha & along with control. Observation was made on five randomly selected plants from each plot and the total number of leaves of those showing phytotoxicity, if any, were counted on 3, 7 and 10<sup>th</sup> days after spray and were recorded on wilting, necrosis, vein clearing, epinasty and hyponasty *etc.* The data collected are converted into percentage. Phyto-toxicity was assessed using a scale of different degree of effect on the plant during the entire cropping period. When there was no phyto-toxicity effect on plant, it was recorded as absolute zero grade.

#### Phyto-toxicity grades :

**Observations on natural enemies :** To see the

toxic impact of test insecticide at different doses on naturally occurring predator and parasites in Greengram ecosystem, the observations on numbers of natural enemies were recorded on 5 randomly selected plants in each replication in different treatments at 3, 7 and 10 days after each spray.

**Green gram yield :** The yield data were recorded after harvest of the crop and was computed per hectare and was summed up replication-wise for each treatment and subjected to ANOVA. The per cent increase in yield was worked out treatment-wise by using the formula: [(yield in treatment – yield in control) ÷ (yield in control)] x 100.

## Results and Discussion

### Efficacy against whitefly

**First Season :** Efficacy of different treatment

schedules of Pyriproxyfen 10% + Bifenthrin 10% EC was evaluated at three doses of 600, 1000 and 1250 ml/ha together with standard pesticides against whitefly has been presented in Table-1. It can be seen from the table that all the treatments undertaken for the trial were significantly superior over control. Pyriproxyfen 10% + Bifenthrin 10% EC @ 1250 ml/ha (2.93/trifoliolate leaf) was excellent in controlling the pest which was at par with Pyriproxyfen 10% + Bifenthrin 10% EC @ 1000 ml/ha (3.10/trifoliolate leaf), recorded 86.29 & 85.81 percent reduction after second application. Whereas Pyriproxyfen 10% EC @ 500 ml/ha (5.05), Bifenthrin 10% EC @ 800 ml/ha (7.16)

**Table-9 : Evaluation of different doses of Pyriproxyfen 10% + Bifenthrin 10% EC for phytotoxicity in greengram during kharif season, 2018 (I Season).**

| Treatments                                        | Phytotoxicity parameters (mean observations recorded 1, 3, 5, 7 and 10 days after first spray)* |   |   |   |    |          |   |   |   |    |          |   |   |   |    |
|---------------------------------------------------|-------------------------------------------------------------------------------------------------|---|---|---|----|----------|---|---|---|----|----------|---|---|---|----|
|                                                   | Vein clearing                                                                                   |   |   |   |    | Necrosis |   |   |   |    | Epinasty |   |   |   |    |
|                                                   | 1                                                                                               | 3 | 5 | 7 | 10 | 1        | 3 | 5 | 7 | 10 | 1        | 3 | 5 | 7 | 10 |
| Pyriproxyfen 10% + Bifenthrin 10% EC @ 1000 ml/ha | 0**                                                                                             | 0 | 0 | 0 | 0  | 0        | 0 | 0 | 0 | 0  | 0        | 0 | 0 | 0 | 0  |
| Pyriproxyfen 10% + Bifenthrin 10% EC @ 2000 ml/ha | 0                                                                                               | 0 | 0 | 0 | 0  | 0        | 0 | 0 | 0 | 0  | 0        | 0 | 0 | 0 | 0  |
| Pyriproxyfen 10% + Bifenthrin 10% EC @ 4000 ml/ha | 0                                                                                               | 0 | 0 | 0 | 0  | 0        | 0 | 0 | 0 | 0  | 0        | 0 | 0 | 0 | 0  |
| Control                                           | 0                                                                                               | 0 | 0 | 0 | 0  | 0        | 0 | 0 | 0 | 0  | 0        | 0 | 0 | 0 | 0  |

\*Spray volume of 500lts/ha, \*\* Scale 0=Healthy, 1=0-10%, 2 =11-20 %, 3=21-30%, 4=31-40 %, 5=41-50%, 6 =51-60%, 7=61-70%, 8=71-80%, 9=81-90% and 10=91-100%.

**Table-10 : Evaluation of different doses of Pyriproxyfen 10% + Bifenthrin 10% EC for phytotoxicity in greengram during Rabi 2018-2019 (II Season)..**

| Treatments                                        | Phytotoxicity parameters (mean observations recorded 1, 3, 5, 7 and 10 days after first spray)* |   |   |   |    |          |   |   |   |    |          |   |   |   |    |
|---------------------------------------------------|-------------------------------------------------------------------------------------------------|---|---|---|----|----------|---|---|---|----|----------|---|---|---|----|
|                                                   | Vein clearing                                                                                   |   |   |   |    | Necrosis |   |   |   |    | Epinasty |   |   |   |    |
|                                                   | 1                                                                                               | 3 | 5 | 7 | 10 | 1        | 3 | 5 | 7 | 10 | 1        | 3 | 5 | 7 | 10 |
| Pyriproxyfen 10% + Bifenthrin 10% EC @ 1000 ml/ha | 0**                                                                                             | 0 | 0 | 0 | 0  | 0        | 0 | 0 | 0 | 0  | 0        | 0 | 0 | 0 | 0  |
| Pyriproxyfen 10% + Bifenthrin 10% EC @ 2000 ml/ha | 0                                                                                               | 0 | 0 | 0 | 0  | 0        | 0 | 0 | 0 | 0  | 0        | 0 | 0 | 0 | 0  |
| Pyriproxyfen 10% + Bifenthrin 10% EC @ 4000 ml/ha | 0                                                                                               | 0 | 0 | 0 | 0  | 0        | 0 | 0 | 0 | 0  | 0        | 0 | 0 | 0 | 0  |
| Control                                           | 0                                                                                               | 0 | 0 | 0 | 0  | 0        | 0 | 0 | 0 | 0  | 0        | 0 | 0 | 0 | 0  |

\*Spray volume of 500lts/ha., \*\* Scale 0=Healthy, 1=0-10%, 2 =11-20 %, 3=21-30%, 4=31-40 %, 5=41-50%, 6 =51-60%, 7=61-70%, 8=71-80%, 9=81-90% and 10=91-100

and Dimethoate 30% EC @500 ml/ha (7.63). Untreated (Control) recorded maximum whitefly population (21.82/trifoliolate leaves).

**Second Season :** Efficacy of different treatment schedules of Pyriproxyfen 10% + Bifenthrin 10% EC was evaluated at three doses of 600, 1000 and 1250 ml/ha together with standard pesticides against whitefly has been presented in Table-2. It can be seen from the table that all the treatments undertaken for the trial were significantly superior over control. Pyriproxyfen 10% + Bifenthrin 10% EC @ 1250 ml/ha (3.10/trifoliolate leaf) was excellent in controlling the pest which was at par with Pyriproxyfen 10% + Bifenthrin 10% EC @ 1000 ml/ha (2.93/trifoliolate leaf), recorded 86.81 & 86.75 percent reduction after second application. Whereas Pyriproxyfen 10% EC @ 500 ml/ha (6.34), Bifenthrin 10% EC @ 800 ml/ha (5.70) and Dimethoate 30% EC @ 500 ml/ha (6.99). Untreated (Control) recorded maximum whitefly population (24.43/trifoliolate leaves).

**Effect on Moong bean Yellow Mosaic Virus :** These results proved that Pyriproxyfen 10% + Bifenthrin 10% EC @ 1250 ml/ha, were effective in controlling whitefly as well as incidence of yellow mosaic virus and registered higher yields with best cost: benefit ratio. Crop age influences the disease intensity and yield loss. If the disease occurs in the first 20 days of crop growth, the total yield loss may reach up to 94 % (Sastri and Singh, 1974). Plants of 50 and 65 days age suffer a yield loss as high as 84 and 49 %, respectively. Hence the spray imposed plots escaped the vector infestation in the early stages of crop growth resulting in less MBMV incidence and yield loss in the respective plots. The observation are recorded in tables (Table-3 and 4).

**Effect on parasites and predators :** Different coleopteran predators viz.; *Coccinella* spp. and *Spider* were found to be prevalent in Greengram eco-system. Attempts were also made to observe the relative toxicity of Pyriproxyfen 10% + Bifenthrin 10% EC against these natural enemies (Table-5 and 6). The results showed that

of Pyriproxyfen 10% + Bifenthrin 10% EC at all the dosages were absolutely soft against the naturally occurring predators irrespective of dosages. Thus, the test product was found IPM compatible as per our observations under West Bengal Gangetic alluvial plain agro-climatic conditions.

**Phytotoxicity :** No phytotoxic symptoms as mentioned in Table-9 and 10 were observed in any of the treated plots with of Pyriproxyfen 10% + Bifenthrin 10% EC @ 1000, 1250 and 2500 ml / ha during both the seasons. Thus, the product has been found to safe to the Green gram crop.

**Yield :** Yield data for two seasons is given in Table-7. The pooled data of two years revealed that Pyriproxyfen 10% + Bifenthrin 10% EC 1250 ml/ha recorded maximum fruit yield (14.55 q/ha) followed by Pyriproxyfen 10% + Bifenthrin 10% EC @ 1000 ml/ha (13.12 q/ha)

**Benefit : Cost Ratio :** Pyriproxyfen 10% + Bifenthrin 10% EC @ 1000 ml/ha recorded higher B: C ratio of 1.20, followed by Pyriproxyfen 10% + Bifenthrin 10% EC @ 1250 ml/ha (1.16) compared to remaining treatments (Table-9).

## Conclusion

The different insecticides tested in field revealed that Pyriproxyfen 10% + Bifenthrin 10% EC was the most effective comparatively to the other treatments against the control of whitefly and the prevention of Yellow vein Mosaic Virus spread by the pest. Pyriproxyfen 10% + Bifenthrin 10% EC @ 1250 ml/ha was found to be most effective for the control of Whitefly followed by the dosage treatment of Pyriproxyfen 10% + Bifenthrin 10% EC @ 1000 ml/ha for Green gram. The plot treated with Pyriproxyfen 10% + Bifenthrin 10% EC has no adverse effects or mortality of natural enemies thereby confirms the eco-safety. Looking at cost effectiveness and benefit cost ratio along with other parameters, Pyriproxyfen 10% + Bifenthrin 10% EC @ 1000 ml/ha can be recommended as the best dose for the control of Whitefly menace in the field.



## Effect of Maturity on Chemical Content of Bottle Gourd (*Lagenaria siceraria* Mol. Standl.) Fruits cv. Samrat

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### Abstract

Variation in chemical properties of bottle gourd fruits were analyzed at different maturity stages of plant. The observations were performed on the fruits from 65 days after sowing (M<sub>1</sub>), 70 days after sowing (M<sub>2</sub>), 75 days after sowing (M<sub>3</sub>) and 80 days after sowing (M<sub>4</sub>). The maturity of bottle gourd fruits measured by decreased moisture content, reducing sugars, non-reducing sugars, chlorophyll content, carbohydrates and phosphorus content while fiber content, calcium content, vitamin C and total soluble solids was found to be increased with advancement of maturity stages.

**Key words :** Bottle gourd, ripening, chemical configuration.

### Introduction

Bottle gourd (*Lagenaria siceraria* Mol. Standl.) is an important vegetable crop of tropical and subtropical region of the world belongs to family Cucurbitaceae and genus *Lagenaria*. The total area of *Lagenaria siceraria* cultivation in India is 149 thousand hectares with 2458 thousand tons of production (Anon, 2016).

Besides, *Lagenaria siceraria* has many health and nutritional on dry weight basis g per 100 g of *Lagenaria siceraria* reported moisture 94.5 g, fat 0.2 g, fiber 0.7 g, carbohydrate 3.75 g, calcium 12 mg, phosphorus 10 mg, iron 0.8 mg, thiamin 0.3 mg, riboflavin 0.05 mg, niacin 0.3 mg, sodium 1.7 mg, potassium 87 mg, and vitamin C 12 mg (Rumeza, 2006). The *Lagenaria siceraria* fruits are rich source of vitamins B, ascorbic acid, pectin, various saponins, fatty oils and fatty alcohols (Badmanaban and Patel, 2009). The manufacturing of value added products of *Lagenaria siceraria* will also help to start small scale industries because the demand for this product is increasing now days. Maturity stage of fruits affects physico-chemical parameters of *Lagenaria siceraria* fruits. This ultimately affects quality. Hence, an experiment was conducted to view the effect of different maturity stages on chemical configuration of bottle gourd fruits.

### Materials and Methods

The field experiment was carried out during the year *kharif*-2013 and summer-2014 at Instruction cum Research Farm, Department of Horticulture, MPKV, Rahuri on 'Samrat' variety of *Lagenaria siceraria* developed by Mahatma Phule Krishi Vidyapeeth, Rahuri with 3.0 x 1.5 m spacing of university recommendation.

The experiment was laid out in Completely Randomized Design with five replications. The cultural and plant protection measures were carried out as per university recommendations. Harvesting of *Lagenaria siceraria* fruits was done at 65-70-75 and 80 days after sowing i.e. immature, mature and over mature stage named as M<sub>1</sub>, M<sub>2</sub>, M<sub>3</sub> and M<sub>4</sub> respectively and used for chemical analysis. To study the chemical analysis, edible part of *Lagenaria siceraria* fruit from different maturity stages was taken. Moisture and total soluble solids were estimated by the method described by AOAC (Anon., 1990). However, reducing sugars, non-reducing sugars, titrable acidity, chlorophyll content, calcium, phosphorus, fiber, vitamin C by the Ranganna (2005).

### Results and Discussion

The *Lagenaria siceraria* fruits were harvested at different maturity stages i.e., M<sub>1</sub>, M<sub>2</sub>, M<sub>3</sub> and M<sub>4</sub> during *kharif* and summer seasons to analyse chemical configuration. The *Lagenaria siceraria* fruits were cylindrical in shape in all maturity stages whereas colour was change from dark green to light green with advancement of maturity stages.

Chemical parameters studied showed significant difference with respect to maturity stages of fruit. The moisture content in *Lagenaria siceraria* fruits was found to be significantly decreased with increased maturity stages from M<sub>1</sub> to M<sub>4</sub> during *kharif* as 95.15 to 94.30 per cent and during summer as 95.13 to 94.28 per cent. The fiber content was increased with respect to maturity stages from M<sub>1</sub> to M<sub>4</sub> ranged between 0.44 to 0.81 g/100 g during *kharif* and 0.44 to 0.82 g/100 g during summer. Reducing sugars content was significantly decreased with maturity stages increases from M<sub>1</sub> to M<sub>4</sub> during *kharif* (3.68 to 3.36 per cent) and during summer (3.69 to 3.36 per cent).

**Table-1 : Effect of different maturity stages on chemical parameters of *Lagenaria siceraria* fruits.**

| Treatment      | Moisture (%) |        | Fiber (g/100g) |        | Reducing sugars (%) |        | Non-reducing sugars (%) |        | Chlorophyll (mg/ml) |        | Vitamin C (mg / 100 g) |        |
|----------------|--------------|--------|----------------|--------|---------------------|--------|-------------------------|--------|---------------------|--------|------------------------|--------|
|                | Kharif       | Summer | Kharif         | Summer | Kharif              | Summer | Kharif                  | Summer | Kharif              | Summer | Kharif                 | Summer |
| M <sub>1</sub> | 95.15        | 95.13  | 0.44           | 0.44   | 3.68                | 3.69   | 6.61                    | 6.62   | 5.56                | 5.52   | 7.72                   | 7.73   |
| M <sub>2</sub> | 94.50        | 94.49  | 0.50           | 0.51   | 3.64                | 3.64   | 6.56                    | 6.56   | 5.30                | 5.29   | 7.89                   | 7.90   |
| M <sub>3</sub> | 94.47        | 94.46  | 0.69           | 0.69   | 3.44                | 3.44   | 6.35                    | 6.35   | 4.28                | 4.27   | 8.45                   | 8.47   |
| M <sub>4</sub> | 94.30        | 94.28  | 0.81           | 0.82   | 3.36                | 3.36   | 6.31                    | 6.31   | 4.17                | 4.16   | 8.24                   | 8.26   |
| G. mean        | 94.61        | 94.59  | 0.61           | 0.62   | 3.54                | 3.53   | 6.45                    | 6.46   | 4.83                | 4.81   | 8.08                   | 8.09   |
| S.E.±          | 0.00         | 0.00   | 0.006          | 0.003  | 0.009               | 0.01   | 0.001                   | 0.001  | 0.003               | 0.007  | 0.005                  | 0.029  |
| C.D.at 5%      | 0.01         | 0.01   | 0.018          | 0.011  | 0.029               | 0.05   | 0.003                   | 0.003  | 0.010               | 0.022  | 0.016                  | 0.089  |

**Table-1 : Contd....**

| Treatment      | TSS (°Brix) |        | Carbohydrate (g/100 g) |        | Phosphorus (mg/100g) |        | Calcium (mg/100 g) |        |
|----------------|-------------|--------|------------------------|--------|----------------------|--------|--------------------|--------|
|                | Kharif      | Summer | Kharif                 | Summer | Kharif               | Summer | Kharif             | Summer |
| M <sub>1</sub> | 3.29        | 3.30   | 2.53                   | 2.52   | 11.68                | 11.69  | 18.64              | 18.65  |
| M <sub>2</sub> | 3.33        | 3.33   | 2.39                   | 2.37   | 9.47                 | 9.47   | 20.54              | 20.55  |
| M <sub>3</sub> | 3.35        | 3.36   | 2.16                   | 2.14   | 9.23                 | 9.24   | 21.45              | 21.46  |
| M <sub>4</sub> | 3.37        | 3.37   | 1.89                   | 1.87   | 8.67                 | 8.67   | 22.77              | 22.78  |
| G. mean        | 3.33        | 3.34   | 2.24                   | 2.23   | 9.76                 | 9.77   | 20.85              | 20.86  |
| S.E.±          | 0.01        | 0.01   | 0.005                  | 0.005  | 0.001                | 0.001  | 0.001              | 0.001  |
| C.D. at 5%     | 0.02        | 0.02   | 0.017                  | 0.017  | 0.003                | 0.003  | 0.003              | 0.003  |

Non-reducing sugars content in *Lagenaria siceraria* fruit was significantly decreased with advancement of maturity stages from M<sub>1</sub> to M<sub>4</sub> as 6.62 to 6.31 per cent and 6.61 to 6.31 during *kharif* and summer, respectively. The chlorophyll content was significantly decreased with the advancement of maturity stages during *kharif* (5.56 to 4.17 mg/ml) and during summer (5.50 to 4.16 mg/ml). The titrable acidity in fruit was decreased with advancement of maturity stages from 0.15 to 0.11 per cent during *kharif* and 0.15 to 0.11 per cent during summer. The carbohydrate content in fresh fruit of *Lagenaria siceraria* decreased in respect of M<sub>1</sub> to M<sub>4</sub> maturity stages from 2.53 to 1.89 g/100 g during *kharif* and 2.52 to 1.87 g/100 g during summer. The TSS content (total soluble solid) was significantly increased for M<sub>1</sub> to M<sub>4</sub> maturity stages from 3.29 to 3.45 °B and 3.30 to 3.47 °B during *kharif* and summer, respectively. The vitamin-C content was increased significantly with advancement of maturity stages varying for M<sub>1</sub> to M<sub>4</sub> during *kharif* (7.72 to 8.24 mg/100 g) and during summer (7.73 to 8.25 mg/100 g). The calcium content in fresh fruit was increased significantly with advancement of maturity stages and accounted in M<sub>1</sub> to M<sub>4</sub> varying from 18.64 to 22.77 mg/100 g during *kharif* and 18.65 to 22.78 mg/100 g during summer. The phosphorus content was significantly decreased from M<sub>1</sub> to M<sub>4</sub> stages of maturity during *kharif* as 11.68 to 8.67 mg/100 g and during summer as 11.69 to 8.67 mg/100 g.

The chemical configurations of fresh *Lagenaria siceraria* fruits viz., fiber content, calcium content, vitamin-C content and total soluble solids was found to be increased, while moisture content, reducing sugars, non-reducing sugars, chlorophyll content, carbohydrate content and phosphorous content was found to be decreased with advancement of maturity stages (Table 2). The results are therefore supports the earlier work of Levis *et al.* (1983) in cucumber, Bhatnagar and Sharma (1994) in *Lagenaria siceraria* cv. Pusa Prolific Long, Libra *et al.* (2011) in *dioscoria* bulbils proximate configuration during growing period.

## Conclusion

From the present study it is conclude that, the chemical parameters viz. moisture, total soluble solids, reducing sugars, non-reducing sugars, carbohydrate, chlorophyll content, calcium, phosphorus, fiber and vitamin C could be considered as maturity indices to judge the maturity stages of *Lagenaria siceraria* fruits .

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## Food and Nutrition Security of Marginal and Small Farmers through Integrated Farming System in Southern Part of Chhattisgarh State

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### Abstract

The present study seeks to examine (1) the income and employment generation of integrated farming system models in Southern part of Chhattisgarh, (2) the changes in food consumption pattern of integrated farming system models in Southern part of Chhattisgarh, and (3) the perception of farmers in adoption of integrated farming system models in Southern part of Chhattisgarh. Out of 7 blocks of the Kanker district, 2 blocks namely Kanker and Charama were considered purposively as more number of IFS models were adopted in these blocks. A sample of 20 marginal and 20 small farmers were selected from each selected block. Thus, total 40 farmers were selected for the study.

### Introduction

Agriculture is an important sector of the Indian economy for long-term growth, since nearly 70% of rural and 8% of urban households still depends on it for their livelihood. At present, farming especially marginal and small farms are not economical viable due to changes in socio-economic and political environment. Indian farming is not viable, especially for marginal and small farmers.

Integrated farming system (IFS) model is one of the approaches to make the farming business economical viable at marginal and small farms. The various models of integrated farming system are developed by the scientists of Indira Gandhi Krishi Vishwavidyalaya, Raipur after doing research and validate at fields of marginal and small farmers. In view of this, the present study has been fulfilled with following specific objectives:

### Objectives

To work out the income and employment generation of integrated farming system models in Southern part of Chhattisgarh.

To examine the changes in food consumption pattern of integrated farming system models in Southern part of Chhattisgarh.

To identify the perception of farmers in adoption of integrated farming system models in Southern part of Chhattisgarh.

### Research Methodology

The present study was confined to Kanker district of Southern part of Chhattisgarh State it is because of most of the Integrated Farming System (IFS) models were developed by Krishi Vigyan Kendra, Kanker and same were validate into the marginal and small farmers' fields and adopted by farmers. Out of 7 blocks of the district, 2

blocks namely Kanker and Charama were undertaken purposively as more number of integrated farming systems was found in these blocks. The IFS models were validate in Aturgaon, Mohpur and Kulgaon villages in Kanker block, and Pradhandongri, Kartha, Telgara villages in Charama block of Kanker district. Therefore, these six villages were considered for the study. A list of the farmers having less than or equal to five acres of operational holding was prepared for each selected villages and further categorized into marginal farmers (2.5 acres) and small farmers (2.5 to 5 acres). From the lists, a sample of 20 marginal and 20 small farmers were considered from each selected block. Thus, total 40 farmers were selected to fulfilled the objectives of study. The primary data were collected through personal interview method on well-designed questionnaire and schedule of all the relevant aspects of study. The collected primary data were analyzed by using the simple averages and percentages statistical methods and finally presented in tabular form. The primary data was pertaining to the agriculture year 2020-21.

### Results and Discussion

The present study yielding many useful results and presented on the following heads.

**Different IFS models adopted by marginal and small farmers :** The six IFS models were developed by Krishi Vigyan Kendra (KVK) according to availability of resources and compatibility of farmers of Southern part in Kanker district i.e., (i) Crop + Dairy + Horticulture + Piggery, (ii) Crop + Dairy + Goatry + Horticulture (iii) Crop + Dairy + Fishery + Horticulture + Poultry + Piggery (iv) Crop + Dairy + Fishery + Goatry + Horticulture + Poultry (v) Crop + Fishery + Goatry + Horticulture + Poultry and (vi) Crop + Goatry + Horticulture. These IFS models were introduce into the marginal and small farmers' fields.

Table-1 : Income generation through introduction of IFS at marginal and small farms (Rs/farm/year).

| S. No. | Particular        | Marginal farmer  |                  | Small farmer     |                  |
|--------|-------------------|------------------|------------------|------------------|------------------|
|        |                   | Before IFS       | After IFS        | Before IFS       | After IFS        |
|        |                   | (Rs.)            | (Rs.)            | (Rs.)            | Percentage       |
| 1.     | Crop enterprises  | 53554.33 (83.58) | 42654.33 (26.22) | 48704.33 (42.91) | 41546.33 (13.29) |
| 2.     | Dairy             | -                | 53023.46 (32.60) | -                | 69673.46 (22.29) |
| 3.     | Poultry           | 2649.57 (4.14)   | 9959.57 (6.12)   | 3049.57 (2.69)   | 10959.57 (3.50)  |
| 4.     | Goatry            | 7864.13 (12.28)  | 30701.31 (18.87) | -                | 94701.31 (30.32) |
| 5.     | Piggery           | -                | 8749.75 (5.38)   | -                | 18649.75 (5.97)  |
| 6.     | Fisheries         | -                | 17545.66 (10.78) | 61738.55 (54.40) | 76945.66 (24.63) |
|        | Total farm income | 64068.03 (100)   | 162634.08 (100)  | 113492.45 (100)  | 312476.08 (100)  |

Table-2 : Different in income earned after adoption of IFS model at marginal and small farms. (Rs/farm/year).

| S.No. | Particular   | Marginal farmers                  |                                | Small farmers                     |                                |
|-------|--------------|-----------------------------------|--------------------------------|-----------------------------------|--------------------------------|
|       |              | Income from Different model (Rs.) | Percent change after IFS model | Income from Different model (Rs.) | Percent change after IFS model |
| 1.    | C+D+H+PG     | 104427.54                         | 62.99                          | 129869.54                         | 14.43                          |
| 2.    | C+D+G+H      | 114379.10                         | 78.52                          | 205921.10                         | 81.44                          |
| 3.    | C+D+F+H+P+PG | 131932.77                         | 105.92                         | 217774.77                         | 91.88                          |
| 4.    | C+D+F+G+H+P  | 153884.33                         | 140.18                         | 293826.33                         | 158.89                         |
| 5.    | C+F+G+H+P    | 100860.87                         | 57.42                          | 224152.87                         | 97.50                          |
| 6.    | C+G+H        | 73355.64                          | 14.49                          | 136247.67                         | 20.04                          |

(C-Crop, D-Dairy, F-Fisheries, G-Goatry, H- Horticulture PG-Piggery and P-Poultry)

#### Income through individual enterprise before and after adoption of IFS models :

Before adoption of IFS model, farmers of Kanker district, crop enterprise was commonly undertaken by sampled farmers under IFS models, despite crop enterprise, dairy, poultry, goatry, fishery, piggery and some of the horticultural crop were introduced through IFS model among marginal and small farmers of study area and same has been estimated in Rs./farm/year Table-1. It reveals that after introduction on IFS models a farm income per year of marginal farms was increased from Rs.64068.03 to Rs.162634.08 and found to be robust increase in percentage term i.e., 153.84 percent per farm/years. However, income of small farms was increased from Rs. 113492.45 to Rs.312476.08 per farm/year and in percentage term, it was increased to 175.32 percent per farm / year at small farm. It can be inferred that farm income of small farmers was increased more as compared to marginal farmers, it might be happened by proper manage of farms.

From the findings of income earned from crop enterprises were declined at marginal and small farms. The decline of income from crop enterprise were supplemented through introduction of dairy, goatry, piggery and fisheries enterprises at marginal and small farms by KVK Kanker. The increases in income at marginal farms was the maximum through dairy enterprise and found to be Rs.53023.46 per farm/year followed by crop enterprises (Rs. 42654.33), goatry (Rs.

30701.31), fisheries (Rs. 17545.66), poultry (Rs. 9959.57) and piggery (Rs. 8749.75), respectively. However, at small farms, goatry enterprises contributed the maximum and it was found to be Rs.94701.31 per farm / year followed by fisheries (Rs.76945.66), dairy (Rs.69673.46), crop enterprises (Rs.41546.33), piggery (Rs.18649.75), and poultry (Rs.10959.57), respectively. Thus, it could be concluded that IFS models are important to increase the income of most-lower class of farmers and these IFS models in study area helps to remove the poverty and backwardness of most lower class of farmers.

**Income earned through adoption of IFS models :** The IFS model means integrated farming a combination of different agricultural activities in a unit area of land with an aim to maximize the return as a whole and same has been worked out in Rs/farm/year, which is present in Table-2. It reveals that among the six introduced IFS models, Crop enterprises + Dairy + Fishery + Goatry + Horticulture and Poultry. (C+D+F+G+H+P) IFS model was found the maximum income and accounted Rs. 153884.33 per farm /year followed by C+D+F+H+P+PG (Rs. 131932.77), C+D+G+H (Rs.114379.10), C+D+H+PG (Rs.104427.54), C+F+G+H+P (Rs. 100860.87), and C+G+H (Rs.77355.64), respectively. The percent change from before adoption of IFS model was the maximum in C+D+F+G+H+P IFS model at marginal farms and it was found to be 140.18 percent increase after adoption of model and lowest percentage increase in C+G+H IFS

**Table-3 : Change in food expenditure on food consumption pattern after adoption of IFS model of marginal and small farmers.**  
(Rs./households/year)

| Particular         | Marginal farmer  |                  | Percentage Change | Small farmer    |                  | Percentage Change |
|--------------------|------------------|------------------|-------------------|-----------------|------------------|-------------------|
|                    | Before Rs.       | After Rs.        |                   | Before Rs.      | After Rs.        |                   |
| Cereals            | 10114.15 (31.01) | 12065.99 (28.06) | 19.29             | 11650.8 (30.81) | 13246.76 (27.18) | 13.69             |
| Pulses             | 3962.4 (12.14)   | 4054.7 (9.42)    | 2.32              | 3080.5 (8.14)   | 4132.5 (8.48)    | 34.15             |
| Vegetable          | 8451.75 (25.91)  | 10657.2 (24.79)  | 26.09             | 9062 (23.96)    | 10680 (21.91)    | 17.85             |
| Milk and product   | 604 (1.85)       | 1023 (2.38)      | 69.37             | 805 (2.13)      | 911 (1.86)       | 13.16             |
| Edible Oil         | 3073 (9.43)      | 5036 (11.72)     | 63.87             | 5279 (13.96)    | 7979 (16.36)     | 51.14             |
| Spices             | 1584 (4.85)      | 1819 (4.23)      | 14.83             | 1762 (4.66)     | 1977 (4.05)      | 12.20             |
| Meat               | 3167 (9.72)      | 6030 (14.02)     | 90.40             | 4042 (10.70)    | 7183 (14.73)     | 77.70             |
| Fruits             | 552 (1.70)       | 889 (2.06)       | 61.05             | 507 (1.34)      | 678 (1.39)       | 33.72             |
| Sugar and jiggery  | 1009 (3.09)      | 1300 (3.03)      | 28.84             | 1099 (2.92)     | 1344 (2.76)      | 22.29             |
| Miscellaneous item | 97 (0.30)        | 124.8 (0.29)     | 27.83             | 522 (1.38)      | 621 (1.28)       | 18.96             |
| Total food items   | 32614.30 (100)   | 42998.70 (100)   | 31.84             | 37809.30 (100)  | 48752.26 (100)   | 28.94             |

**Table-4 : Perceptions of farmers for adoption of IFS models.**

| S. No | Particulars                                                                                          | No. of farmers |    |
|-------|------------------------------------------------------------------------------------------------------|----------------|----|
|       |                                                                                                      | Yes            | No |
| 1.    | IFS help in reducing the vulnerability of In adverse weather condition                               | 36             | 4  |
| 2.    | Marketing become difficult for different products from IFS farm.                                     | 1              | 39 |
| 3.    | IFS make sure of food and nutritional security of farm family.                                       | 34             | 6  |
| 4.    | IFS helps to accelerate income enterprises.                                                          | 37             | 3  |
| 5.    | IFS ensure year round employment for family members.                                                 | 38             | 2  |
| 6.    | The manure and organic waste obtained from IFS farm reduce the dependence on fertilizer requirement. | 35             | 5  |
| 7.    | IFS helps to protect environment through recycling of animal waste.                                  | 36             | 4  |
| 8.    | The management of IFS farm is more difficult than conventional farm.                                 | 31             | 9  |
| 9.    | Fodder shortage can be managed by planting perennial fodder trees as a part of IFS.                  | 39             | 1  |
| 10.   | Every pieces of land can be effectively utilized in IFS.                                             | 33             | 7  |

model, which was found to be 14.49 percentage increased at marginal farms. However, income earned after adoption of IFS models at small farms was the maximum in C+D+F+G+H+P and accounted Rs. 293826.33 per farm /years followed by C+F+G+H+P (Rs. 224152.87), C+D+F+H+P+PG (Rs.217774.77), C +D+G+H (Rs.205921.10), C+G+H (Rs.136247.67) and C+D+H+PG (Rs. 129869.54), respectively. The changes in the income earned after adoption of IFS models at small farms was the maximum in adoption of C+D+F+G+H+P, which accounted 158.89 percent increase in the income after adoption of IFS models and minimum increase in the income earned was 14.43 percent in a adoption of C+D+H+PG. Thus, it can be inferred from the results that all the adopted six IFS models was supplement the significant amount of income at marginal and small farms as compared to non-adoption of IFS models.

**Change in food consumption expenditure after adoption of IFS models by sampled households :**  
Food consumption expenditure refers to monetary value

of acquired food items, which is estimated in changes of it before and after adoption of IFS models by marginal and small farmers of study area and same in presented in Table-3. It reveals that total food consumption expenditure of marginal and small farmers before adoption of IFS model was Rs. 32614.30 and Rs. 37809.30 per households/year and after adoption of IFS models it was Rs.42998.70 and Rs. 48752.26 per households/ year, which was found to be 31.84 and 28.94 percentage change in expenditure after adoption of IFS model than that of non-adoption IFS models. The expenditure on meat of marginal and small farmers was the maximum and found to be 90.40 and 77.70 percentage change after adoption of IFS model. The expenditure on vegetables, milk product, edible oil, fruits, sugar and jiggery and miscellaneous items were found to be significantly higher amongst the marginal farmers as compared to small farmers.

Thus, it was confirmed that as per increases in the income of poor farmers i.e., marginal and smallfarmers

have concentrate to fulfill the food and nutrition security of family members.

**Perception of farmers for adoption of IFS models :**

The various statements with regards to adoption of IFS models were asked from sampled of marginal and small farmers and it is presented in Table-4. It reveals that all the sampled farmers were agree with IFS model is help to reduce the risk and uncertainty in adverse weather conditions, secure the food and nutrition, accelerate the income, ensure to provide year round employment of family members, reduce the dependency on chemical fertilizers by utilization of organic waste from IFS models, protect the environment through recycling of animal waste and small pieces of land utilized effectively.

**Constraints in Adoption of IFS models :** Constraints in adoption of IFS models in their locality have taken into account from sampled farmers have reported that initial fund requirement is too high for the establishment of different enterprises. However, the Government has taken the initiative through sponsored the different schemes in favour to improve the livelihood of marginal and small farmers but the sampled farmers were reported that they did not have enough knowledge caused to not obtain the benefit of the scheme. They also reported that some time the unavailability of labour in peak time of agricultural

operation was a limiting factor. Another major constraint was unavailability of improve breed of goat and milch animals in the locality. The sampled farmers were also reported that often happening in resource competition in fish farming, cattle rearing and farming, which contradict to each other.

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## Response of GA<sub>3</sub> and Spacing on Quality Parameters of Gladiolus

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### Abstract

An experiment entitled "response of GA<sub>3</sub> and spacing on quality parameters of gladiolus (*Gladiolus grandifloras* L.) Cv. snow princess" have been conducted at the research instructional farm of AKSU, Satna during rabi seasons of 2015-16. Experiment compromised of three level of GA<sub>3</sub> such as 50ppm, 100ppm, 150ppm and three spacing viz., 30x15, 30x20 and 30x25cm etc. The results of the experiment showed application of GA<sub>3</sub> had significantly. Influence on the most parameters such as Days to opening of first flowering, no. of spike per plant, length of spikes and vase life of spikes at the @ 150ppm GA<sub>3</sub> and also significant all parameters on the wider spacing (30x25cm) of the plants.

**Key word :** *Gladiolus*, snow princess, iridaceae, GA<sub>3</sub> and quality.

### Introduction

Gladiolus is a botanically known as *Gladiolus grandifloras*, belonging to family Iridaceae. In the international cut flower trade gladiolus occupies fourth place. It is mainly cultivated for cut-flowers because of its elegant appearance and prolonged vase life. As a cut flower, it has great potentialities for the export to European countries during the winter months to even the valuable foreign exchange. Therefore, growing gladiolus on scientific footing is of immense needs for getting the quality blooms with exportable standards. Gladiolus spikes are most popular in flower arrangements and for preparing attractive bouquets. The magnificent above inflorescence with various colours have made it attractive for use in herbaceous borders, beddings, rockeries, pots and for cut flower. Due to its immense potential as ornamental crop and utter dearth of plant material of such elite species for commercial cultivation, need was felt to recuperate our production technologies for better qualitative as well as quantitative traits. An exogenous application of gibberellins has brought major advances in field of agriculture. Among exogenous gibberellins, GA<sub>3</sub> has been commonly used to manipulate vegetative growth, flowering and quality aspects in flowering crops. Apart from ornamental value, gladiolus have extensively utilized in medicines for headache, lumbago, diarrhea. Rheumatism and allied pains. Flower and corm of some gladiolus are used as food in many countries (Khan, 2006).

### Materials and Methods

The experiment was laid out in Randomized Block Design using nine treatments and three replications. The plan of the experiment is given in technical programme as under variety Snow princess, number of treatment

combination 09, GA<sub>3</sub> 50ppm, 100ppm, 150ppm, spacing-30 x15, 30x20 and 30x25cm row to row and plant to plant spacing etc.

### Results and Discussion

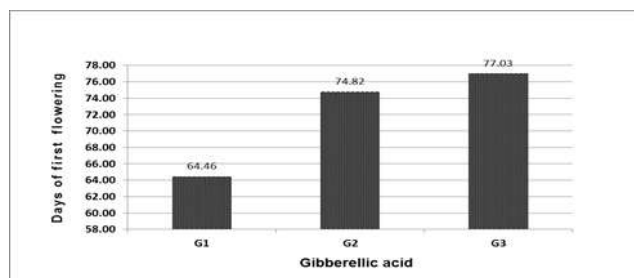
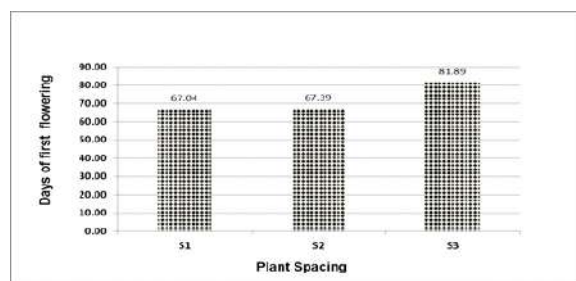
**Days to opening of 1<sup>st</sup> flowering (Days) :** An observation on the data obviously indicated that days to opening of 1<sup>st</sup> florets in gladiolus were significantly affected by the use of gibberellic acid higher doses of GA<sub>3</sub> which is minimum days to opening of 1<sup>st</sup> florets *i.e.*- 64.46 (days) were recorded by the use of 150ppm gibberellic acid. Spacing also highlighted the effect on days to opening of 1<sup>st</sup> florets in gladiolus and maximum days to opening of 1<sup>st</sup> florets *i.e.*- 67.04 was recorded by the use of wider spacing 30 x 25cm plant spacing followed by 30 x 20cm.

**Number of spikes/plant :** It is observed from the data referred in above table indicated that received the application GA<sub>3</sub> @ 150ppm brought paramount improvement in number of spikes plant<sup>-1</sup> and maximum spikes plant<sup>-1</sup> (1.37) spikes/plant were found which was significantly superior over rest of the treatment. A higher number of spikes were noticed when higher doses of GA<sub>3</sub> were used. Use of spacing also caused beneficial response on number of spikes of gladiolus and maximum number of spikes plant<sup>-1</sup> *i.e.* 1.49 was obtained when wider spacing (30 x 25cm) was used followed by 30 x 20 cm.

**Number of florets/spike :** An examination of data mentioned in above table obviously indicated that number of florets spike<sup>-1</sup> in gladiolus was significantly affected by the use of Gibberellic acid and maximum number of florets spike<sup>-1</sup> *i.e.* 21.48 florets/spikes were recorded by the use of 150ppm gibberellic acid. Spacing also highlighted the effect on number of florets spike<sup>-1</sup> in gladiolus and maximum number of florets *i.e.*- 23.21 spikes/plant was

**Table-1 : Days to opening of 1<sup>st</sup> flowering of Gladiolus as influenced by different doses of GA<sub>3</sub> and spacing.**

| Treatments                  | Days to first flowering |
|-----------------------------|-------------------------|
| <b>GA<sub>3</sub></b>       |                         |
| G <sub>1</sub> (50 ppm)     | 77.03                   |
| G <sub>2</sub> (100 ppm)    | 74.82                   |
| G <sub>3</sub> (150 ppm)    | 64.46                   |
| SEm±                        | 2.12                    |
| CD (p=0.05)                 | 6.37                    |
| <b>Spacing</b>              |                         |
| S <sub>1</sub> (30 x 15 cm) | 81.89                   |
| S <sub>2</sub> (30 x 15 cm) | 67.39                   |
| S <sub>3</sub> (30 x 15 cm) | 67.04                   |
| SEm±                        | 2.12                    |

**Fig-1 : Days to opening of 1<sup>st</sup> flowering of Gladiolus as influenced by different doses of GA<sub>3</sub>.****Fig-2 : Days to opening of 1<sup>st</sup> flowering of Gladiolus as influenced by different spacing.**

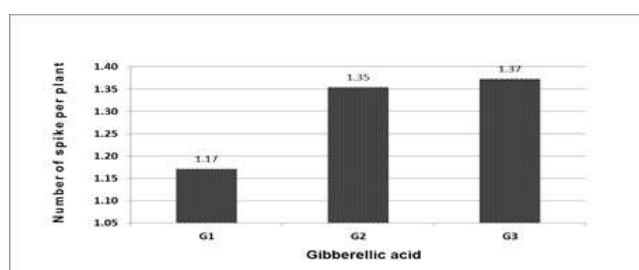
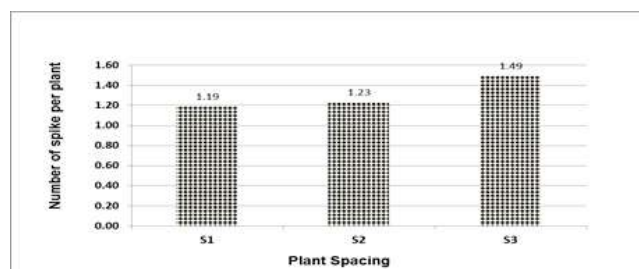
recorded by the use of wider spacing 30 x 25cm spacing followed by 30 x 20 cm.

**Length of spike (cm) :** An observation on the data obviously indicated that length of spikes in gladiolus was significantly affected by the use of gibberellic acid and higher doses of GA<sub>3</sub> which is maximum length of spikes *i.e.* 102.28 cm was recorded by the use of 150 ppm gibberellic acid. Use of spacing also caused beneficial response on length of spike of gladiolus and maximum length of spikes *i.e.* 111.21 cm was obtained when wider spacing (30 x 25cm) was used followed by 30 x 20 cm.

**Vase life of spike :** It is observed from the data referred in above table indicated that received the application of GA<sub>3</sub> @ 150ppm brought paramount improvement in vase life of spikes and maximum vase life of spikes plant<sup>-1</sup> 17.46 were found which was significantly superior over rest of the treatment. A maximum vase life of spikes was noticed

**Table-2 : Number of spikes of gladiolus as influenced by different doses of GA<sub>3</sub> and spacing.**

| Treatments                 | Number of spike plant |
|----------------------------|-----------------------|
| <b>GA<sub>3</sub></b>      |                       |
| G <sub>1</sub> (50 ppm)    | 1.17                  |
| G <sub>2</sub> (100 ppm)   | 1.35                  |
| G <sub>3</sub> (150 ppm)   | 1.37                  |
| SEm±                       | 0.04                  |
| CD (p=0.05)                | 0.12                  |
| <b>Spacing</b>             |                       |
| S <sub>1</sub> (30 x 15cm) | 1.19                  |
| S <sub>2</sub> (30 x 20cm) | 1.23                  |
| S <sub>3</sub> (30 x 25cm) | 1.49                  |
| SEm±                       | 0.04                  |
| CD (p=0.05)                | 0.12                  |

**Fig-3 : Number of spikes per plant of Gladiolus as influenced by different doses of GA<sub>3</sub>.****Fig-4 : Number of spikes per plant of Gladiolus as influenced by different spacing.**

when higher doses of GA<sub>3</sub> were word. Use of spacing also caused beneficial response on length of spike of gladiolus and maximum length of spikes *i.e.* 18.99 cm was obtained when wider spacing (30 x 25cm) was used followed by 30 x 20 cm.

In addition to these various other factors like days to opening of first flowering, number of spikes plants<sup>-1</sup>, number of florets spikes, length of spikes and vase life of spikes also considered as these are the parameters which ultimately decide the flower spikes. A cultivar possessing the desirable characters as mentioned above would be considered good cultivars even through it lacks one or more other characters. The merits and demerit of one cultivars are dis-abuse based on the different parameter studied. Hona and Goo (1991) under vindhya conditions found that sprouting was earlier in the corms of Cv. snow princess. This trend may be attributed to varietal quality

**Table-3 : Number of florets per spike of gladiolus as influenced by different doses of GA<sub>3</sub> and spacing.**

| Treatments                  | Number of florets per spike |
|-----------------------------|-----------------------------|
| <b>GA<sub>3</sub></b>       |                             |
| G <sub>1</sub> (50 ppm)     | 18.27                       |
| G <sub>2</sub> (100 ppm)    | 21.12                       |
| G <sub>3</sub> (150 ppm)    | 21.48                       |
| SEm±                        | 0.67                        |
| CD (p=0.05)                 | 2.00                        |
| <b>Spacing</b>              |                             |
| S <sub>1</sub> (30 x 15 cm) | 18.56                       |
| S <sub>2</sub> (30 x 20 cm) | 19.10                       |
| S <sub>3</sub> (30 x 25 cm) | 23.21                       |
| SEm±                        | 0.67                        |

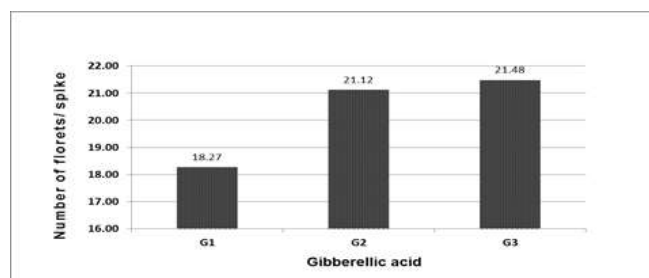


**Fig-5 : Number of florets per spike of Gladiolus as influenced by different doses of GA<sub>3</sub>.**

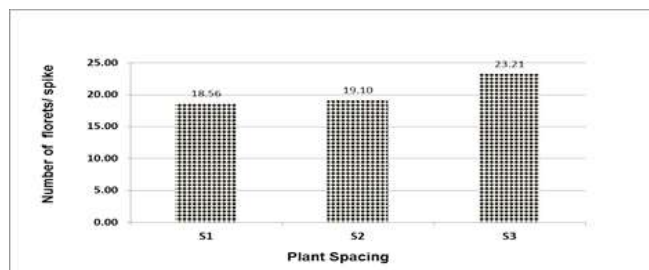


**Fig-6 : Number of florets per spike of Gladiolus as influenced by different spacing.**

parameter's; it may differ in particulars variety according to temperature and season. The cultivars had shown highly significant differences for the time taken for highly days to opening of first flowering, number of spikes plants<sup>-1</sup>, number of florets spikes, length of spikes and vase life of spikes. Cultivar was the earliest to come for highly days to opening of first flowering, number of spikes plants<sup>-1</sup>, number of florets spikes, length of spikes and vase life of spikes. This variation may be attributes to the different temperatures and seasonal conditions prevailing at different places in the particular area cultivars have maintained the difference, noticed in the number of days taken for highly days to opening of first flowering, number of spikes plants<sup>-1</sup>, number of florets spikes, length of spikes and vase life of spikes. Cultivars had shown highly significant all superior over the parameter's.

**Table-4 : Spike length of Gladiolus as influenced by different doses of GA<sub>3</sub> and spacing.**

| Treatments                  | Length of spike |
|-----------------------------|-----------------|
| <b>GA<sub>3</sub></b>       |                 |
| G <sub>1</sub> (50 ppm)     | 88.13           |
| G <sub>2</sub> (100 ppm)    | 101.61          |
| G <sub>3</sub> (150 ppm)    | 102.28          |
| SEm±                        | 3.06            |
| CD (p=0.05)                 | 9.19            |
| <b>Spacing</b>              |                 |
| S <sub>1</sub> (30 x 15 cm) | 88.92           |
| S <sub>2</sub> (30 x 20 cm) | 91.89           |
| S <sub>3</sub> (30 x 25 cm) | 111.21          |
| SEm±                        | 3.06            |
| CD (p=0.05)                 | 9.19            |

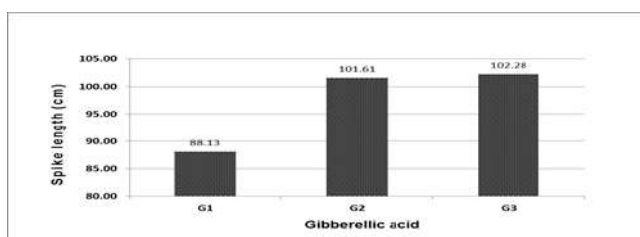


**Fig-7 : Spike length of Gladiolus as influenced by different doses of GA<sub>3</sub>.**

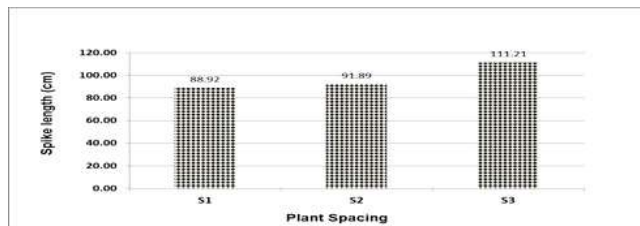


**Fig-8 : Length of spike of Gladiolus as influenced by different spacing.**

## Conclusion

The effect of GA<sub>3</sub> 150 ppm found significant role on quality parameters such as days to opening of first flowering, number of spikes plants<sup>-1</sup>, number of florets spikes, length of spikes and vase life of spikes of gladiolus. The treatments 150ppm GA<sub>3</sub> and wider spacing 30x25cm was found significantly superior over the treatments in respects to all quality parameters of gladiolus. But GA<sub>3</sub> 150 ppm and wider spacing 30x25 cm was found significantly in increase the gladiolus florets. On the basis of result summarized above the following specific conclusions are being warranted : (1) It may be concluded that foliar feeding of GA<sub>3</sub> @ 150 ppm and wider spacing 30x25 cm caused beneficial effect on days to opening of first flowering, number of spikes plants<sup>-1</sup>, number of florets spikes, length of spikes and vase life of spikes.

**Table-5 : Vase life of spike of gladiolus as influenced by different doses of GA<sub>3</sub> and spacing.**

| Treatments                  | Vase life |
|-----------------------------|-----------|
| <b>GA<sub>3</sub></b>       |           |
| G <sub>1</sub> (50 ppm)     | 15.12     |
| G <sub>2</sub> (100 ppm)    | 17.43     |
| G <sub>3</sub> (150 ppm)    | 17.46     |
| SEm±                        | 0.52      |
| CD (p=0.05)                 | 1.57      |
| <b>Spacing</b>              |           |
| S <sub>1</sub> (30 x 15 cm) | 15.25     |
| S <sub>2</sub> (30 x 20 cm) | 15.76     |
| S <sub>3</sub> (30 x 25 cm) | 18.99     |
| SEm±                        | 0.52      |

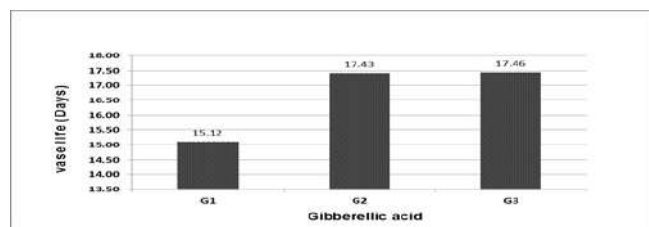


**Fig-9 : Vase life of spike of Gladiolus as influenced by different doses of GA<sub>3</sub>.**

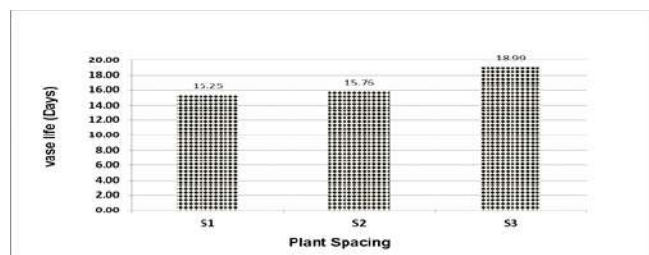


**Fig.-10 : Vase life of spike of Gladiolus as influenced by different spacing.**

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## Impact of In-Situ Incorporation of Paddy Straw with Different Nutrients Management Practices on Growth and Yield of Wheat (*Triticum aestivum* L.)

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### Abstract

A field experiment was carried out at Student Instructional farm, Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar, Kumarganj, Ayodhya (U.P.) during *Rabi* season 2019-2020 to evaluate the effect of *in-situ* applications of paddy in combination with various nutrients management practices on growth and yield of wheat. The experiments consist of six treatments T<sub>1</sub>-Control (No fertilizer), T<sub>2</sub>-RDF (120:60:40) No paddy Straw, T<sub>3</sub>-RDF (120:60:40) + Paddy Straw (5t/ha), T<sub>4</sub>-RDF (120:60:40) + Paddy Straw (5t/ha)+ FYM, T<sub>5</sub>-RDF (120:60:40) + Paddy Straw (5t/ha) + Extra N (20kg/ha), T<sub>6</sub>- RDF (120:60:40) + Paddy Straw (5t/ha) + Extra N (30kg/ha). The result revealed that maximum plant height, no. of tillers, test weight, grain per spike, Grain yield (q ha<sup>-1</sup>) Straw yield (q ha<sup>-1</sup>), Harvest index were obtained with treatments applying T<sub>6</sub>- RDF (120:60:40) + Paddy Straw (5t/ha) + Extra N (30kg/ha) which is closely followed by applying T<sub>5</sub>-RDF (120:60:40) + Paddy Straw (5t/ha) + Extra N (20kg/ha).

**Key words :** Wheat, paddy straw, growth, yield.

### Introduction

Wheat (*Triticum aestivum* L.) is a major cereal crop, which plays an important role in food and nutritional security. In India, total area under wheat is 31.0 mha, with production of 86.53 mt and the productivity of 2.8 t/ha (India stat, 2019). It is the staple food and meets nearly 61% of the protein requirement of India. Incorporation of rice straw before wheat planting compared to wheat straw before rice planting is difficult due to low temperatures and the short interval between rice harvest and wheat planting. Farmers use different straw management practices: burning, removal, or incorporation. Rice and wheat yields under these practices are generally similar. In few studies, wheat yields were lower during the first one to three years of rice straw incorporation 30 days prior to wheat planting, but in later years, straw incorporation did not affect wheat yields adversely. Incorporation of rice straw three weeks before wheat sowing significantly increases wheat yields on clay loam but not on sandy loam soil. About 10%-20% of N supplied through organic materials having high C:N ratio such as rice straw and stubble is assimilated by the rice crop, 10%-20% is lost through various pathways, and 60%-80% is immobilized in the soil. Addition of 10 tons per ha rice straw at four to five weeks before transplanting rice is equivalent to the basal application of 40 kg N per ha through urea. Application of 15 to 20 kg N per ha as starter dose with straw incorporation increases yields of wheat and rice compared to either burning of straw or its incorporation in the soil. At recommended fertilizer-N level, rice straw incorporation reduces rice yields than urea alone. Therefore, a higher dose of urea-N application with rice straw incorporation is necessary to get good

yields. The beneficial effect of straw incorporation before rice planting does not carry over to the succeeding wheat crop. Application of 30 kg extra N per ha than the recommended fertilizer dose increases rice yields only slightly (Singh and Singh 2001). Keeping these facts in view, the present investigation was done to evaluate the effect of *insitu* applications of paddy in combination with various nutrients management practices on growth and yield of wheat.

### Materials and Methods

The present investigation was carried out at Student Instructional farm of Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar Kumarganj, Ayodhya (U.P.) during *Rabi* season 2019-2020 to evaluate the effect of *insitu* applications of paddy in combination with various nutrients management practices on growth and yield of wheat. The experiments consist of six treatments T<sub>1</sub>-Control (No fertilizer), T<sub>2</sub>-RDF (120:60:40) No paddy Straw, T<sub>3</sub>-RDF (120:60:40) + Paddy Straw (5t/ha), T<sub>4</sub>-RDF (120:60:40) + Paddy Straw (5t/ha)+ FYM, T<sub>5</sub>-RDF (120:60:40) + Paddy Straw (5t/ha) + Extra N (20kg/ha), T<sub>6</sub>- RDF (120:60:40) + Paddy Straw (5t/ha) + Extra N (30kg/ha). All six treatments were randomly allocated and replicated three times in a randomized block design was adopted for the experimentation. The wheat variety PBW-502 was sown in first fortnight of December. All recommended agronomic practices were followed to raise the crop. Below normal temperatures prevalent during April 2019 delayed the maturity considerably at experimental site. Straw and grain yield parameters were recorded at maturity. Other observations included number of effective tillers per plant or per meter row, plant height at

**Table-1** : Effect of various nutrient management practices on plant height.

| Treatments     |                                                           | Plant height (cm) |        |        |                  |
|----------------|-----------------------------------------------------------|-------------------|--------|--------|------------------|
|                |                                                           | 30 DAS            | 60 DAS | 90 DAS | At harvest stage |
| T <sub>1</sub> | Control (No fertilizer)                                   | 18.15             | 40.10  | 79.15  | 78.10            |
| T <sub>2</sub> | RDF (120:60:40) No paddy Straw                            | 18.80             | 46.25  | 87.12  | 86.12            |
| T <sub>3</sub> | RDF (120:60:40) + Paddy Straw (5t/ha)                     | 19.10             | 49.85  | 89.18  | 88.26            |
| T <sub>4</sub> | RDF (120:60:40) + Paddy Straw (5t/ha) + FYM               | 19.60             | 56.80  | 96.80  | 95.10            |
| T <sub>5</sub> | RDF (120:60:40) + Paddy Straw (5t/ha) + Extra N (20kg/ha) | 19.70             | 57.15  | 97.15  | 95.93            |
| T <sub>6</sub> | RDF (120:60:40) + Paddy Straw (5t/ha) + Extra N (30kg/ha) | 19.95             | 58.45  | 99.25  | 98.33            |
| SEm±           |                                                           | 0.12              | 1.37   | 1.61   | 1.37             |
| C.D. (P=0.05)  |                                                           | 0.37              | 4.12   | 4.85   | 4.14             |

**Table-2** : Effect of various nutrient management practices on no. of tillers.

| Treatments     |                                                           | Number of tillers per meter <sup>2</sup> |        |        |                  |
|----------------|-----------------------------------------------------------|------------------------------------------|--------|--------|------------------|
|                |                                                           | 30 DAS                                   | 60 DAS | 90 DAS | At harvest stage |
| T <sub>1</sub> | Control (No fertilizer)                                   | 187.90                                   | 272.25 | 274.90 | 265.85           |
| T <sub>2</sub> | RDF (120:60:40) No paddy Straw                            | 195.24                                   | 322.18 | 324.10 | 318.65           |
| T <sub>3</sub> | RDF (120:60:40) + Paddy Straw (5t/ha)                     | 208.25                                   | 333.10 | 338.45 | 334.45           |
| T <sub>4</sub> | RDF (120:60:40) + Paddy Straw (5t/ha) + FYM               | 210.10                                   | 348.45 | 358.10 | 352.85           |
| T <sub>5</sub> | RDF (120:60:40) + Paddy Straw (5t/ha) + Extra N (20kg/ha) | 219.60                                   | 368.29 | 371.15 | 367.55           |
| T <sub>6</sub> | RDF (120:60:40) + Paddy Straw (5t/ha) + Extra N (30kg/ha) | 224.36                                   | 372.14 | 376.80 | 372.25           |
| SEm±           |                                                           | 2.84                                     | 3.17   | 3.43   | 3.72             |
| C.D. (P=0.05)  |                                                           | 8.56                                     | 9.54   | 10.34  | 11.20            |

maturity, spike length, number of grains per spike, grain test weight, etc. For plant height, plants selected at random were tagged and height was measured in centimeters from ground level to the base of the ear head. Effective tillers in one meter row length were counted from randomly selected rows in each plot. Grains per spike were assessed by randomly selecting ten ear heads from each plot. The data recorded on various parameters were subjected to statistical analysis following analysis of variance technique and were tested at 5% level of significance to interpret the significant differences.

## Results and Discussion

**Growth attributes :** The maximum plant height at 30, 60, 90 DAS (Table-1) was recorded with treatment applying T<sub>6</sub>- RDF (120:60:40) + Paddy Straw (5t/ha) + Extra N (30kg/ha) which statistically at par with the treatment having T<sub>5</sub>-RDF (120:60:40) + Paddy Straw (5t/ha) + Extra N (20kg/ha) but significantly higher to treatments viz. T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub>. The increased plant height might be due to cumulative effect of narrow C:N ratio, nutrients availability, soil health and good plant establishment with rice residue incorporation treatment and thus, with the effect of these factors, increased plant height was recorded. Stubble treatment had the little effect on plant height as reported by Griffin *et al.* (1982). Meelu *et al.* (1994) also reported that incorporation of residue had beneficial effects on plant height. Under Hissar conditions, Dhiman *et al.* (2000) reported the adverse effect of residue incorporation on

plant height during initial years however, the deleterious effect was counter balanced during the subsequent years. The maximum number of tillers at 30, 60, 90 DAS (Table-2) was recorded with the treatment consisting integrated approach of RDF + Paddy straw (5t/ha) + Extra N (30kg/ha) T<sub>6</sub> which was significantly higher to all the treatments which do not contains extra doses of nitrogen viz. T<sub>1</sub>, T<sub>2</sub>, T<sub>3</sub> and found non-significant with T<sub>5</sub> RDF + Paddy straw (5t/ha) + Extra N (20kg/ha). The minimum no. of tillers registered with treatment T<sub>1</sub>Control (No fertilizer).The higher no. of tillers might be due to hypothermal condition provided by paddy straw. These findings are also confirmed by Ahmed *et al.* 2007.

**Yield and yield attributes :** The yield attributes viz. Grains spike<sup>-1</sup>, Test weight (g) (Table-3)and Grain yield (q ha<sup>-1</sup>) Straw yield (q ha<sup>-1</sup>) (Table-4) were significantly higher in the treatment containing extra doses of nitrogen viz. T<sub>6</sub> RDF + Paddy straw (5t/ha) + Extra N (30kg/ha)which is statistically at par with T<sub>5</sub>- RDF + Paddy straw (5t/ha) + Extra N (20kg/ha). Treatment having T<sub>3</sub> RDF (120:60:40) + Paddy Straw (5t/ha) and T<sub>4</sub> -RDF (120:60:40) + Paddy Straw (5t/ha) + FYM found statistically at par with each other. Maximum value of harvest index was recorded under rice residue incorporation followed by rice residue removed and rice residue retained, respectively. It might be due to increase in grain yield, which was highest with rice residue incorporated as compared to increase in straw yield. Grain and straw yields affected significantly due to paddy straw

**Table-3 : Effect of various nutrient management practices on yield attributes.**

| Treatments     |                                                           | Grains spike <sup>-1</sup> | Test weight (g) |
|----------------|-----------------------------------------------------------|----------------------------|-----------------|
| T <sub>1</sub> | Control (No fertilizer)                                   | 33.94                      | 38.82           |
| T <sub>2</sub> | RDF (120:60:40) No paddy Straw                            | 37.67                      | 38.94           |
| T <sub>3</sub> | RDF (120:60:40) + Paddy Straw (5t/ha)                     | 41.08                      | 39.04           |
| T <sub>4</sub> | RDF (120:60:40) + Paddy Straw (5t/ha)+ FYM                | 46.06                      | 39.31           |
| T <sub>5</sub> | RDF (120:60:40) + Paddy Straw (5t/ha) + Extra N (20kg/ha) | 47.06                      | 39.36           |
| T <sub>6</sub> | RDF (120:60:40) + Paddy Straw (5t/ha) + Extra N (30kg/ha) | 48.69                      | 39.87           |
| SEm±           |                                                           | 1.83                       | 0.67            |
| C.D. (P=0.05)  |                                                           | 5.50                       | NS              |

**Table-4 : Effect of various nutrient management practices on yield of wheat.**

| Treatments     |                                                           | Grain yield (q ha <sup>-1</sup> ) | Straw yield (q ha <sup>-1</sup> ) | Harvest index |
|----------------|-----------------------------------------------------------|-----------------------------------|-----------------------------------|---------------|
| T <sub>1</sub> | Control (No fertilizer)                                   | 18.10                             | 23.53                             | 43.47         |
| T <sub>2</sub> | RDF (120:60:40) No paddy Straw                            | 31.18                             | 39.05                             | 42.80         |
| T <sub>3</sub> | RDF (120:60:40) + Paddy Straw (5t/ha)                     | 35.40                             | 46.25                             | 43.35         |
| T <sub>4</sub> | RDF (120:60:40) + Paddy Straw (5t/ha) + FYM               | 36.51                             | 48.06                             | 43.40         |
| T <sub>5</sub> | RDF (120:60:40) + Paddy Straw (5t/ha) + Extra N (20kg/ha) | 40.48                             | 53.84                             | 42.91         |
| T <sub>6</sub> | RDF (120:60:40) + Paddy Straw (5t/ha) + Extra N (30kg/ha) | 41.97                             | 56.24                             | 42.73         |
| SEm±           |                                                           | 1.13                              | 1.80                              | -             |
| C.D. (P=0.05)  |                                                           | 3.41                              | 5.42                              | -             |

management practices. The higher grain and straw yields were recorded with paddy straw incorporation which was significantly more than other paddy straw treatments. It might be due to the addition of crop residue which might have improved the soil health and consequently higher uptake of available nutrients from the soil. Thus, increased the number of grains per spike which ultimately attributed to increase in grain yield. Crop residue on decomposition released nutrients slowly throughout the growth period, which resulted better plant growth and higher straw yield. Under the clay loam soil incorporation of rice straw increased the wheat yield over sandy loam soil as reported by Singh *et al.* (1992). Increase in grain and straw yields of wheat with residue incorporation were also reported by Dwivedi and Thakur (2000) and Das *et al.* (2001).

## Conclusion

From the above, it may be clearly concluded that maximum plant height, no. of tillers, test weight, grain per spike, Grain yield (q ha<sup>-1</sup>), Straw yield (q ha<sup>-1</sup>), Harvest index were obtained with treatments applying T<sub>6</sub>- RDF (120:60:40) + Paddy Straw (5t/ha) + Extra N (30kg/ha) which is closely followed by applying T<sub>5</sub>-RDF (120:60:40) + Paddy Straw (5t/ha) + Extra N (20kg/ha) considered to be most effective for sustainable wheat production.

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## **An Appraisal of Trend in Area, Production and Productivity of Small Cardamom in Idukki District of Kerala**

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### **Abstract**

The present study is based on "An appraisal of Trend in Area, Production and Productivity of Small Cardamom in Idukki district of Kerala." Small cardamom (*Elettaria cardamom* Matton), the aromatic queen of spices, is one of the world's oldest and most expensive spices. The evergreen forests of South India's Western Ghats are regarded cardamom's native habitat as well as its source. The quality of Indian cardamom is well-known around the world, and it is sold to a number of countries. The major findings of the study concluded that, compound growth rate of the small cardamom in Idukki district and Kerala state was, area is negative significant growth rate of -0.28 percent and -0.32 percent because of uneven rainfall, climate change, higher input cost and higher labour cost. But the production and the productivity was 4.13 percent, 4.42 percent and 3.81 percent, and 4.14 percent it shows the positive compound growth rate. This may be the reason of the introducing of the higher yielding varieties and improved cultural practices followed by the cardamom cultivators.

**Key words :** area, production, productivity, compound growth rate.

### **Introduction**

Small cardamom (*Elettaria cardamom matton*), the aromatic queen of spices, is one of the world's oldest and most expensive spices. The evergreen forests of South India's Western Ghats are regarded cardamom's native habitat as well as its source. The quality of Indian cardamom is well-known around the world, and it is sold to a number of countries. Guatemala is the largest producer and exporter of small cardamom in the world with an average annual production of 38,000 tonnes in 2015-16. India, formerly the largest producer, is now the world's second largest producer with an annual production of 20,640 tonnes in 2017-18 (Spices Board, 2018). In India, Kerala accounts for 57 per cent of the area under cardamom cultivation and 89 per cent of the production in the country during the Triennial End (TE) 2016-17 (Spices Board, 2018), followed by Karnataka and Tamil Nadu. In Kerala, Idukki district accounts for the major share with an area of 31,166 hectares under small cardamom cultivation and a production of 17,914 tonnes in 2017-18.

**Objective of the Study :** To assess the increase rate of cardamom area, production, and productivity during the previous two decades in Idukki district and Kerala state. The main motto of the present study is the examine the existing situation of the small cardamom cultivation and assess the trend in area, production, production and productivity of small cardamom.

### **Materials and Methods**

For assess the compound growth rate of area, production

and productivity of Idukki district and Kerala state the secondary data was collected for the periods of 2000-01 to 2019-20. The secondary data will be collected from various government officials such as Spices Board of India, Directorate of Economics and Statistics, Govt. of Kerala, Krishi Bhavans, Department of Agriculture and from various sources.

**Compound growth rate :** By fitting an exponential function of the following form to an annual compound growth rate in area, production, and productivity of cardamom for Idukki district and Kerala state, annual compound growth rates in area, production, and productivity of cardamom were calculated for Idukki district and Kerala state. The following formula is used for finding the compound growth rate.

$$Y = A B^t$$

$$\text{Log } y = \log A + t \log B$$

Where,

Y = area/production/productivity

A = Constant

B = regression coefficient

### **Results and Discussion**

**Compound growth rate of area, production and productivity of small cardamom in Idukki district :** The growth rate of area, production and productivity of small cardamom in Idukki district (2000-01 to 2019-20) are presented in Table 2 and Fig 1,2,3 it reveals that the area under cardamom crop increases from 32,767 ha to 32865

**Table-1 : Area, production, and productivity of small cardamom in Idukki district (2000-01 to 2019-20).**

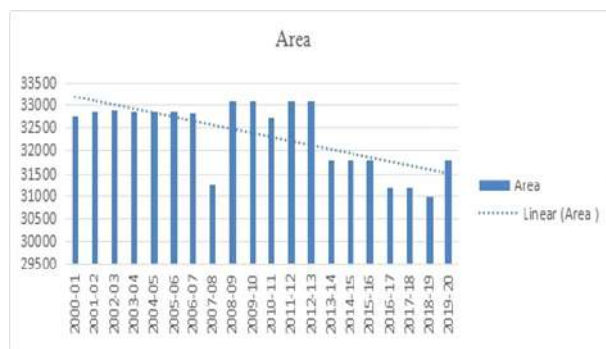
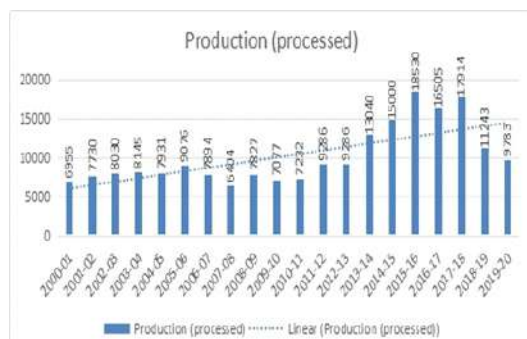
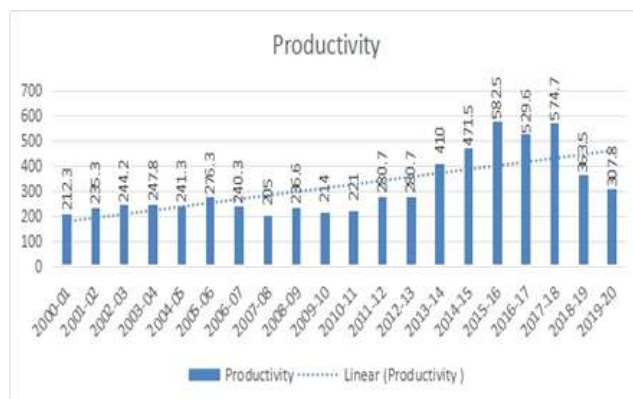
| Sl. No. | Year    | Area (ha) | Production processed (MT) | Productivity (Kg/ha) |
|---------|---------|-----------|---------------------------|----------------------|
| 1.      | 2000-01 | 32767     | 6955                      | 212.3                |
| 2.      | 2001-02 | 32845     | 7730                      | 235.3                |
| 3.      | 2002-03 | 32891     | 8030                      | 244.2                |
| 4.      | 2003-04 | 32857     | 8145                      | 247.8                |
| 5.      | 2004-05 | 32865     | 7931                      | 241.3                |
| 6.      | 2005-06 | 32846     | 9076                      | 276.3                |
| 7.      | 2006-07 | 32840     | 7894                      | 240.3                |
| 8.      | 2007-08 | 31241     | 6404                      | 205                  |
| 9.      | 2008-09 | 33078     | 7827                      | 236.6                |
| 10.     | 2009-10 | 33083     | 7077                      | 214                  |
| 11.     | 2010-11 | 32723     | 7232                      | 221                  |
| 12.     | 2011-12 | 33076     | 9286                      | 280.7                |
| 13.     | 2012-13 | 33076     | 9286                      | 280.7                |
| 14.     | 2013-14 | 31810     | 13040                     | 410                  |
| 15.     | 2014-15 | 31810     | 15000                     | 471.5                |
| 16.     | 2015-16 | 31810     | 18530                     | 582.5                |
| 17.     | 2016-17 | 31165     | 16505                     | 529.6                |
| 18.     | 2017-18 | 31166     | 17914                     | 574.7                |
| 19.     | 2018-19 | 30968     | 11243                     | 363.5                |
| 20.     | 2019-20 | 31783     | 9783                      | 307.8                |

**Source :** Directorate of Economics and Statistics, Kerala 2019-20.

**Table-2 : Compound growth rate of area, production and productivity of small cardamom in Idukki district.**

| Particulars | Area (%) | Production (%) | Productivity (%) |
|-------------|----------|----------------|------------------|
| CGR         | -0.28*   | 4.13*          | 4.42*            |

**Note :** \*Significant at 1% level of significance

**Fig-1 : Area of the cardamom in Idukki district.****Fig-2 : Production of cardamom in Idukki district.****Fig-3 : Productivity of cardamom in Idukki district.**

ha in 2004-05 decreases to 31,241 in 2007-08 and again increases to 33,083 ha in 2009-10. But again 2019-20 the area will be decreased to 31,783 ha. Therefore the compound growth rate has shown the negative significant growth rate of -0.28 percent.

The production of small cardamom crop increases from 6955 MT in 2000-01 to 15,000 MT in 2014-15. The highest productivity shown in 2015-16 18,530 MT. It shows a positively significant compound growth rate of 4.13 percent. It shows a small growth rate in productivity because in 2019-20 the productivity is decreased to 9783 MT.

The productivity of small cardamom crop increases from 212.3 kg/ha in 2000-01 to 582.5 kg/ha in 2015-16, again it was decrease to 307.8 kg/ha in 2019-20 and it shows the positively significant compound growth rate of 4.42 percent. Table and figures clearly indicates that small cardamom crop in Idukki district showed an area is decreased but increasing trend in production and productivity.

**Compound growth rate of area, production and productivity of small cardamom in Kerala state :** The area, production and productivity of small cardamom in Kerala state was (2000-01 to 2019-20) are presented in Table 4 and Fig 4, 5, 6 it reveals that the area under cardamom crop increases from 41288 ha in 2000-01 to 41600 ha in 2011-12 but again it will be decreases to 39,697 in 2019-20. Therefore the compound growth rate has showed the negative significant growth rate of -0.32 percent.

The production of small cardamom crop increases from 7580 MT in 2000-01 to 9765 MT in 2005- 06. The highest productivity shown 19,500 MT in 2015-16. But again it was decreased to 10,075 MT in 2019-20. It shows a positively significant compound growth rate of 3.81 percent. It shows a small growth rate in productivity because in 2019-20 the productivity is decreased to 10,075 MT.

**Table-3 : Area, production and productivity of small cardamom in Kerala state (2000-01 to 2019-20).**

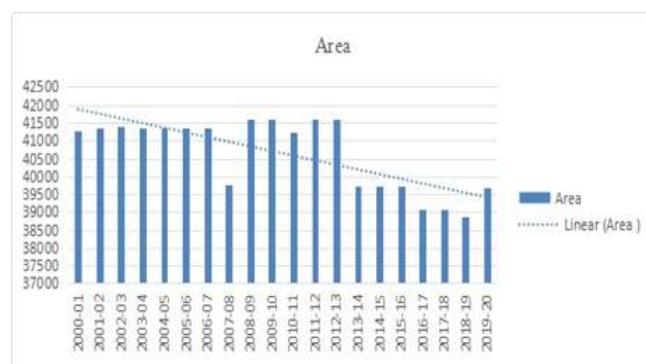
| Sl. No | Year    | Area (ha) | Production processed (MT) | Productivity (Kg/ha) |
|--------|---------|-----------|---------------------------|----------------------|
| 1.     | 2000-01 | 41288     | 7580                      | 183.5                |
| 2.     | 2001-02 | 41366     | 8380                      | 202.5                |
| 3.     | 2002-03 | 41412     | 8680                      | 209.6                |
| 4.     | 2003-04 | 41378     | 8875                      | 214.5                |
| 5.     | 2004-05 | 41367     | 8616                      | 208.2                |
| 6.     | 2005-06 | 41378     | 9765                      | 240                  |
| 7.     | 2006-07 | 41362     | 8545                      | 206.5                |
| 8.     | 2007-08 | 39763     | 7301                      | 183.6                |
| 9.     | 2008-09 | 41588     | 8550                      | 205.5                |
| 10.    | 2009-10 | 41593     | 7800                      | 187.5                |
| 11.    | 2010-11 | 41242     | 7935                      | 192.4                |
| 12.    | 2011-12 | 41600     | 10222                     | 245.7                |
| 13.    | 2012-13 | 41600     | 10222                     | 245.7                |
| 14.    | 2013-14 | 39730     | 14000                     | 352.3                |
| 15.    | 2014-15 | 39730     | 16000                     | 402.7                |
| 16.    | 2015-16 | 39730     | 19500                     | 490.8                |
| 17.    | 2016-17 | 39080     | 17147                     | 438.7                |
| 18.    | 2017-18 | 39080     | 18350                     | 469.5                |
| 19.    | 2018-19 | 38882     | 11535                     | 296.6                |
| 20.    | 2019-20 | 39697     | 10075                     | 253.7                |

**Source :** Directorate of Economics and Statistics, Kerala

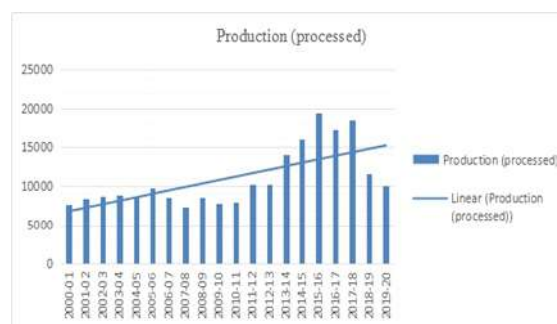
**Table-4 : Compound growth rate of area, production and productivity of small cardamom in Kerala state.**

| Particulars | Area (%) | Production (%) | Productivity (%) |
|-------------|----------|----------------|------------------|
| CGR         | -0.32*   | 3.81*          | 4.14*            |

**Note :** \*Significant at 1% level of significance.

**Fig.-4 : Area of cardamom in Kerala state.**

The productivity of small cardamom crop increases from 183.5 kg/ha in 2000-01 to 490.8 kg/ha in 2015-16. Again it was decreased to 253.7 kg/ha in 2019-20 and it shows the positively significant compound growth rate of 4.14 percent. Table and figures clearly indicates that small cardamom crop in Kerala state showed an area is decreased but increasing trend in production and productivity.

**Fig-5 : Production of cardamom in Kerala state.****Fig-6 : Productivity of cardamom in Kerala state.**

## Conclusion

As per the results of the study compound growth rate of the small cardamom in Idukki district was shown the negative significant growth rate. But the production and the productivity are positive compound growth rate. Compound growth rate of the small cardamom in Kerala state was negative significant growth rate. But the production and the productivity was positive compound growth rate. In both of the conditions area is shown the negative compound growth rate because of uneven rainfall, climate change, higher input and higher labour cost and higher capital investment during the establishment period. The area was decreased but the production and productivity was increased during the periods the reasons behind this was introduction of higher yielding varieties and improved cultural practices are followed by the farmers.

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## Bio-Efficacy of Different Insecticides against Bihar Hairy Caterpillar, *Spilosoma obliqua* (Walker) Infesting Soybean

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### Abstract

An experiment on bio-efficacy of different insecticides viz; Indoxacarb, flubendiamide, chlorantraniliprole, chlorfenapyr, novaluron, emamectin benzoate, beta-cyfluthrin and quinalphos evaluated against *Spilosoma obliqua* infesting soybean was conducted at Agricultural Research Station, College of Agriculture, Anand Agricultural University, Jabugam. The result indicated that the plots treated with of chlorantraniliprole and flubendiamide (3 ml/ 10 litre of water) found effective against hairy caterpillar. Indoxacarb (5 ml/ 10 litre of water) also found promising in controlling the population of *S. obliqua*.

**Key words :** bio-efficacy, different insecticides, Bihar hairy caterpillar, *Spilosoma oblique*, soybean.

### Introduction

Soybean [*Glycine max* L. (Merrill)] is an economic important oil seed as well as leguminous crop for feed, oil and soya food products. It contains about 40% protein and 20% oil in the seed and in the international trade markets, is ranked number one in oil production (48%) among the major oil seed crops (Singh 1999, Lodaya, 2016). Soybean oil is an excellent source of these essential fatty acids (Pratap *et al.* 2012). Soybean is known as Soja bean, Soya bean, Chinese pea and Manchurian bean which belong to family Fabaceae and sub family Faboideae. In world, an average area under cultivation of soybean was 121.53 million hectares with an average production and productivity was 336.53 million metric tons and 20723 kg/ha respectively. The leading soybean growing countries are Brazil, U.S, India, China and Argentina. In India, the total area under the cultivation was 107.61 lakh hectares with production was 90.00 lakh metric tons. The major growing states are Madhya Pradesh, Maharashtra, Gujarat, Rajasthan, Andhra Pradesh, Chhattisgarh and Karnataka. (Anon., 2019a). In Gujarat, total area under cultivation was 106.26 hectares with production 140.83 tons. Sabarkantha, Bharuch, Vadodara, Chhotaudepur, Dahod, Panchmahal and Amreli are major districts known for cultivation of this crop. (Anon. 2019b). The crop is mainly attacked by leaf eating caterpillar [*Spodoptera litura* Fabricius], green semilooper [*Chrysodeixis acuta* (Walker)], grey semilooper [*Amyna octo* (Guenee)], gram pod borer [*Helicoverpa armigera* (Hubner) Hardwick] and Bihar hairy caterpillar [*Spilosoma (=Diacrisia) obliqua* (Walker)] which are considered to be important lepidopteran pests (Singh *et al.*, 1989; Sojitra, 1990. Vyas, 1996, Patel, 2015 and Lodaya, 2016). Among

them, *S. obliqua* is important pest of soybean in Gujarat. It is commonly known as Bihar hairy caterpillar (Katra) belongs to the Family Arctiidae of the Order Lepidoptera. As earlier worker Deshmukh *et. al.* (1979) studied the host range of this caterpillar and observed that it was feeding on nearly 76 plant species. This pest adult emerge at the time of first heavy shower when temperature is 30 C and 50-80 relative humidity in atmospheres. The emerged adult female mat with male and laid eggs in clusters of 100-150 or more on weeds plant around field boundaries. Newly borne / early instars larvae gregarious feeding and voracious feeding nature of late instars of *S. obliqua* cause green foliage into paper like white skeleton to the growing plant. Later, such leaves get dried-up and defoliate from the plant (Lodaya, 2016 and Anon., 2019<sub>a</sub>). Therefore, it is necessary to evaluate these newer molecules against Bihar hairy caterpillar on soybean.

### Materials and Methods

In order to assess the effect of various insecticides (Table-1) on *S. oblique* infesting soybean, a field experiment was conducted at Agricultural Research Station, College of Agriculture, Anand Agricultural University, Jabugam during the *Kharif* 2014 and 2016. The experiment was laid out in Randomized Block Design replicated thrice. The gross and net plot size was 3.0 x 2.7 m and 2.4 x 1.8 m, respectively. All the recommended agronomic practices were followed to raise the crop. The chemical spray was applied on appearance of *S. oblique* by using high volume sprayer (knapsack) with required concentration. Ten plants were selected randomly from each net plot area and tagged for recording the observations. Observations of *S. obliqua* were recorded before spray, 3, 5, 10 and 15 days after each spray. The

data obtained were analyzed by using standard statistical techniques.

#### Treatment details :

| Sr. No.                                             | Name of Insecticides        | Conc. (%) | ml or g/10 litre of water |
|-----------------------------------------------------|-----------------------------|-----------|---------------------------|
| T <sub>1</sub>                                      | Indoxacarb 15.8 EC          | 0.0079    | 5 ml                      |
| T <sub>2</sub>                                      | Flubendiamide 480 SC        | 0.0145    | 3 ml                      |
| T <sub>3</sub>                                      | Chlorantraniliprole 18.5 SC | 0.006     | 3 ml                      |
| T <sub>4</sub>                                      | Chlorfenapyr 10 EC          | 0.01      | 10 ml                     |
| T <sub>5</sub>                                      | Novaluron 10 EC             | 0.01      | 10 ml                     |
| T <sub>6</sub>                                      | Emamectin benzoate 5 WG     | 0.0025    | 5 g                       |
| T <sub>7</sub>                                      | Beta-cyfluthrin 25 EC       | 0.0125    | 5 ml                      |
| T <sub>8</sub>                                      | Quinalphos 25 EC            | 0.025     | 20 ml                     |
| T <sub>9</sub>                                      | Control (water spray)       | -         | -                         |
| (a.i. is calculated based on 500 litre of water/ha) |                             |           |                           |

## Results and Discussion

**First year :** The larval population of *S. obliqua* on soybean before spray was non-significant which indicated uniformity in experimental plots. The results also revealed that all the insecticidal treatments were significantly superior over control at all intervals against Bihar hairy caterpillar. Larval population (Table-1) of *S. obliqua* recorded after first spray indicated significant reduction in plots treated with chlorantraniliprole (24.21 larvae /10 plants) and flubendiamide (32.72) in comparison to rest of plots (37.58 to 67.90). Superiority of chlorantraniliprole (5.06 larvae /10 plants) and flubendiamide (13.25) in suppressing the pest was also revealed in second spray. Pooled over years (Table 1) data found that least (14.82 larvae/10 plants) numbers of *S. obliqua* were found in chlorantraniliprole followed by flubendiamide (21.90), novaluron (27.46) and indoxacarb (28.41). The chronological order of treatments based on average number of larvae(s) per ten plants was chlorantraniliprole > flubendiamide > novaluron > indoxacarb > emamectin benzoate > beta-cyfluthrin > quinalphos > control. The present findings are in accordance with the report of Nair *et al.* (2007) who reported that emamectin benzoate and indoxacarb were found effective against *S. obliqua* in laboratory condition.

**Second year :** The periodical data on average number of larvae(s) per ten plants of *S. obliqua* on soybean are presented in Table-2. The larval populations of Bihar hairy caterpillar were uniform in all plots as the difference was non-significant at time of before spray. *S. obliqua* larval population (Table-2) recorded pooled over periods after first spray indicated significant reduction of the pest in

plots treated with chlorantraniliprole (25.10 larvae /10 plants) and flubendiamide (29.27) in comparison to rest of treatments (34.93 to 65.12). Superiority of chlorantraniliprole (6.25 larvae /10 plants) and flubendiamide (10.11) in suppressing the pest was also noticed in second spray. Pooled over years (Table 2) data confirmed that less (14.06 larvae/10 plants) numbers of *S. obliqua* were found in chlorantraniliprole followed by flubendiamide (18.15) and indoxacarb (25.40). The pest was suppressed significantly in plots sprayed with these insecticides over control. The chronological order of treatments based on average number of larvae(s) per ten plants was chlorantraniliprole > flubendiamide > indoxacarb > novaluron > emamectin benzoate > beta-cyfluthrin > quinalphos > control.

**Pooled :** Data on pooled over periods, sprays and years (Table-3) revealed that there was significant difference among the treatments and all the insecticidal treatments recorded significantly lower larval population than control. Among various treatments, the less (13.47 larvae/ 10 plants) numbers of *S. obliqua* was found in chlorantraniliprole whereas, better performance of flubendiamide (19.96) and indoxacarb (26.94) was also observed in suppressing the larval population of *S. obliqua* in comparison to rest of treatments. The pest was suppressed significantly in plots sprayed with these insecticides over control. This result is in conformity with Patel (2015) who found that the significantly maximum larval mortality found in treatment of chlorantraniliprole, emamectin benzoate and flubendiamide in laboratory condition. Mohapatra and Gupta (2018) also found that the larval reduction of *S. obliqua* in plot treated with indoxacarb in field conditions on blackgram. According to Thodsare and Srivastava (2014) observed that indoxacarb was faster action as compared to emamectin benzoate. Kishor *et al.* (2020) revealed that the emamectin benzoate was found most effective against *S. obliqua*. Mishra *et al.* (2017) reported that the treatment of flubendiamide and indoxacarb exhibited lower larval population as compared to other chemical insecticides. The chronological order of treatments based on average number of larvae(s) per ten plants was chlorantraniliprole > flubendiamide > indoxacarb > novaluron > emamectin benzoate > beta-cyfluthrin > quinalphos > control.

## Conclusion

In present study result revealed that bioefficacy of different insecticides, it was advised to apply two sprays of chlorantraniliprole 0.006 per cent (3 ml/10 litre of water) or flubendiamide 0.0145 per cent (3 ml/10 litre of water) or indoxacarb 0.0079 per cent (5 ml/ 10 litre of water) of *S. obliqua* infesting soybean for management of pest.

Table-1 : Effect of different insecticides on population of Bihar hairy caterpillar, *S. obliqua* infesting soybean (2014).

| Sr. No. | Treatments                  | Average number of larva(e)/10 plants |                    |                    |                    |                   |                    |                   |                   |                    |                   |                   |       |       |        |
|---------|-----------------------------|--------------------------------------|--------------------|--------------------|--------------------|-------------------|--------------------|-------------------|-------------------|--------------------|-------------------|-------------------|-------|-------|--------|
|         |                             | First spray                          |                    |                    |                    |                   |                    |                   | Second spray      |                    |                   |                   |       |       |        |
|         |                             | BS                                   | 3 DAS              | 5 DAS              | 10 DAS             | 15 DAS            | Pooled             | 3 DAS             | 5 DAS             | 10 DAS             | 15 DAS            | Pooled            | 3 DAS | 5 DAS | Pooled |
| 1.      | Indoxacarb 15.8 EC          | 7.68<br>(58.98)                      | *6.65bc<br>(44.22) | 6.42bc<br>(41.22)  | 5.85bcd<br>(34.22) | 5.59bc<br>(31.25) | 6.13de<br>(37.58)  | 5.00bc<br>(25.00) | 4.69bc<br>(22.00) | 4.35bcd<br>(18.92) | 4.08bc<br>(16.65) | 4.53cd<br>(20.52) |       |       |        |
| 2.      | Flubendiamide 480 SC        | 7.68<br>(58.98)                      | 6.36cd<br>(40.45)  | 6.04cd<br>(36.48)  | 5.43cd<br>(29.48)  | 5.04cd<br>(25.40) | 5.72e<br>(32.72)   | 4.62c<br>(21.34)  | 3.77c<br>(14.21)  | 3.55d<br>(12.60)   | 2.63de<br>(6.92)  | 3.64e<br>(13.25)  |       |       |        |
| 3.      | Chlorantraniliprole 18.5 SC | 7.78<br>(60.53)                      | 5.48d<br>(30.03)   | 5.20d<br>(27.04)   | 4.79d<br>(22.94)   | 4.22d<br>(17.81)  | 4.92f<br>(24.21)   | 3.25d<br>(10.56)  | 2.24d<br>(5.02)   | 1.88e<br>(3.53)    | 1.61e<br>(2.59)   | 2.25f<br>(5.06)   |       |       |        |
| 4.      | Chlorfenapyr 10 EC          | 7.88<br>(62.09)                      | 7.14abc<br>(50.98) | 6.78bc<br>(45.97)  | 6.40bc<br>(40.96)  | 6.16bc<br>(37.95) | 6.62cd<br>(43.82)  | 5.83bc<br>(33.99) | 5.38b<br>(28.94)  | 4.89bcd<br>(23.91) | 4.11bc<br>(16.89) | 5.05bc<br>(25.50) |       |       |        |
| 5.      | Novaluron 10 EC             | 7.83<br>(61.31)                      | 6.70bc<br>(44.89)  | 6.47bc<br>(41.86)  | 5.99bc<br>(35.88)  | 5.73bc<br>(32.83) | 6.24de<br>(38.94)  | 5.08bc<br>(25.81) | 4.33bc<br>(18.75) | 3.96cd<br>(15.68)  | 3.55cd<br>(12.60) | 4.23de<br>(17.89) |       |       |        |
| 6.      | Enamectin benzoate 5 WG     | 7.77<br>(60.37)                      | 7.19abc<br>(51.70) | 6.82bc<br>(46.51)  | 6.45bc<br>(41.60)  | 6.21bc<br>(38.56) | 6.67bcd<br>(44.49) | 5.87bc<br>(34.46) | 5.23b<br>(27.35)  | 4.87bcd<br>(23.72) | 4.33bc<br>(18.75) | 5.07bc<br>(25.70) |       |       |        |
| 7.      | Beta-cyfluthrin 25 EC       | 7.92<br>(62.73)                      | 7.49abc<br>(56.10) | 7.21abc<br>(51.98) | 6.86b<br>(47.06)   | 6.64b<br>(44.09)  | 7.05bc<br>(49.70)  | 6.33b<br>(40.07)  | 5.57b<br>(31.02)  | 5.29bc<br>(27.98)  | 4.78b<br>(22.85)  | 5.49b<br>(30.14)  |       |       |        |
| 8.      | Quinalphos 25 EC            | 8.12<br>(65.93)                      | 7.67ab<br>(58.83)  | 7.39ab<br>(54.46)  | 7.05b<br>(49.70)   | 6.61b<br>(43.69)  | 7.18b<br>(51.55)   | 6.30b<br>(39.69)  | 5.71b<br>(31.04)  | 5.53b<br>(30.58)   | 4.84b<br>(23.43)  | 5.59b<br>(31.25)  |       |       |        |
| 9.      | Control (water spray)       | 7.86<br>(61.78)                      | 8.03a<br>(64.48)   | 8.24a<br>(67.90)   | 8.32a<br>(69.22)   | 8.35a<br>(69.72)  | 8.24a<br>(67.90)   | 8.42a<br>(70.90)  | 8.50a<br>(72.25)  | 8.53a<br>(72.76)   | 8.56a<br>(73.27)  | 8.50a<br>(72.25)  |       |       |        |
|         | S. Em.(+) Treatment (T)     | 0.39                                 | 0.34               | 0.35               | 0.37               | 0.40              | 0.17               | 0.44              | 0.44              | 0.43               | 0.36              | 0.20              |       |       |        |
|         | Period (P)                  | -                                    | -                  | -                  | -                  | -                 | 0.12               | -                 | -                 | -                  | -                 | 0.13              |       |       |        |
|         | T x P                       | -                                    | -                  | -                  | -                  | -                 | 0.35               | -                 | -                 | -                  | -                 | 0.40              |       |       |        |
|         | C.D. at 5% Treatment (T)    | NS                                   | 1.01               | 1.05               | 1.10               | 1.19              | 0.49               | 1.33              | 1.33              | 1.28               | 1.06              | 0.57              |       |       |        |
|         | Period (P)                  | -                                    | -                  | -                  | -                  | -                 | 0.33               | -                 | -                 | -                  | -                 | 0.38              |       |       |        |
|         | T x P                       | -                                    | -                  | -                  | -                  | -                 | NS                 | -                 | -                 | -                  | -                 | NS                |       |       |        |
|         | C.V. (%)                    | 8.68                                 | 8.36               | 9.04               | 10.09              | 11.41             | 9.29               | 13.67             | 15.27             | 15.58              | 14.43             | 14.16             |       |       |        |

\*Figures in parentheses are retransformed values, those outside are  $\sqrt{x}$  transformed values. NS : Not Significant, DAS : Day after spray, BS : Before Spray  
Treatment means with letter(s) in common are not significant by DNMR at 5 % level of significance.

Table-2 : Effect of different insecticides on population of hairy caterpillar, *S. obliqua* infesting soybean (2016).

| Sr. No. | Treatments                  | Average number of larva(e)/10 plants |                     |                    |                    |                    |                   |                    |                   |                   |                   |                   |       |       |        |
|---------|-----------------------------|--------------------------------------|---------------------|--------------------|--------------------|--------------------|-------------------|--------------------|-------------------|-------------------|-------------------|-------------------|-------|-------|--------|
|         |                             | First spray                          |                     |                    |                    |                    |                   |                    | Second spray      |                   |                   |                   |       |       |        |
|         |                             | BS                                   | 3 DAS               | 5 DAS              | 10 DAS             | 15 DAS             | Pooled            | 3 DAS              | 5 DAS             | 10 DAS            | 15 DAS            | Pooled            | 3 DAS | 5 DAS | Pooled |
| 1.      | Indoxacarb 15.8 EC          | 7.32<br>(53.58)                      | *6.46bcd<br>(41.73) | 6.22bcd<br>(38.69) | 5.62bcd<br>(31.58) | 5.34bcd<br>(28.52) | 5.91de<br>(34.93) | 4.73bcd<br>(22.37) | 4.39bc<br>(19.27) | 4.02bc<br>(16.16) | 3.59bc<br>(12.89) | 4.18d<br>(17.47)  |       |       |        |
| 2.      | Flubendiamide 480 SC        | 7.41<br>(54.91)                      | 6.10cd<br>(37.21)   | 5.75cd<br>(33.06)  | 5.10cd<br>(26.01)  | 4.69cd<br>(22.00)  | 5.41ef<br>(29.27) | 4.24cd<br>(17.98)  | 3.28cd<br>(10.76) | 2.94cd<br>(8.64)  | 2.02cd<br>(4.08)  | 3.18e<br>(10.11)  |       |       |        |
| 3.      | Chlorantraniliprole 18.5 SC | 7.38<br>(54.46)                      | 5.57d<br>(31.02)    | 5.29d<br>(27.98)   | 4.88d<br>(23.81)   | 4.31d<br>(18.58)   | 5.01f<br>(25.10)  | 3.44d<br>(11.83)   | 2.93d<br>(8.58)   | 2.23d<br>(4.97)   | 1.38d<br>(1.90)   | 2.50f<br>(6.25)   |       |       |        |
| 4.      | Chlorfenapyr 10 EC          | 7.50<br>(56.25)                      | 7.22abc<br>(52.13)  | 6.87abc<br>(47.20) | 6.49b<br>(42.12)   | 6.22bc<br>(38.69)  | 6.70b<br>(44.89)  | 5.92bc<br>(35.05)  | 5.48b<br>(30.03)  | 5.00b<br>(25.00)  | 4.22b<br>(17.81)  | 5.15bc<br>(26.52) |       |       |        |
| 5.      | Novaluron 10 EC             | 7.13<br>(50.84)                      | 6.57bcd<br>(43.16)  | 6.26bcd<br>(39.19) | 5.75bcd<br>(33.06) | 5.49bcd<br>(30.14) | 6.01cd<br>(36.12) | 4.80bcd<br>(23.04) | 4.58bc<br>(20.98) | 4.24bc<br>(17.98) | 3.85b<br>(14.82)  | 4.37d<br>(19.10)  |       |       |        |
| 6.      | Emamectin benzoate 5 WG     | 7.40<br>(54.76)                      | 7.07abc<br>(49.98)  | 6.71bc<br>(45.02)  | 6.32bc<br>(39.94)  | 6.07bc<br>(36.84)  | 6.54bc<br>(42.77) | 5.73bc<br>(32.83)  | 5.07b<br>(25.70)  | 4.64b<br>(21.53)  | 4.04b<br>(16.32)  | 4.87cd<br>(23.72) |       |       |        |
| 7.      | Beta-cyfluthrin 25 EC       | 7.54<br>(56.85)                      | 7.32abc<br>(53.58)  | 7.04abc<br>(49.56) | 6.74ab<br>(45.43)  | 6.44b<br>(41.47)   | 6.87b<br>(47.20)  | 6.13b<br>(37.58)   | 5.70b<br>(32.49)  | 5.43b<br>(29.48)  | 4.94b<br>(24.40)  | 5.55bc<br>(30.80) |       |       |        |
| 8.      | Quinalphos 25 EC            | 7.55<br>(57.00)                      | 7.43ab<br>(55.20)   | 7.16ab<br>(51.27)  | 6.80ab<br>(46.24)  | 6.57b<br>(43.16)   | 6.99b<br>(48.86)  | 6.25b<br>(39.06)   | 5.83b<br>(33.99)  | 5.66b<br>(32.04)  | 4.98b<br>(24.80)  | 5.68b<br>(32.26)  |       |       |        |
| 9.      | Control (water spray)       | 7.34<br>(53.88)                      | 7.95a<br>(63.20)    | 8.08a<br>(65.29)   | 8.10a<br>(65.61)   | 8.15a<br>(66.42)   | 8.07a<br>(65.12)  | 8.29a<br>(68.72)   | 8.46a<br>(71.57)  | 8.64a<br>(74.65)  | 8.90a<br>(79.21)  | 8.57a<br>(73.44)  |       |       |        |
|         | S. Em. (+) Treatment (T)    | 0.27                                 | 0.37                | 0.39               | 0.41               | 0.46               | 0.19              | 0.52               | 0.45              | 0.49              | 0.52              | 0.24              |       |       |        |
|         | Period (P)                  | -                                    | -                   | -                  | -                  | -                  | 0.13              | -                  | -                 | -                 | -                 | 0.16              |       |       |        |
|         | T x P                       | -                                    | -                   | -                  | -                  | -                  | 0.39              | -                  | -                 | -                 | -                 | 0.48              |       |       |        |
|         | C.D. at 5 % Treatment (T)   | NS                                   | 1.11                | 1.17               | 1.24               | 1.37               | 0.55              | 1.57               | 1.34              | 1.48              | 1.54              | 0.68              |       |       |        |
|         | Period (P)                  | -                                    | -                   | -                  | -                  | -                  | 0.37              | -                  | -                 | -                 | -                 | 0.45              |       |       |        |
|         | T x P                       | -                                    | -                   | -                  | -                  | -                  | NS                | -                  | -                 | -                 | -                 | NS                |       |       |        |
|         | C.V. (%)                    | 6.28                                 | 9.39                | 10.30              | 11.58              | 13.36              | 10.65             | 16.5               | 15.26             | 18.01             | 21.20             | 16.95             |       |       |        |

\*Figures in parentheses are retransformed values, those outside are  $\sqrt{x}$  transformed values., NS : Not Significant, DAS : Day after spray, BS : Before Spray  
Treatment means with letter(s) in common are not significant by DNMRT at 5 % level of significance

Table-3 : Effect of different insecticides on population of Bihar hairy caterpillar, *S. obliqua* infesting soybean.

| Sr. No. | Treatments                  | Average number of larva(e)/ 10 plants |            |                |            |               |            |
|---------|-----------------------------|---------------------------------------|------------|----------------|------------|---------------|------------|
|         |                             | 2014                                  |            | 2016           |            | Pooled        |            |
| 1.      | Indoxacarb 15.8 EC          | *5.33e (28.41)                        |            | 5.04d (25.40)  |            | 5.19d (26.94) |            |
| 2.      | Flubendiamide 480 SC        | 4.68f (21.90)                         |            | 4.26e (18.15)  |            | 4.47e (19.98) |            |
| 3.      | Chlorantraniliprole 18.5 SC | 3.85g (14.82)                         |            | 3.75f (14.06)  |            | 3.67f (13.47) |            |
| 4.      | Chlorfenapyr 10 EC          | 5.83d (33.99)                         |            | 5.93bc (35.16) |            | 5.88c (34.57) |            |
| 5.      | Novaluron 10 EC             | 5.23e (27.35)                         |            | 5.19d (26.94)  |            | 5.21d (27.14) |            |
| 6.      | Emamectin benzoate 5 WG     | 5.87cd (34.46)                        |            | 5.70c (32.49)  |            | 5.79c (33.52) |            |
| 7.      | Beta-cyfluthrin 25 EC       | 6.27bc (39.31)                        |            | 6.21b (38.56)  |            | 6.24b (38.94) |            |
| 8.      | Quinalphos 25 EC            | 6.39b (40.83)                         |            | 6.34b (40.20)  |            | 6.36b (40.45) |            |
| 9.      | Control (water spray)       | 8.37a (70.06)                         |            | 8.32a (69.22)  |            | 8.35a (69.72) |            |
|         |                             | S. Em.(+)                             | C.D. at 5% | S. Em.(+)      | C.D. at 5% | S. Em.(+)     | C.D. at 5% |
|         | Treatment (T)               | 0.13                                  | 0.37       | 0.15           | 0.43       | 0.10          | 0.28       |
|         | Period (P)                  | 0.88                                  | 0.24       | 0.10           | 0.28       | 0.07          | 0.19       |
|         | Spray (S)                   | 0.06                                  | 0.17       | 0.07           | 0.20       | 0.05          | 0.13       |
|         | Year (Y)                    | -                                     | -          | -              | -          | 0.05          | NS         |
|         | T x P                       | 0.26                                  | NS         | 0.30           | NS         | 0.20          | NS         |
|         | T x S                       | 0.18                                  | 0.52       | 0.21           | 0.60       | 0.14          | 0.39       |
|         | T x Y                       | -                                     | -          | -              | -          | 0.14          | NS         |
|         | P x S                       | 0.12                                  | NS         | 0.14           | NS         | 0.09          | NS         |
|         | P x Y                       | -                                     | -          | -              | -          | 0.09          | NS         |
|         | S x Y                       | -                                     | -          | -              | -          | 0.07          | NS         |
|         | T x P x S                   | 0.37                                  | NS         | 0.43           | NS         | 0.29          | NS         |
|         | T x P x Y                   | -                                     | -          | -              | -          | 0.29          | NS         |
|         | T x S x Y                   | -                                     | -          | -              | -          | 0.20          | NS         |
|         | P x S x Y                   | -                                     | -          | -              | -          | 0.13          | NS         |
|         | T x P x S x Y               | -                                     | -          | -              | -          | 0.40          | NS         |
|         | C.V. (%)                    | 11.33                                 | 13.36      | 12.37          |            |               |            |

\*Figures in parentheses are retransformed values, those outside are  $\sqrt{x}$  transformed values. NS : Not Significant  
Treatment means with letter(s) in common are not significant by DNMRT at 5% level of significance.

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## Relationship of Profile Characteristics of Televiewing Farmers with their Televiewing Behaviour

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### Abstract

Television is the most powerful medium of mass communication and education. The audio and visual component feature of television arouses interest, attracts attention and increases desire in learning. The present study was conducted in the state of Andhra Pradesh during 2014 – 2020 to find out the relationship between profile characteristics of farmers with their televiewing behavior. The study was conducted in four district viz., West Godavari, Kurnool, Guntur and Srikakulam with a sample size of 240. Out of sixteen selected profile characteristics of televiewing farmers, twelve characteristics such as education, farming experience, socio-economic status, innovativeness, mass media exposure, marketing orientation, risk orientation, economic orientation, scientific orientation, extension contact, social participation and training exposure had significant relationship with televiewing behaviour at 0.01 level of probability. The remaining characteristics viz., age, farm size, annual income and cropping intensity did not show any significant relationship with televiewing behaviour. The MLR analysis revealed that the selected sixteen profile characteristics put together, explained about 80.05 per cent variation in the televiewing behaviour. Remaining 19.95 per cent is due to the extraneous profile characteristics which were away from the present study.

### Introduction

Among all forms of mass media, television is the most powerful audio-visual medium with a modest beginning in 1936. It has grown into a massive network of mass information and mass entertainment in today's world. The 'visual ness' of television makes people remain glued to the TV set for hours. Television captures our imagination and is the most complete and dramatic of all mass media. In addition to providing news and events, television also packages fiction, drama, culture, economy and many other things. It is a most promising medium of education. The audio and visual component feature of television arouse interest, attracts attention and increases desire in learning.

In Andhra Pradesh nineteen agricultural programmes are being broadcasted in different channels in Telugu language. In order to plan the future extension programmes and taking policy decisions regarding mass communication, the information about the profile characteristics and their relationship with televiewing behavior is very much essential. For this purpose the present study was taken up in Andhra Pradesh.

### Materials and Methods

**Research Design :** An *ex-post-facto* research design has been followed in this study, as the events have already occurred.

**Sampling Procedure :** Andhra Pradesh state consists of thirteen districts. Out of which four districts namely West

Godavari, Kurnool, Guntur and Srikakulam were selected randomly. Two mandals from each district were chosen randomly, thus comprising of eight mandals. Two villages from each mandal were selected randomly, thus making a total number of 16 villages. After listing out the total number of farmers who are in possession of TV sets, 15 farmers from each of the selected village were chosen by simple random sampling method, there by the total sample size become 240. Statistical analysis was carried out by using Pearsons' Correlation Co-efficient (r) and Multiple Regression Analysis to find out the relationship between dependent and independent variables.

### Results and Discussion

An attempt has been made to find out if there exists any relationship of the profile characteristics of televiewing farmers viz., age, education, farm size, farming experience, socio-economic status, innovativeness, mass media exposure, marketing orientation, risk orientation, economic orientation, scientific orientation, extension contact, annual income, social participation, cropping intensity and training exposure with their televiewing behaviour.

It is evident from the Table-1 that computed 'r' values of education, farming experience, socio-economic status, innovativeness, mass media exposure, marketing orientation, risk orientation, economic orientation, scientific orientation, extension contact, social participation and training exposure were significant at 0.01 level of probability. The other variables such as age,

farm size, annual income and cropping intensity did not show any significant relationship with televiewing behaviour of the farmers.

**Null Hypothesis :** There will be no significant relationship of the selected profile characteristics of televiewing farmers with their televiewing behaviour.

**Empirical Hypothesis :** There will be a significant relationship of the selected profile characteristics of televiewing farmers with their televiewing behaviour.

**Age Vs Televiewing Behaviour :** From Table-1 it is evident that there was no significant relationship between the age and the televiewing behaviour of the farmers. This might be due to information acquisition, processing and application depending on individual's interest, needs, social status, motivation, knowledge & skills and environment in which he/she brought up. Hence, the age had not show any significant relationship with the televiewing behaviour of the farmers. The above finding was in line with the findings of Laharia and Joshi (1992), Reddy (1995a), Behera (1996) and Goudappa *et al.* (2017).

**Education Vs Televiewing Behaviour :** It evident from the Table-1 that there was a positive and significant relationship between the education and the televiewing behaviour of the farmers at 0.01 level of probability. From this, it is evident that as the education increases, the televiewing behaviour of farmers also increases. The reasons might be as the education increases, the awareness about the channels which broadcasting agricultural programmes, timings, duration, credibility will also increases. The education will also help in better understanding of rationality behind scientifically proven technologies. This finding was in conformity with the findings of Praveena (1991), Darmadhikari *et al.* (1993), Behera (1996), Vikram (2000) and Goudappa *et al.* (2017).

**Farm Size Vs Televiewing Behaviour :** It was evident from the Table-1 that there was no significant relationship between the farm size and the televiewing behaviour of the farmers. It implied that the individual's behaviour is a combination of cognitive, affective and psychomotor domains, which may not be affected by the farm size. Similar findings were reported by Ingole and Ingole (1992), Mane and Shetay (1992) and Goudappa *et al.* (2017).

**Farming Experience Vs Televiewing Behaviour :** From the Table-1 it was quite interesting to note that the farming experience of televiewing farmers show negatively significant relationship with their televiewing behaviour at 0.01 level of probability. From this, it was clear that as the farming experience increases, the televiewing behaviour

decreases. As the experience in farming increases, the level of knowledge on cultivation practices as well as confidence on their job will also increases over years. Hence, the dependency on information sources will be reduced gradually. This finding was in contrast to the findings of Reddy (1995a), Reddy (1995b), Behara (1996), Vikram (2000) and Sivanandan (2002).

**Socio-Economic Status Vs Televiewing Behaviour :** It is clear from the Table-1 that the socio-economic status showed positive and strong relationship with the televiewing behaviour of the farmers at 0.01 level of probability. From this, it is evident that individual's behaviour will be influenced by environment in which they born and brought up. As the influence of socially and economically forward peoples on others is more in rural areas, they invariably improve their knowledge to sustain their status. This result was new to the earlier research findings.

**Innovativeness Vs Televiewing Behaviour :** It is clear from Table-1 that there was a positive and highly significant relationship between the innovativeness and their televiewing behaviour of farmers at 0.01 level of probability. This means that the higher innovativeness of the farmer, the more would be the televiewing behaviour. This trend might be due to the fact that the farmers with high innovativeness were the first people to adopt new technologies. Getting information from various sources including television is one of the reasons for this trend. The above finding was in line with the findings of Sivanandan (2002).

**Mass Media Exposure Vs Televiewing Behaviour :** From the Table-1 it could be revealed that there was a positive and significant relationship between the mass media exposure and the televiewing behaviour of the farmers at 0.01 level of probability. It could be inferred that the mass media like radio, television, information materials, farm journals provide authenticated and latest farm information to farmers. It is quite natural that the farmers who acquire knowledge through mass media also watch television frequently, as television is most effective medium of mass communication, with both audio and visual components. This finding was in agreement with the findings of Mane and Shetay (1992), Laharia and Jhoshi (1992), Dharmadhikari *et al.* (1993), Reddy (1995b), Behra (1996), Vikram (2000) and Sivanandan (2002).

**Marketing Orientation Vs Televiewing Behaviour :** Findings shown in the Table-1 that the marketing orientation had positive and significant relationship with the televiewing behaviour of farmers at 0.01 level of probability. The more the marketing orientation, more will be the televiewing behaviour. Because, the farmers were interested in market related information would watch

**Table-1 : Correlation coefficients of profile characteristics of televiewing farmers with their televiewing behavior.**  
(n=240)

| S. No. | Profile Characteristics | 'r' Value |
|--------|-------------------------|-----------|
| 1.     | Age                     | 0.069 NS  |
| 2.     | Education               | 0.492 **  |
| 3.     | Farm Size               | 0.096 NS  |
| 4.     | Farming Experience      | - 0.487** |
| 5.     | Socio-Economic Status   | 0.506**   |
| 6.     | Innovativeness          | 0.624**   |
| 7.     | Mass Media Exposure     | 0.474**   |
| 8.     | Marketing Orientation   | 0.314**   |
| 9.     | Risk Orientation        | 0.781**   |
| 10.    | Economic Orientation    | 0.699**   |
| 11.    | Scientific Orientation  | 0.792**   |
| 12.    | Extension Contact       | 0.546**   |
| 13.    | Annual Income           | 0.098 NS  |
| 14.    | Social Participation    | 0.401**   |
| 15.    | Cropping Intensity      | 0.023 NS  |
| 16.    | Training Exposure       | 0.303**   |

NS = Non significant, \*Significant at 0.05 level of probability,  
\*\*Significant at 0.01 level of probability

television more frequently to get information like prices, grading, processing, storage in addition to production technologies for production of quality produce. This finding is new to the earlier research findings.

**Risk Orientation Vs Televiewing Behaviour :** An overview of Table-1 revealed that there was a positive and highly significant relationship between the risk orientation and the televiewing behaviour of farmers at 0.01 level of probability. This shows that as the risk orientation increases, the televiewing behaviour increases. The risk orientation is expressed as the degree to which a farmer is oriented to take risk and to face uncertainties in crop cultivation. The risk taking individuals would go out all the way to get the information from different sources in order to acquire more knowledge. Television is one of the authenticated source for getting information. Hence, efforts need to be made to take advantage of risk bearing ability in testing new technologies in farmers fields. This finding was in contrast to the finding of Goudappa *et al.* (2017).

**Economic Orientation Vs Televiewing behavior :** Table-1 clearly explains that there was a positive and highly significant relationship between the economic orientation and the televiewing behaviour of farmers at 0.01 level of probability. It could be inferred that, increase in the economic orientation will show corresponding increase in the televiewing behaviour of the farmers. This might be due to the fact that the farmers having high economic orientation will have the habit of getting more credible information for making their farming profitable. As the agricultural programmes broadcasted over television

provides more authenticate information, the televiewing behaviour increases with increasing economic orientation. This finding was in line with the findings of Reddy (1995) and Vikram (2000).

#### **Scientific Orientation Vs Televiewing Behaviour :**

From the Table-1 it could be revealed that there was a positive and highly significant relationship between the scientific orientation and the televiewing behaviour of farmers at 0.01 level of probability. Hence, it could be inferred that higher the scientific orientation, the more will be the televiewing behaviour. The probable reason may be that the scientifically oriented farmers adopt only scientifically proven technologies only. In general, they believe and get information from authenticated sources only. As per TRAI regulations, television channels broadcast only authenticated information from agricultural universities, ICAR institutes and other line department people. This finding was in agreement with the findings of Reddy (1995b), Vikram (2000) and Sivanandan (2002).

**Extension Contact Vs Televiewing Behaviour :** The data shown in Table-1 revealed that there was a positive and highly significant relationship between the extension contact of farmers and their televiewing behaviour at 0.01 level of probability. This clearly indicated that the televiewing behaviour increases with the increase in extension contact. Extension agencies were considered as best and reliable sources of information for the farmers. The farmers having more extension contact will be more aware of other sources of information such as television, radio, farm magazines etc. Which will help in supplementing their knowledge already gained through extension contact. Hence, the above relationship was noticed. This calls for extended efforts of extension agencies. Similar findings were reported by Subramanian (1991), Patil and Kulakarni (1993) and Dharmadhikari *et al.* (1993).

**Annual Income Vs Televiewing Behaviour :** It is clear from Table-1 that the annual income of the farmers shows no significant relationship with the televiewing behaviour. It could be inferred that the individual's behaviour will be influenced by motivation, environment, social status, inspiration and inner drive to learn. Hence annual income didn't show any significant relationship with the televiewing behaviour of the farmers. The above finding was in line with the findings of Mane and Shetay (1992) and Goudappa *et al.* (2017).

**Social Participation Vs Televiewing Behaviour :** It is clear from Table-1 that the social participation showed positively significant relationship with the televiewing behaviour of farmers at 0.01 level of probability. From this, it could be inferred that increase in social participation will result in significant increase in the televiewing behaviour

**Table-2 : Multiple linear regression analysis of profile characteristics of the televiewing farmers with their televiewing behavior.** (n=240)

| S. No. | Profile Characteristics | Regression Coefficient | Standard error | 't' Value | p-Value |
|--------|-------------------------|------------------------|----------------|-----------|---------|
| 1.     | Age                     | 2.7839                 | 2.8639         | 0.9720 NS | 0.3320  |
| 2.     | Education               | 3.3348                 | 1.4413         | 2.3136 *  | 0.0215  |
| 3.     | Farm Size               | 0.2535                 | 1.6615         | 0.1526 NS | 0.8788  |
| 4.     | Farming Experience      | 4.9301                 | 1.7409         | 2.8319 *  | 0.0050  |
| 5.     | Socio-Economic Status   | 1.6326                 | 0.3519         | 4.6394 ** | 0.0000  |
| 6.     | Innovativeness          | 1.5790                 | 1.2522         | 1.2609 NS | 0.2086  |
| 7.     | Mass Media Exposure     | 1.7884                 | 0.8233         | 2.1720 *  | 0.0309  |
| 8.     | Marketing Orientation   | 0.1333                 | 2.1185         | 0.0632 NS | 0.9496  |
| 9.     | Risk Orientation        | 11.5119                | 2.1107         | 5.4539 ** | 0.0000  |
| 10.    | Economic Orientation    | 2.0738                 | 0.5883         | 3.5247 ** | 0.0005  |
| 11.    | Scientific Orientation  | 3.4657                 | 0.5913         | 5.8608 ** | 0.0000  |
| 12.    | Extension Contact       | -2.1153                | 1.3044         | 1.6216 NS | 0.1062  |
| 13.    | Annual Income           | -8.1839                | 1.4714         | 5.5619**  | 0.0000  |
| 14.    | Social Participation    | 8.5213                 | 2.9405         | 2.8979**  | 0.0041  |
| 15.    | Cropping Intensity      | -0.1173                | 0.0495         | 2.3703*   | 0.0186  |
| 16.    | Training Exposure       | -6.6895                | 3.2634         | 2.0498*   | 0.0415  |

$b = -158.469$ ,  $R^2 = 0.8005$ , NS = Non-Significant, \*Significant at 0.05 level of probability, \*\*Significant at 0.01 level of probability

From the above table the MLR equation can be fit as

$$Y = -158.469 + 2.7839X_1 + 3.3348X_2 + 0.2535X_3 + 4.9301X_4 + 1.6326X_5 + 1.5790X_6 + 1.7884X_7 + 0.1333X_8 + 11.5119X_9 + 2.0738X_{10} + 3.4657X_{11} + -2.1153X_{12} + -8.1839X_{13} + 8.5213X_{14} + -0.1173X_{15} + -6.6895X_{16}$$

of farmers. This might be due to the general habit of farmers to approach socially active farmers for getting advises, in order to sustain their status in the village and to improve and refresh their knowledge. Hence, televiewing behaviour increases with increasing social participation. This finding was in conformity with the findings of Reddy (1995b), Vikram (2000) and Sivanandan (2002).

**Cropping Intensity Vs Televiewing Behaviour :** It is clear from Table-1 that there is no significant relationship between cropping intensity and televiewing behaviour of farmers. As the cropping intensity is completely dependent on water availability and rain fall, it had not shown any affect on the televiewing behaviour of the farmers. This finding was new to the earlier research findings.

**Training Exposure Vs Televiewing Behaviour :** It is clear from Table-1 that there was a positive and significant relationship between the training exposure and the televiewing behaviour of farmers at 0.01 level of probability. Trainings will help in improving the farmers knowledge. But, the majority of the training programmes organized by line departments only for half day and they may not provide complete picture about the technology. Moreover, trainings provide general awareness about other information sources like mass media. For supplementing the knowledge gained through training programmes, farmers will watch televisions for getting comprehensive picture of the technology. This finding was new to the earlier research findings.

## II. Multiple Linear Regression Analysis of Profile Characteristics of the Televiewing Farmers with their Televiewing Behaviour

An attempt has been made to find out the amount of contribution made by the profile characteristics in explaining the variation in the dependent variable i.e. the televiewing behaviour of farmers. The results are presented in Table-2.

Table-2 revealed that the coefficient of determination " $R^2$ " value was significant, as the value of " $b$ " was found to be significant. The " $R^2$ " value of 0.8005 indicated that all the selected sixteen (16) profile characteristics put together, explained about 80.05 per cent variation in the televiewing behaviour of the farmers. Remaining 19.95 per cent is due to the extraneous profile characteristics which were not under consideration in the study. Hence, it could be stated that the profile characteristics selected to a large extent explained the variation in televiewing behaviour of the farmers.

The regression coefficient given in Table-2 further explained that the profile characteristics namely socio-economic status, risk orientation, economic orientation, scientific orientation, annual income and social participation were found to be positively significant at 0.01 level of probability. Whereas education, farming experience, mass media exposure, cropping intensity and training exposure were found to be positively significant at 0.05 level of probability. Remaining variables viz., age, farm size, innovativeness, marketing orientation and

extension contact were not significant in their contribution to the variation in the televiewing behaviour of farmers. This implied that socio-economic status, risk orientation, economic orientation, scientific orientation, annual income, social participation, education, farming experience, mass media exposure, cropping intensity and training exposure contributed significantly to predict the variation in the televiewing behaviour of the farmers.

## Conclusions

The profile characteristics namely education, farming experience, socio-economic status, innovativeness, mass media exposure, marketing orientation, risk orientation, economic orientation, scientific orientation, extension contact, social participation and training exposure showed a positive and significant relationship with the televiewing behaviour of televiewing farmers. Keeping this in mind, appropriate extension strategies like training programmes, awareness programmes, group discussions should be designed to improve the televiewing behaviour of the farmers.

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## Research Review on Pulses in Rice (*Oryza Sativa*) Fallow Situations

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### Abstract

In the South Asia, particularly in India Rice fallow, a rainfed lowland agro-ecology, is presently gaining particular attention for sustainable cropping intensification. The intensification of cropping in rice-fallow areas is largely facing problems in less availability of water for irrigation, the poor soil and financial status of the farmers. In India around 11.695 M ha remains fallow after the harvesting of rice in which around Eastern India has the 82% of the total fallow lands and the rest falls in three southern states viz., Tamil Nadu, Karnataka and Andhra Pradesh. Pulse crops such as lentil, chickpea, lathyrus, mungbean and uradbean have a great opportunity to grow these kinds of crops which require low input and low water requirements. The fallow lands utilization may increase the productivity and make the whole system sustainable. Soil condition and environmental conditions clearly suggest that short duration crop will simply fit in that situation. The establishment strategies included utera, zero-till, reduced-till and conventionally till cropping. Introspection to past research established the importance of system approach for choice of crops and cultivars and management of tillage, nutrient, water and weed. Timely sowing and selection of good YMV resistant varieties in pulses with short duration are well fitting under limited water sources under rice fallow situation besides improvement in soil health.

**Key words :** Rice fallow, pulses, zero tillage, soil nutrients, soil fertility.

### Introduction

India is the largest producer as well as consumer of pulses with in the world. Pulses take a vital role in human's daily life. It not only providing high quality protein but also in several ways benefits the cropping system. The resources present in the rice fallows clearly gives an opportunity to introduce different pulse crops. The unutilized lands can be efficiently converted into productive ones if the location specific constraints are been efficiently managed.

Pulses are the major source of protein in vegetarian's diet. As they are leguminous crops, they help in restoring soil fertility by fixing the atmospheric nitrogen in the soil. Pulses are widely used in crop rotation due to its high nitrogen fixation capacity. They require less moisture and can survive in less water conditions. Pulses giving extra income and also acts as biofertilizers which increase the nutrient status of soil. The remnants after harvesting of pulses will be decomposed in the field. Paddy yields become increased when the rice is sown next to the pulse crops, by the availability of different nutrients in the soil.

After kharif rice under the rainfed conditions, relay crops are grown with the minimal moisture although soil moisture which may be the limiting factor at the later stage resulting in poor yields of the crops. The low water requirement crops such as lathyrus and lentil having could be most suitable in such situations (Das and Das, 1994). The utera cropping is the sowing of the pulses before the harvesting of paddy when it is at the stage of maturity, is a

highly locationspecific opportunity for increasing cropping intensity in considerable area which otherwise remain fallow after kharif rice (Yadav, 1992). Due to the abnormal onset and the withdrawal of the monsoons, the land preparation often becomes difficult. (Parya *et al.*, 2010). Under this kind of situations, the relay cropping is the best opportunity for getting proper time of sowing for succeeding crop after kharif rice (Sharma *et al.*, 2014).

Grain legumes constitute several Vitamins, Minerals, dietary fiber, starch and different complex sugars. In addition, a wide assortment of non-nutritive bioactive constituents, for example, catalyst inhibitors, phytic acid, lectins, phytosterols, phenols, and saponins, are available in grain legumes which have well-being defensive impacts (Champ 2002).

**Pulses in Rice fallows :** In most parts of the South Asian countries, growing rice is the predominant activity for farmers during *kharif* season under both irrigated and rainfed conditions under different cropping systems the pulses can be grown. About 22.2 million hectares of land in South Asia remains fallow after rice harvest during rabi/winter season due to number of biotic, abiotic, and socioeconomic constraints (Gumma *et al.*, 2016). Out of total rice fallow area, 88% lies in India. Despite ample opportunities, rice fallow systems did not get enough attention in the past.

In rice fallows, during the past several years vast number of abiotic factors soil and water related leads to low productivity of grain legumes. During the flowing and

pod-filling stages, if the water moisture content in the soil is low then the productivity or yield of grain legumes are severely affected. Many of the organisms like rhizobia would not be able to survive due to anaerobic conditions in rice cultivation. Rice fallows also affect seed germination, seedling emergence, and crop establishment due to disruption of the soil structure, soil water deficit, poor aeration, and mechanical impedance of the seed zone. Legumes have the ability to fix atmospheric N and thus improve/restore soil fertility of sick soils which developed due to continuous cultivation of the rice crop.

Millions of or small and marginal farmers get benefited if the fallow area is brought under cultivation. With suitable crop management techniques although with less water availability the productivity and profitability from grain legumes in rice fallows can be improved. By resource conservation, short duration and disease resistant varieties with timely sowing, plant population, timely weed management practices, with proper irrigation (lifesaving) would definitely increase the grain yield in legumes in rice fallow situations (Kumar *et al.* 2016a, b). If crop residues are retained on the soil surface in combination with suitable planting techniques, it may alleviate terminal drought/heat stress in pulses by conserving and regulating the soil moisture (Kumar *et al.* 2013a; 2016c). Due to no-till and minimum soil disturbance and different crop residues impacts the soil moisture content of the soil (Kumar *et al.* 2014; Meena *et al.* 2015c).

Bandyopadhyay *et al.* (2016) reported that, the hydraulic conductivity under no till and straw retained conditions are much higher than the conventional tillage technology. In Rainfed areas of Eastern India, the higher yield of lentil is observed after rainy (*khari*) season under conservation tillage, which will also reduce cost of cultivation through savings in labor, time, and farm power and improve input-use efficiency. Traditionally, seeds of pulses are broadcasted in the standing rice field without any tillage. Under such situation, 20–30 cm rice stubble needs to be maintained in the field to get an advantage similar to that of conservation tillage. In areas where grain legumes are sown after a harvest of rice with land preparation, zero-till seeding may be advocated as it facilitates advance planting by 7 to 10 days and saves energy and labor.

Rice ratoons are also a major problem in growing grain legumes under rice fallows. Residual soil moisture in large quantities is lost by nonproductive rice ratoons. Besides, the farm pond concept need to be advocated for the harvesting of excess rainfall and to use during the critical growth period of grain legumes for life saving irrigation through micro-irrigation system. Under soil moisture stress conditions, as the plant growth and yield is limited by the movement of plant nutrients from soil.

Under such soil moisture conditions, the foliar nutrition of 2 percent urea and micronutrients may be used to reduce the soil moisture stress up to some extent (Kumar *et al.* 2014a).

### Crop Diversification in Crops with Legumes :

Continuous cultivation of cereal crops year after year causes several soil, environmental and pest incidence problems, which can be overcome by the crop diversification with the legume crops (Chauhan *et al.* 2012; Congreves *et al.* 2015). By the increase of availability of various farm inputs and irrigation facilities which increased the cultivation of cereals which further more increased the several problems (Kerr *et al.* 2007). By adopting the different diversification/conventional cropping systems will be the best option to avoid the problems caused by the monocropping of cereals all round the year (Njeru 2016). Where in turn the crop rotation with legumes in the cereal based cropping system leads to improvement of soil health and higher accessibility of various plant required nutrients in the soil (Hazra *et al.* 2014; Ghosh *et al.* 2006). The above ground crop residues from the remaining legume crop parts which leads to decomposition and enrich the soil N-pool equivalent to 40kg N ha<sup>-1</sup> (Singh *et al.* 2005).

**Table-1 : Rice fallows in major districts of different states in India.**

|                |                                                                                                                                   |
|----------------|-----------------------------------------------------------------------------------------------------------------------------------|
| Andhra Pradesh | Krishna, Guntur, East Godavari, West Godavari, Srikakulam, Nellore and Prakasham                                                  |
| Assam          | Lakhimpur, Jorhat, Sibsagar, Dibrugarh, Golaghat, Karbi, Nagaon and Maringon                                                      |
| Bihar          | Kishanganj, Gaya, Aurangabad, Katihar, Mokama, Bhagalpur and Nalanda                                                              |
| Chhattisgarh   | Surguja, Jashpur, Raipur, Raigarh, Durg, Bilaspur and Bastar                                                                      |
| Jharkhand      | Ranchi, Bokaro, Purbi Singhbhum, Pashchim Singhbhum, Hazaribagh, Gumla, Sahibganj, Deogarh, Palamau, Dumka and Dhanbad            |
| Maharashtra    | Dhule, Amravati, Nagpur, Wardah, Bhandara, Chandrapur and Nanded                                                                  |
| Madhya Pradesh | Shahdo, Seoni, Balaghat, Damoh, Mandla, Rewa, Jabalpur, Betul and Sidhi                                                           |
| Odisha         | Koraput, Kalahandi, Sambalpur, Sundergarh, Bhadrak, Cuttak, Puri, Dhenkanal and Mayurbhanj                                        |
| West Bengal    | Purulia, Bankura, Birbhum, Bardhaman, Medinapur, Murshidabad, South 24-Parganas, Maldah, West Dinajpur, Jalpaiguri and Coochbihar |
| Uttar Pradesh  | Gonda, Siddarthnagar, Lakhimpur, Kheri, Pilibhit, Etawah, Mirzapur, Sonbhadra and Chandauli                                       |
| Karnataka      | Shimoga and Belgaum                                                                                                               |
| Tamil Nadu     | Salem, Namakkal, Tiruchirappali, Cuddalore, Ramnathpuram, Madurai and Villupuram                                                  |

**Source :** National Academy of Agricultural Sciences (NAAS) 2013.

### Grain legumes for the improvement of Soil health :

The legume crops not only food supplement and also beneficial for the soil health by virtue of :

**Biological nitrogen fixation** : Leguminous crops fix the nitrogen from 30-150 Kg N/ha based upon the different population of rhizobia present, host plant and different ecological conditions. For symbiotic nitrogen fixation in grain legumes the Rhizobium and Bradyrhizobium are helpful. Compared to the Bradyrhizobium the Rhizobium quickly develops the acid-releasing microbes (Brady and Weil 2002).

**Table-2 : Nitrogen availability in the soil for the next crop due to inclusion of Pulse crops.**

| Preceding legume   | Following cereal | N-equivalent (Kg N/ha) |
|--------------------|------------------|------------------------|
| Chickpea           | Maize            | 60                     |
| Chickpea           | Rice             | 40                     |
| Pigeonpea          | Wheat            | 40                     |
| Greengram          | Rice             | 40                     |
| Blackgram/mungbean | Wheat            | 30                     |
| Lentil             | Maize            | 30                     |
| Fieldpea           | Maize            | 25                     |
| Rajmash            | Rice             | 10                     |
| Cowpea             | Rice             | 40                     |
| Cowpea             | Wheat            | 43                     |

**Nutrient recycling** : Soil nutrients are recycled by the grain legumes due to the presence of the deep rooting systems. The carbon and Nitrogen quantity supplied by the roots of grain legumes which are most prominent for the soil organic matter present which is helpful for the nutrient recoveries (Sanju *et al.* 2005; Verma *et al.* 2015a)

**Weed smothering affects (crop rotation, intercrop and crop residues)** : The reporting from Chauhan and Johnson (2010) reported that the monoculture of rice around from the decades develops high weed infestation which will be decreased by the crop which are having different developmental behavior. The fallow period between the main crops in the mono cropping systems by the legumes decreases the weedy rice seed bank in the soil.

**Table-3 : Weed smothering efficiency of different cropping systems.**

| Intercropping systems    | Weed smothering efficiency (%) |
|--------------------------|--------------------------------|
| Pigeonpea + urdbean      | 32.82                          |
| Pigeonpea + mungbean     | 31.01                          |
| Pigeonpea + cowpea       | 39.06                          |
| Pigeonpea + sesame       | 36.6                           |
| Pigeonpea + pearl millet | 50.8                           |
| Maize + urdbean          | 17.3                           |
| Maize + pigeonpea        | 16                             |

**Table-4 : Amount of Litter fall and Nutrient availability through the leaf litter (crop residues).**

| Crop       | Leaf litters (t ha <sup>-1</sup> ) | N (Kg ha <sup>-1</sup> ) | P (Kg ha <sup>-1</sup> ) | K (Kg ha <sup>-1</sup> ) |
|------------|------------------------------------|--------------------------|--------------------------|--------------------------|
| Chickpea   | 1.1-1.7                            | 7-14                     | 3-5.5                    | 8-20                     |
| Lentil     | 1.3-1.6                            | 8-10                     | 3.5-4.5                  | 12.5-19                  |
| Pigeon pea | 1.3-2.8                            | 8-16                     | 2.5-5                    | 13.5-2                   |

**Water saving** : Less water or irrigation facilities are required by legumes when compared to the cereals or commercial crops. Hardly legume crop requires 250-300 mm of water which is far less than many types of cereals and other crops. The water applied to the pulses is used more efficiently due to the presence of deep root system. 12.5 kg of chickpea is produced by the 1ha-mm of water which is more high than compared to wheat – 7.0 kg and rice 2.5kg.

**Major constraints for pulses in rice fallow situations are :**

#### A. Common constraints :

**Abiotic** : Abiotic stress is related with the physical stress which is related to soil moisture stress, poor fertile soils, problematic soils and different unpredictable environmental conditions at the time of sowing and at the peak requirement period for irrigation comes under abiotic stress. Low moisture levels and faster evaporation of moisture present in the soil frequently leads to the drought conditions which inward affects the flowering and harvesting stages which decreases the grain yield. Lack of little rains in winter at the grain-filling stage may lead to crop failures. Grain legume production is directly affected by the availability of the moisture, specific nutrients and soil organic carbon (SOC) (Pande *et al.*, 2012). In the coastal low land areas, the staging of water at one place which leads to the destruction of crop which causes economical losses at a high extent.

**Biotic** : Evidences says that pulses are the more susceptible host for the insects mainly act as source for virus transmission. Serious threat with the diseases such as powdery mildew, mungbean yellow mosaic virus (MYMV) and many wilts and root rots are also severe in pulses which are bottle necks for production constraints.

**Socio-economic constraints** : Lack of awareness on available technologies and modern inputs at local village level, the farmers paid with production losses in rice fallows. The less or non-availability of improved resistant varieties of pulses seeds and not aware of scientific knowledge and less technical experience all together becomes the small and marginal farmers pish into low production flat form. These socio-economic constraints are in substantiated with Praharaj *et al.*, 2017. Hence

**Table-5. Constraints in relay cropping and in rice fallows.**

| Crop     | Biotic stresses                                                            | Abiotic stresses                                                           |
|----------|----------------------------------------------------------------------------|----------------------------------------------------------------------------|
| Chickpea | Fusarium wilt, root rot, chickpea stunt, Botrytis Gray Mould and pod-borer | Low and high temperature and terminal drought                              |
| Mungbean | MYMV, root and stem rot, sucking insect pests and Pre-harvest sprouting    | High temperature, terminal drought and excessive soil moisture at sowing   |
| Urdbean  | MYMV, root and stem rot, stem and Pre-harvest sprouting                    | Temperature stress, terminal drought and excessive Soil moisture at sowing |
| Lentil   | Lentil Fusarium wilt, root rot and rust                                    | Soil moisture and high temperature (under late sown)                       |

focus should be on identification of socio-economic constraints as first goal and chalk out problems with economically viable technologies.

**B. Production constraints :** Less plant population and less/no use of fertilizers leads to the decrease in production and productivity. Unavailability of hybrids or varieties of different pest and disease resistant varieties leads to reducing the production in pulse crops.

**Table-6. Interventions in the pulses production and Solutions for those interventions.**

| Intervention           | Solutions             |
|------------------------|-----------------------|
| Seed                   | Improved varieties    |
| Crop establishment     | Zero tillage machines |
| Diseases               | Wilt resistance       |
| Pod Borer              | IPM responsive        |
| Fertilizers            | DAP                   |
| Micronutrients         | Mb, Zn, S             |
| Herbicides             | Pendimethalin         |
| Transfer of technology | Empowerment           |
| Seed systems           | Empowerment           |

**Economic impact :** Cultivation of pulses is not only agronomically feasible but also viable in terms of economically sustainable. By substitution of pulses in the Rice/Wheat cropping systems, the 11.65 M ha of land of rice fallows can be well utilized with soil enrichment. So that system can be benefitted for small and marginal farmers with use of improved varieties and techniques which in turn increases the productivity by 20-30%. This also increases the opportunity for the labor and agro based workers to obtain the additional income in the off growing seasons of main crops. Around 502.7-million-person days are added to the workers which creates additional employment which can be bought by the cultivation of pulses in the Rice fallows.

## Conclusion

At present, environment and soil becoming challenge in this modern era of agriculture, rice fallow pulses will be the best opportunity to enhance the soil health besides production of pulses. The unutilized area of 11.7 M. ha. Will become rich source of soil carbon development and also livelihood of small and marginal farmers with low cost production technology. If the farmers able to use the

proper strategies and technologies in the rice fallow for growing pulses, they increase the soil health and productivity by the fixing of atmospheric nitrogen into the soil and giving the farmers an extra income to the farmers. Use of improved varieties and recommended methodologies improve the yields and income of small and marginal farmers.

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## **Factors Associated with Livelihood Security among the Small and Marginal Farmers in Betul District of Madhya Pradesh**

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### **Abstract**

The study was carried out over 80 respondents sample size in Betul district of Madhya Pradesh to know the factors associated with livelihood security among the small and marginal farmers. The finding indicated that majority of the respondents had medium level of food security (36.25 per cent), economic security, (42.5 per cent), health security (51.25 per cent), educational security (43.75 per cent), social security (42.5 per cent), institutional security (61.25 per cent). The study also shows that 48.75 percent respondents had medium level infrastructural security. The findings also indicated that the variables, like size of land holding and cropping system were shows positive correlation at 5% level of significance and annual family income was also shows positive correlation at 1% level of significance with the 'livelihood security' of the farmers. The regression analysis showed that experience in farming (3.29), annual family income (3.39), and cropping system (2.26) were the most important factors contributing, significantly, towards the 'livelihood security of farmers. The  $R^2$  (0.4070) indicated that the set of variables explain 40.70 per cent of the total variability towards dependent variable i.e. livelihood security.

### **Introduction**

India is predominantly an agrarian country. Agriculture and its allied activities act as main source of livelihood for more than 80% population of rural India. It provides employment to approximately 52% of labourers. Its contribution to Gross Domestic Products (GDP) is 15.4% (2017). Rural India had an estimated total of 90.2 million agricultural households, accounting for approximately 57.8 per cent of the country's total estimated rural households. Major source of income of agricultural households is mainly determined by the extent of land ownership. The majority of agricultural households with more than 0.40 hectare of land reported cultivation as their main source of income. Livelihood security, especially food security is the most important factor that determines the survival of humankind. Without food security, a nation cannot expect better life for its people. "Livelihood Security" can be defined as adequate and sustainable access to income and other resources to enable households to meet basic needs. This includes adequate access to food, potable water, health facilities, educational opportunities, housing, time for community participation and social integration (Frankenberger, 1996). The livelihood security is a term which comprises of several other securities such as food security, economic security, educational security, social security, health security, institutional security and infrastructural security. All these securities are together contributing in achieving the overall livelihood security of a person. Keeping in view, the study aims to assess the "Factors associated with livelihood security among the farmers of Small and Marginal farmers in Betul district of Madhya Pradesh".

### **Research Methodology**

The research enterprise was carried out in the randomly selected Betul District of Madhya Pradesh. There are ten blocks in Betul district. Out of these, two blocks Multai and Betul were purposively selected, because these, two blocks have maximum number of main cultivator population person having maximum number of small and marginal farmers. There are total 139 and 193 villages in Multai and Betul block respectively. Out of these villages, Sarra & Joulkheda from Multai block and Sehra and Soorgaon from Betul block randomly selected for the present investigation. Based on number of household 10 marginal and 10 small farmers has been randomly selected from the selected each village. Thus, from four villages a total number of 80 respondents were constituted as the sample for the present study. Suitable statistical tools such as frequency, percentage, arithmetic mean, standard deviation, correlation and regression analysis Garrett ranking method have been used.

### **Results and Discussion**

**Livelihood means and livelihood security among the small and marginal farmers :** The study has been carried out in terms of seven sub-indicators such as food security, economic security, health safety, education security, social security, institutional security, and infrastructural security. All of these securities contributed together to a respondent's overall livelihood security.

**Food Security :** Data presented in table-1 indicates that 36.25 percent of the respondents had medium level of food security followed by 32.50 and 31.25 percent of the

respondents had low and high level of food security, respectively. The overall extent of food security in the study area was 72.53 percent. This result indicates that only 31.25 percent of the respondents had the high level of food while more than 68.75 percent of the respondents were having low and medium level of food security, which revealed the vulnerable condition of the farmer towards the food security. The similar results were also confirmed by Ponnusamy (2006) and Parmanand (2012).

**Table-1 : Distribution of respondents on the basis of food, economic, health, education, social, institutional and infrastructural security level.**

| Food security level                   | Respondents (N=80) |            | Mean   |
|---------------------------------------|--------------------|------------|--------|
|                                       | Frequency          | Percentage |        |
| Low (<0.68)                           | 26                 | 32.50      | 0.7253 |
| Medium (0.68 – 0.79)                  | 29                 | 36.25      |        |
| High (>0.79)                          | 25                 | 31.25      |        |
| <b>Economic security level</b>        |                    |            |        |
| Low (< 0.30)                          | 27                 | 33.75      | 0.3581 |
| Medium (0.30 – 0.44)                  | 34                 | 42.50      |        |
| High (> 0.44)                         | 19                 | 23.75      |        |
| <b>Health Security level</b>          |                    |            |        |
| Low (< 0.56)                          | 23                 | 28.75      | 0.602  |
| Medium (0.56 – 0.70)                  | 41                 | 51.25      |        |
| High (> 0.70)                         | 16                 | 20.00      |        |
| <b>Education Security level</b>       |                    |            |        |
| Low (< 0.23)                          | 29                 | 36.25      | 0.2936 |
| Medium (0.23 – 0.43)                  | 35                 | 43.75      |        |
| High (> 0.43)                         | 16                 | 20.00      |        |
| <b>Social Security level</b>          |                    |            |        |
| Low (< 0.43)                          | 25                 | 31.25      | 0.4835 |
| Medium (0.43-0.60)                    | 34                 | 42.50      |        |
| High (> 0.60)                         | 21                 | 26.25      |        |
| <b>Institutional Security level</b>   |                    |            |        |
| Low (< 0.31)                          | 25                 | 31.25      | 0.4125 |
| Medium (0.31 – 0.51)                  | 49                 | 61.25      |        |
| High (> 0.51)                         | 6                  | 7.50       |        |
| <b>Infrastructural Security level</b> |                    |            |        |
| Low (< 0.56)                          | 19                 | 23.75      | 0.580  |
| Medium (0.56 – 0.66)                  | 39                 | 48.75      |        |
| High (> 0.66)                         | 22                 | 27.50      |        |

**Economic Security :** The results related with the economic security revealed that 42.5 percent of the respondents had medium level of economic security followed by 33.7 and 23.75 percent of the respondents had low and high level of economic security, respectively. The overall level of economic security in the study area was 35.81 percent. More than one-third of the respondents were having the low level of economic security in the study area, which indicates the necessity of increasing the economic opportunities for respondent in the study area for enhancing their economic security.

**Health Security :** The data presented in table-1 related with the health security in the sub-area of livelihood security indicated that 51.25 percent of the respondents

had medium level of health security followed by 28.75 and 20 percent of the respondents had low and high level of health security, respectively. The overall extent of health security was found to be 60.20 percent. As more than half of the respondents were found in the medium level of health security, which explore that the respondents are aware about their health conditions and able to access the necessary health services to maintain the healthy lifestyle.

**Educational Security :** It is evident from the table that 43.75 percent of the respondents had medium level of educational security followed by 36.25 and 20.00 percent respondents had low and high level of educational security, respectively. The overall level of educational security in the study area was 29.36 percent. The level of educational security was found not so good since, 80 percent of the respondents were having medium and low level of educational security which revealed that in the study area effort should be made to improve the educational facilities which in turn will enhance their livelihood security.

**Social Security :** The results presented in table-1 shows that 42.5 percent of the respondents had medium level of social security followed by 31.25 and 26.25 percent of the respondents had low and high level of social security, respectively. The overall level of social security in the study area was found to be 48.35 percent. Here, it can be interpreted that only a small portion of the respondents in the study area feel 'socially secured' while more than 70 percent of them feel 'socially insecure' which indicate that there is lack of social participation among the respondents.

**Institutional Security :** The perusal of the table-1 indicates that 61.25 percent of the respondents had medium level of institutional security followed by 31.25 and 7.5 percent of the respondents had low and high level of institutional security, respectively. The overall level of institutional security in the study area was 41.25 percent. The results indicate that there is a need of building more institutions and to enhance the access of respondents to different institutions available in their locality for improving the institutional security of the respondents.

**Infrastructural Security :** The table-1 reveals that 48.75 percent of the respondents had medium level of infrastructural security followed by 27.5 and 23.75 percent of the respondents had high and low level of infrastructure security, respectively. The overall extent of infrastructural security was found to be 58 per cent. The results show that maximum number of respondents in the study area, perceived that good infrastructural facilities available to improve their overall livelihood security.

**Overall livelihood security :** The data presented in

table-2 revealed that 41.25 percent of the respondents had medium level of livelihood security followed by 35 and 23.75 percent of the respondents had low and high level of livelihood security, respectively.

The overall extent of livelihood security was found to be 51 per cent. From the results, it has been found that most of the respondents in the study area were having the insecurity of their livelihood, through their respective means of livelihood generation, because majority of them possess low and medium level of livelihood security.

**Table-2 : Distribution of respondents on the basis of overall livelihood Security.**

| Livelihood Security Index | Respondents (N=80) |            | Mean |
|---------------------------|--------------------|------------|------|
|                           | Frequency          | Percentage |      |
| Low (< 0.48)              | 28                 | 35         | 0.51 |
| Medium (0.48–0.55)        | 33                 | 41.25      |      |
| High (> 0.55)             | 19                 | 23.75      |      |

**Correlation analysis between various factors associated with livelihood security :** The relationship between the respondents profile which includes twelve variables viz., age, education, caste, family size, size of land holding, livestock holding, social participation, experience in farming, occupation, annual family income, cropping system, mass media exposure with livelihood security were worked out with the help of coefficient of correlation coefficient (r) and findings are presented in table-3.

**Table-3 : Correlation analysis between livelihood securities.**

| Sl. No. | Factors               | Correlation Coefficient (r) |
|---------|-----------------------|-----------------------------|
| 1.      | Age                   | -0.115                      |
| 2.      | Education             | 0.204                       |
| 3.      | Family size           | -0.038                      |
| 4.      | Size of land holding  | 0.242*                      |
| 5.      | Livestock holding     | 0.007                       |
| 6.      | Social participation  | 0.213                       |
| 7.      | Experience in farming | 0.046                       |
| 8.      | Occupation            | 0.168                       |
| 9.      | Annual family income  | 0.369**                     |
| 10.     | Cropping system       | 0.258*                      |
| 11.     | Mass media exposure   | 0.083                       |

\*\*Correlation is significant at the 0.01 level. (1%), \*Correlation is significant at the 0.05 level.(5%)

It is evident from the table that age and family size was negatively correlated with livelihood security. That means, when the age and family size of the respondents increases the value of livelihood security associated with it decreases and vice-versa. So, if increase the livelihood security of the respondents, the size of family should be kept smaller. It was also true with age, more the age; less livelihood secure. Other factors, such as size of land holding, cropping system, were found to be positively and significantly related with the livelihood security of the

respondents at 5 percent level of significance. It means, by increasing the values of above factors, the value of livelihood security of the respondents is increases. Whereas, annual family income was found to be positively and significantly related with the livelihood security of the respondents at 1 percent level of significance. It indicates this factor is strongly related with the livelihood security. However, variables education, livestock holding, social participation, experience in farming, occupation and mass media exposure were not found to be correlated with livelihood security of the respondents.

#### **Regression analysis between various factors associated and livelihood security :**

Table-4 depicts the results of regression analysis administrated to isolate the prediction potentialities and the amount of variability to be explained by them towards the livelihood security. At a glance over the beta coefficient and their corresponding value indicates varying level of contribution towards dependent variable under the study. When data were put to regression analysis for asserting  $R^2$ -value, then it has been found that they are cumulatively responsible for accounting 40.70 percent variability towards dependent variable i.e. livelihood security. The fitted regression model is found to be significant at 1 percent level of significance. Further, the variables age, experience in farming, and annual family income and were found to be significant at probability 0.01 while, cropping system was found to be significant at probability 0.05.

**Table-4 : Regression analysis between livelihood securities.**

| Sl. No.                                  | Factors              | beta co-efficient | Standard error | "t values" |
|------------------------------------------|----------------------|-------------------|----------------|------------|
| 1.                                       | Age                  | -0.004            | 0.001          | -3.108**   |
| 2.                                       | Education            | 0.005             | 0.005          | 0.908      |
| 3.                                       | Family size          | -0.001            | 0.004          | -0.268     |
| 4.                                       | Size of land holding | 0.002             | 0.006          | 0.393      |
| 5.                                       | Livestock holding    | -0.0002           | 0.003          | -0.060     |
| 6.                                       | Social participation | 0.007             | 0.006          | 1.278      |
| 7.                                       | Experiencing farming | 0.006             | 0.002          | 3.297**    |
| 8.                                       | Occupation           | -0.012            | 0.014          | 0.840      |
| 9.                                       | Annual family income | 0.0000004         | 0.0000001      | 3.396**    |
| 10.                                      | Cropping system      | 0.009             | 0.004          | 2.268*     |
| 11.                                      | Mass media expose    | -0.0004           | 0.003          | -0.181     |
| R <sup>2</sup> = 0.407; F-value = 4.24** |                      |                   |                |            |

\*\*Significant at the 0.01 level. (1%), \*Significant at the 0.05 level. (5%)

#### **Conclusion**

On the basis of above findings as obtained, the study finally concluded that agriculture was the main source of livelihood of farmers in the study area. The respondents had small to marginal land holdings to supplement their income through labourer work, animal husbandry, agribusiness, and any kind of job to sustain the livelihood. Food security (0.72) and infrastructure security (0.58)

were contributing maximum towards improvement of overall livelihood security of the farmers. Size of land holding, cropping system, and annual family income were found to be positively and significantly related with the livelihood security of the respondents. It means, by increasing the values of above factors, the value of livelihood security of the respondents is increases. Age and family size were negatively correlated with livelihood security i.e when the age and family size of the respondent's increases the value of livelihood security associated with it decreases and vice-versa.

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## Effect of Different Growing Media on Essential Elements of Lettuce (*Lactuca sativa* L.) Genotypes under Different Growing System

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### Abstract

An investigation entitled "Effect of different growing media on essential elements of lettuce (*Lactuca sativa* L.) genotypes under different growing systems" was conducted in the Division of Plant Physiology, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu. The experiment was conducted during September, 2019 to March, 2020 to visualize the effect of different growing media for the hydroponic cultivation of *Lactuca sativa* genotypes. Ten feet long, six feet wide and 8 feet height with 4 inch PVC pipes were used to create hydroponics system of 180 pot holes. Two varieties *Romaine* and *Grand rapid* were taken as experimental material. Seeds of the two varieties collected from PAU, Ludhiana, Punjab and HPKV, Palampur, Himachal Pradesh, were sown inside the laboratory of Division of Plant Physiology with the help of white lights. Seedlings at five leaves stage were transplanted to the hydroponic system with Nutrient Film Technique (NFT). In this technique, the roots of plants hang down to the bottom of the channel where they came into contact with the shallow film of the nutrient solution and absorbed nutrients from them instead of soil. The experiment was laid out in Factorial Completely Randomised Design, consisting of 7 treatments viz, T<sub>0</sub>: Coco peat (100 %), T<sub>1</sub>: Coco peat + Vermicompost (1:1), T<sub>2</sub>: Coco peat + Perlite (1:1), T<sub>3</sub>: Coco peat + vermiculite (1:1), T<sub>4</sub>: Coco peat + perlite + vermiculite (1:1:1), T<sub>5</sub>: Coco peat + perlite + vermiculite + vermicompost (1:1:1:1) and T<sub>6</sub>: Conventional method (soil + Vermicompost). After 1 week of transplanting, data was recorded at three different stages of crop growth (12 DAT, 35 DAT and 50 DAT). The present study was carried out to understand how growing system affects the nutrients of lettuce vegetable under different growing media. The experimental results revealed that, maximum nutrient content were noticed in the leaves of both varieties of lettuce that grown in hydroponic system under treatment T<sub>5</sub> rather in soil. Combination of treatment T<sub>5</sub>: coco peat + perlite + vermiculite + vermicompost in the ratio of 1:1:1:1 and hydroponic system were found the most promising treatment for enhancing the essential of both varieties of *Lactuca sativa* as compared to other treatments and growing methods.

**Key words :** Hydroponic, nutrient film technique, *lactuca sativa*, perlite.

### Introduction

Many studies are administrated so as to develop food producing systems. One among them is that the soil less farming systems. Soilless systems developments can reduce farmer's consumption of resources like hydroponics. In keeping with (Espinoza, 2019), hydroponic technique may be considered because the best alternative in areas where serious soil and water problems like soil born pests and diseases, soil and water salinity, chemical residues in soil and water, shortage of water exist. The proposed research meet the state specific goals of enhancing economic opportunities for tiny scale family farms, and improving the standard of life for rural citizens and communities.

Plants in hydroponics are grown in an inert media, like rocks or coco coir fibre (coco peat), perlite, vermicompost, or vermiculite, instead of soil, and are given an answer with an explicit combination of primary, secondary, and micronutrients. The higher performance was represented by coco peat medium could also be thanks to the high water holding capacity, aeration and slightly high potassium content within the medium. Noguera *et al.* (2000) revealed that coconut waste was

the most effective medium for growing horticultural crops under hydroponics. They observed that this medium was light in weight and had high total porosity (94% of total volume). Coco peat also exhibited high air content. The number of present available nutrients like nitrogen, calcium and magnesium was low but phosphorus and potassium contents were high. Lettuce production in an exceedingly hydroponic system is more practical in controlling microbial contamination additionally as higher antioxidant compounds, because this method of production allowed for better visual quality maintenance, browning control, and is more practical in controlling microbial contamination in comparison to lettuces grown in soil (Selma *et al.*, 2012).

*Lactuca sativa* L. which is often called lettuce, could be a member of the asteroid dicot family, a successful and diverse group of plants with a worldwide distribution (Funk *et al.*, 2005). Many medieval authors described garden lettuce and its uses especially as a medicinal herb. Bennett *et al.* (2001) described three basic modern lettuces including lettuce, leaf lettuce, and romaine or cos lettuce. Although lettuce is an exotic vegetable, it's of high demand in India, thanks to change in food habits of the people and also thanks to health conciseness (Kumar *et*

*al.* 2010). Lettuce are rich in nutrients also as vitamins, calcium, fiber (Kim *et al.* 2016). Hence, lettuce is that the best model crop to gauge the performance of those systems. per research (Ismail *et al.*, 2015), lettuce plants are utilized in traditional medicine for several years to treat a range of disorders like inflammation, pain, stomach problems like indigestion and loss of appetite, bronchitis, and tract infections. Since lettuce is extremely low in calories (10 kcal [60 kJ]/100 g, FW) and highly rich in nutrients, it's often prescribed for weight loss programs. Carotenoids possess antioxidant capacity and antioxidant, the water soluble antioxidant, also shows antioxidant properties (Lopez *et al.*, 2014). Hence, our study aimed toward understanding how growing systems are influential within the nutrition attributes of the crop and also to gauge different growing media and systems. Objective of the current study was to analyze the influence of various growing media and systems on N, P, and K on leaf of lettuce cultivars.

## Materials and Methods

The experiment was conducted from October 2019 to March, 2020 in the Division of Plant Physiology, Faculty of Basic Sciences, Sher-e-Kashmir University of Agricultural Sciences and Technology of Jammu, Main Campus Chatha, Jammu-180009, J&K. Geographically the experimental site is located at 32° - 40' N latitude and 74° - 58' E longitude with an altitude of 332 m above mean sea level in the Shiwalik foot hills of North-Western Himalayas. Two growing systems were evaluated using two lettuce cultivars under protected condition.

## Growing systems

**Soil based growing system :** Plants were grown in pots with soil.

**Aggregate media hydroponics :** This is substrate based soilless cultivation technique. Cocopeat, perlite, vermiculite and vermicompost were used as substrate for aggregate media hydroponic system, as it is readily available and affordable in India.

**Hydroponic structure (NFT) :** In hydroponic system nutrient film technique (NFT) was used, which is carried out in a structure made with fine and strong PVC pipes. Eighteen PVC pipes having ten feet long, six feet wide and 8 feet height with 4 inches were used to create hydroponics system of 180 pot holes arranged in three tiers using iron angles or frame. The hydroponic pots were fitted in the holes. The whole structure was covered with polythene sheet to reduce the atmospheric temperature.

**Lettuce cultivars :** The two common varieties of lettuce were used for the study :

V<sub>1</sub> - *Romaine*

V<sub>2</sub> - *Grand rapid*

| Treatment      | Media / Substrates                               | Ratio             |
|----------------|--------------------------------------------------|-------------------|
| T <sub>0</sub> | Coco peat                                        | (100%)            |
| T <sub>1</sub> | Coco peat + Vermicompost                         | (1:1)             |
| T <sub>2</sub> | Coco peat + Perlite                              | (1:1)             |
| T <sub>3</sub> | Coco peat + Vermiculite                          | (1:1)             |
| T <sub>4</sub> | Coco peat + Perlite + Vermiculite                | (1:1:1)           |
| T <sub>5</sub> | Coco peat + Perlite + Vermiculite + Vermicompost | (1:1:1:1)         |
| T <sub>6</sub> | Conventional method (soil + manure)              | No definite ratio |

**Nutrients supplement :** The Green loop Leafy-200 hydroponic nutrient was used in the experiment due to its versatile nature, mainly composed of both macro and micro nutrients. It was generally used for herbs, salad and all kind of leafy vegetables. The nutrient was comprised of two sealed bottles A and B, each contained separate solid nutrient.

## Composition of pure hydroponic nutrient

**Macronutrients :** Calcium 23%, Nitrogen 23%, Phosphorous 7%, Potassium 32%, Magnesium 5.3%, Sulphur 9%

**Micronutrients :** (Boron, Chlorine, Manganese, Zinc, Copper, Sodium, Molybdenum, Iron, Chlorine) 0.7%

**Date of seed sowing :** Seeds of both varieties were sown in seedling trays inside the laboratory of Plant Physiology on 10<sup>th</sup> of October, 2019 and after two weeks, seedlings of both varieties came. Date of transplanting in hydroponics : 29<sup>th</sup> of November, 2019

## Procedure of transplanting in hydroponics

**Experiment was executed on the basis of nutrient film technique :** In this technique, seedlings of both varieties were first transplanted into hydroponic pots filled with separate combination of substrates and then pots were placed in the hydroponic structure containing PVC pipes. There were total 18 pipes, the nine pipes from the ground floor were assigned to *Romaine* lettuce and remained nine pipes were assigned to *Grand rapid* with different concentrations of growing media. The hydroponic nutrient solution was added into the tank that continuously cycled through the pipes for 40 minutes. The pH and electrical conductivity of nutrient solution were checked after every week.

**Conventional method :** For comparison study, conventional method was used in which seeds of both varieties were sown in pots. No treatment was given to pots. For the preparation of pots, soil and manure were used.

**Treatments** : Different growing media were used in different concentration

**Sampling time** : Sampling was done at 12 days after transplanting, 35 days after transplanting and at harvest (50 days after transplanting).

**Observations** : The subsequent observations were recorded at seedling, vegetative and reproductive stages.

#### Collection of experimental data

**Nitrogen content** : Nitrogen estimation was done by Kjeldahl Method developed by a Danish chemist named Johan Kjeldahl. The Kjeldahl method uses sulphuric acid, a spread of catalysts, and salts to convert organically bound nitrogen in samples to ammonium with its subsequent measurement (Saez-Plaza *et al.*, 2013).

**Reagents** : Selenium reaction mixture for nitrogen determination, acid, caustic soda, hydroxide reagent, water, boric acid, tashiro indicator (2 vol. 0.2% methyl red in 90% ethanol + 1 vol. 0.2% thiazine in 90% ethanol) and acid.

#### Procedure

**Digestion** : Within the procedure, a weighed sample of the leaves was heated along with concentrated  $\text{H}_2\text{SO}_4$  within the presence of  $\text{K}_2\text{SO}_4$  and a Se, Hg, or Cu catalyst in an exceedingly heat-resistant tube at a temperature of  $\sim 400^\circ\text{C}$ . This step is actually wet oxidation of the sample, and also the organic constituents are initially carbonized as evidenced by the looks of a grimy black color. Continued heating ends up in complete oxidation to  $\text{CO}_2$  and therefore the digest becomes clear. This digestion step converts sample N into a soluble non-volatile form,  $(\text{NH}_4)_2\text{SO}_4$ . The clear digest is cooled, suitably diluted, and made alkaline by the addition of a way over strong base (NaOH), which releases the N in an exceedingly quantifiable form as free  $\text{NH}_3$ .

**Distillation** : The neutralized digest is then subjected to steam distillation, which separates the volatile  $\text{NH}_3$  from the opposite constituents, and therefore the condensed  $\text{NH}_3$  is trapped in a acid.

**Titration** : The ultimate step involves quantification of the trapped  $\text{NH}_3$  by titration with a regular acid. The number of acid employed in titration can easily be associated with the N content of the sample.

#### Calculation :

$$\text{Nitrogen \%} = \frac{(\text{ml standard acid} - \text{ml blank}) \times \text{N of acid} \times 1.4007}{\text{Weight of sample in grams}}$$

**Phosphorous content** : Phosphorous estimation was done by Vanadate molybdate method

**Principle** : Vanadate molybdate and orthophosphates

react to give relinquish a yellow complex in acidic medium. The intensity of colour provide the idea of quantitative measurement of total P in leaves. (Koenig *et al.*, 1942).

#### Apparatus and Reagents :

Colourimeter / Spectrophotometer

50 ml volumetric flask

Ammonium molybdate ammonium vanadate in  $\text{HNO}_3$  solution : Dissolve 1.25g  $(\text{NH}_4)_6\text{MO}_7\text{O}_{24} \cdot 4\text{H}_2\text{O}$  in 400ml distilled water. Dissolve 1.25 g of ammonium vanadate in 300ml boiling water. Add the ammonium molybdate solution and funky to temperature. Add 250ml conc.  $\text{HNO}_3$  and dilute to 1 litre.

Preparation of standard solution: Dissolve 0.2195g  $\text{KH}_2\text{PO}_4$  and dilute to 12%. This solution contain 50 micro gram phosphorous/ ml.

#### Procedure : Preparation of standard curve :

Transfer 0, 1, 2, 3, 4 and 5 ml of 50 ppm P solution to 50 ml volumetric flasks so as to urge 0, 50, 100, 150, 200 and 250 micro gram / Phosphorous.

Add 10ml vanadomolybdate reagent make up the volume and mix the content thoroughly.

Read the absorbance

Plot the reading against micro gram P and calculate the factor (F).

**Digestion of plant material** : Take one gram of plant material in digestion flask. Add 10-15 ml of Diacid (3:1: nitric acid: perchloric acid) mixture and swirl the content in 150 ml volumetric flask. Place the content on hot plate till the digestion is over. Filter the solution in 100 ml conical flask, wash the residue on filter paper with hot water, and store the solution in air tight container.

#### Estimation :

Transfer 10 ml dilute in 50 ml volumetric flask.

Add 10 ml ammonium molybdate vanadate solution shake the content.

Make up the volume and record the readings.

#### Calculation :

50 micro gram = R

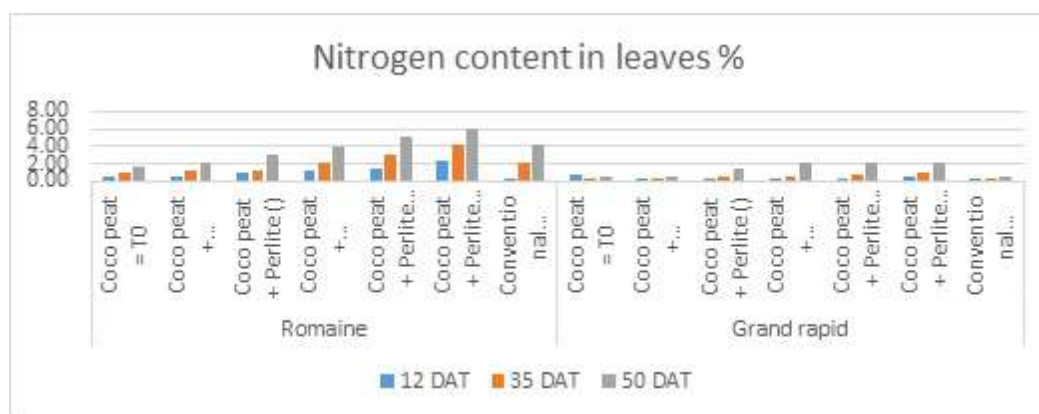
1 R = 50/ R micro gram (Factor)

$$\text{Phosphorous \%} = \frac{\text{Factor} \times \text{Reading}}{10000} \times \frac{100}{10} \times \frac{100}{1}$$

#### Potassium Estimation :

**(A) Wet digestion** : Place 1-2 g of ground plant sample in 100 ml digestion flask. Add 20-25 ml of acid mixture (750ml conc.  $\text{HNO}_3$  + 150 ml conc.  $\text{H}_2\text{SO}_4$  + 300ml of  $\text{HClO}_4$ ) and mix the content of flask by swirling well. Heat

| Nitrogen content (%) |                                |      |      |      |                                |      |      |      |
|----------------------|--------------------------------|------|------|------|--------------------------------|------|------|------|
| Treatments           | Romaine                        |      |      |      | Grand rapid                    |      |      |      |
|                      | Days after Transplanting (DAT) |      |      |      | Days after Transplanting (DAT) |      |      |      |
|                      | 12                             | 35   | 50   | Mean | 12                             | 35   | 50   | Mean |
| T <sub>0</sub>       | 0.45                           | 1.08 | 1.76 | 1.09 | 0.20                           | 0.22 | 0.52 | 0.31 |
| T <sub>1</sub>       | 0.60                           | 1.17 | 2.17 | 1.31 | 0.21                           | 0.38 | 0.54 | 0.37 |
| T <sub>2</sub>       | 0.98                           | 1.24 | 3.13 | 1.78 | 0.32                           | 0.48 | 1.38 | 0.72 |
| T <sub>3</sub>       | 1.15                           | 2.08 | 4.04 | 2.42 | 0.34                           | 0.63 | 2.04 | 1.00 |
| T <sub>4</sub>       | 1.52                           | 3.08 | 5.03 | 3.21 | 0.37                           | 0.68 | 2.10 | 1.05 |
| T <sub>5</sub>       | 2.36                           | 4.10 | 6.10 | 4.19 | 0.45                           | 1.05 | 2.15 | 1.21 |
| T <sub>6</sub>       | 0.39                           | 2.10 | 4.26 | 2.25 | 0.21                           | 0.40 | 0.55 | 0.38 |
| Mean                 | 1.06                           | 2.12 | 3.78 |      | 0.30                           | 0.55 | 1.32 |      |
| C.D. at 5%           | Variety                        |      |      |      | = 0.08                         |      |      |      |
|                      | Treatment                      |      |      |      | = 0.16                         |      |      |      |
|                      | Variety x Treatment            |      |      |      | = 0.22                         |      |      |      |
|                      | DAT                            |      |      |      | = 0.10                         |      |      |      |
|                      | Variety x DAT                  |      |      |      | = 0.14                         |      |      |      |
|                      | Treatment x DAT                |      |      |      | = 0.27                         |      |      |      |
|                      | Variety x Treatment x DAT      |      |      |      | = 0.39                         |      |      |      |

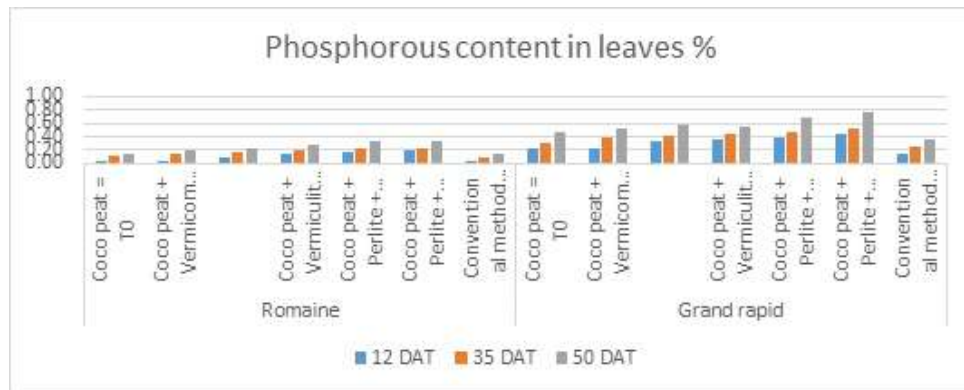


**Statistical analysis :** The parameters recorded were analysed using Statistical tool - Factorial Completely Randomized Block Design (CRBD) for three factors. Treatments were compared using critical difference (CD) at 5 % level of significance. Data was subjected to analysis of variance (ANOVA) using Online Statistical Analysis Package (OPSTAT, Computer Section, CCS Haryana Agricultural University, Hisar 125004, Haryana, India).

**Nitrogen content present in leaves :** Nitrogen content in *Romaine* and *Grand rapid* leaves was recorded with different treatments in Table-1. Reduction in nitrogen content in *Romaine* leaves was recorded in plants treated with treatment T<sub>6</sub>, (0.39, 2.10, 4.26) followed by treatment T<sub>0</sub> (0.45, 1.08, 1.76 %) respectively at 12, 35 and 50 DAT. In treatment T<sub>4</sub>, and T<sub>3</sub>, when applied, also reduced nitrogen content (1.52, 3.08, 5.03 %) and (1.15, 2.08, 4.04 %) respectively at 12, 35 and 50 DAT as compared to treatment T<sub>5</sub>, (2.36, 4.10, 6.10 %) at 12, 35 and 50 DAT respectively. The mean of *Romaine* variety under different treatments, maximum mean was found in plants treated with treatment T<sub>5</sub> (4.19 %) and minimum was found in plants treated with treatment T<sub>6</sub> (2.25 %) followed by plants treated with treatment T<sub>2</sub> (1.78 %) and T<sub>1</sub> (1.31 %) and the nitrogen content was significantly increased from

**Table-2 : Effect of different growing systems and media on Phosphorous content (%) in leaves of *Romaine* and *Grand rapid* lettuce.**

| Treatments     | Phosphorous content (%)        |      |      |      |                                |      |      |      |
|----------------|--------------------------------|------|------|------|--------------------------------|------|------|------|
|                | Romaine                        |      |      |      | Grand rapid                    |      |      |      |
|                | Days after Transplanting (DAT) |      |      |      | Days after Transplanting (DAT) |      |      |      |
|                | 12                             | 35   | 50   | Mean | 12                             | 35   | 50   | Mean |
| T <sub>0</sub> | 0.02                           | 0.11 | 0.15 | 0.09 | 0.21                           | 0.31 | 0.46 | 0.33 |
| T <sub>1</sub> | 0.03                           | 0.13 | 0.18 | 0.11 | 0.23                           | 0.38 | 0.53 | 0.38 |
| T <sub>2</sub> | 0.08                           | 0.17 | 0.23 | 0.16 | 0.32                           | 0.43 | 0.57 | 0.44 |
| T <sub>3</sub> | 0.14                           | 0.19 | 0.27 | 0.20 | 0.36                           | 0.44 | 0.54 | 0.45 |
| T <sub>4</sub> | 0.17                           | 0.22 | 0.32 | 0.23 | 0.39                           | 0.48 | 0.68 | 0.52 |
| T <sub>5</sub> | 0.18                           | 0.24 | 0.33 | 0.25 | 0.44                           | 0.53 | 0.78 | 0.58 |
| T <sub>6</sub> | 0.02                           | 0.09 | 0.14 | 0.08 | 0.14                           | 0.25 | 0.37 | 0.25 |
| Mean           | 0.09                           | 0.16 | 0.23 |      | 0.30                           | 0.40 | 0.56 |      |
| C.D. at 5%     | Variety                        |      |      |      | = 0.01                         |      |      |      |
|                | Treatment                      |      |      |      | = 0.01                         |      |      |      |
|                | Variety x Treatment            |      |      |      | = 0.02                         |      |      |      |
|                | DAT                            |      |      |      | = 0.01                         |      |      |      |
|                | Variety x DAT                  |      |      |      | = 0.01                         |      |      |      |
|                | Treatment x DAT                |      |      |      | = 0.02                         |      |      |      |
|                | Variety x Treatment x DAT      |      |      |      | = 0.03                         |      |      |      |

**Fig.-2 : Graphical presentation showing phosphorous content in leaves of *Romaine* and *Grand rapid* lettuce under different growing systems and media.**

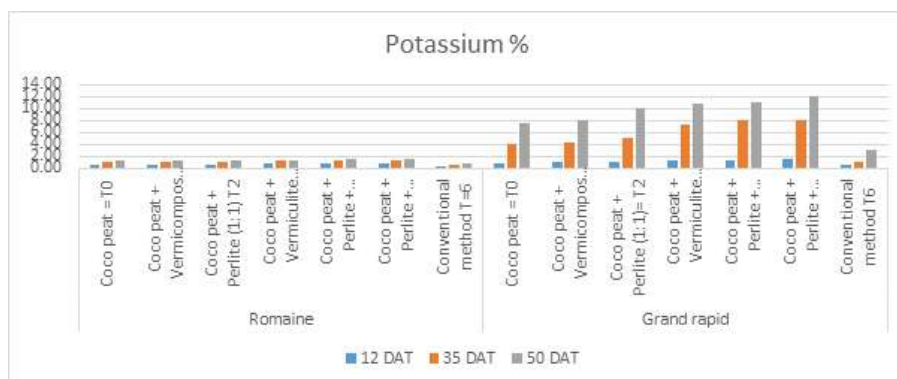
(1.06 to 3.78 %) with increasing period from 12 to 50 DAT respectively. Although in *Grand rapid*, significant reduction in nitrogen content in leaves was recorded in plants treated with treatment T<sub>6</sub> (0.21, 0.40, 0.55) followed by treatment T<sub>0</sub> (0.20, 0.22, 0.52) respectively at 12, 35 and 50 DAT (Table 1). In treatment T<sub>4</sub> and T<sub>3</sub> reduction in nitrogen content was observed *i.e.*, (0.37, 0.68, 2.10) and (0.34, 0.63, 2.04) respectively at 12, 35 and 50 DAT as compared to treatment T<sub>5</sub> (0.45, 1.05, 2.15) at 12, 35 and 50 DAT respectively. The mean of *Grand rapid* variety under different treatments, maximum mean was found in plants treated with treatment T<sub>5</sub> (1.21 %) and minimum was found in plants treated with treatment T<sub>6</sub> (0.38 %) followed by plants treated with treatment T<sub>2</sub> (0.72 %) and T<sub>1</sub> (0.37 %) and the nitrogen content was significantly increased from (0.30 to 1.32 %) with increasing period from 12 to 50 DAT respectively.

**Phosphorous content present in leaves :** Table-2, indicated reduction in phosphorous content in *Romaine* leaves which was recorded in plants treated with

treatment T<sub>6</sub> (0.02, 0.09, 0.14 %) followed by treatment T<sub>0</sub> (0.02, 0.11, 0.15 %) respectively at 12, 35 and 50 DAT. Treatment T<sub>4</sub> and T<sub>3</sub> when applied, also reduced nitrogen content (0.17, 0.22, 0.32 %) and (0.14, 0.19, 0.27 %) respectively at 12, 35 and 50 DAT as compared to treatment T<sub>5</sub> (0.18, 0.24, 0.33 %) at 12, 35 and 50 DAT respectively. The mean of phosphorous content was significantly increased from (0.09 to 0.25) with increasing the period from 12 DAT to 50 DAT. The mean value of *Romaine* was maximum in treatment T<sub>5</sub> (0.25 %) as compared to other treatments. However same trend was observed in *Grand rapid* plants *i.e.*, reduced potassium content in treatment T<sub>6</sub> (0.14, 0.25, 0.37) followed by treatment T<sub>0</sub> (0.21, 0.31, 0.46) respectively at 12, 35 and 50 DAT. So far treatment T<sub>4</sub> and T<sub>3</sub> showed reduced phosphorous content (0.39, 0.48, 0.68) and (0.36, 0.44, 0.54) as compared to treatment T<sub>5</sub> (0.44, 0.53, 0.78) at 12, 35 and 50 DAT respectively. The mean of phosphorous content in *Grand rapid* was significantly increased from (0.30% to 0.56%) with increasing the period from 12 DAT to 50 DAT and also maximum mean with respect to

**Table-3 : Effect of different growing systems and media on Potassium content (%) in leaves of *Romaine* and *Grand rapid* lettuce.**

| Treatments     | Nitrogen content (%)           |      |      |      |                                |      |       |      |
|----------------|--------------------------------|------|------|------|--------------------------------|------|-------|------|
|                | Romaine                        |      |      |      | Grand rapid                    |      |       |      |
|                | Days after Transplanting (DAT) |      |      |      | Days after Transplanting (DAT) |      |       |      |
|                | 12                             | 35   | 50   | Mean | 12                             | 35   | 50    | Mean |
| T <sub>0</sub> | 0.48                           | 1.05 | 1.22 | 0.91 | 0.87                           | 4.10 | 7.47  | 4.15 |
| T <sub>1</sub> | 0.53                           | 1.09 | 1.26 | 0.96 | 1.01                           | 4.24 | 8.14  | 4.46 |
| T <sub>2</sub> | 0.60                           | 1.12 | 1.32 | 1.01 | 1.11                           | 5.13 | 10.11 | 5.45 |
| T <sub>3</sub> | 0.67                           | 1.16 | 1.35 | 1.06 | 1.19                           | 7.35 | 10.77 | 6.44 |
| T <sub>4</sub> | 0.80                           | 1.18 | 1.49 | 1.16 | 1.38                           | 8.05 | 11.14 | 6.86 |
| T <sub>5</sub> | 0.87                           | 1.21 | 1.53 | 1.20 | 1.58                           | 8.13 | 12.06 | 7.26 |
| T <sub>6</sub> | 0.25                           | 0.47 | 0.88 | 0.53 | 0.51                           | 1.03 | 3.09  | 1.54 |
| Mean           | 0.60                           | 1.04 | 1.29 |      | 1.09                           | 5.43 | 8.97  |      |
| C.D. at 5%     | Variety                        |      |      |      | = 0.04                         |      |       |      |
|                | Treatment                      |      |      |      | = 0.07                         |      |       |      |
|                | Variety x Treatment            |      |      |      | = 0.11                         |      |       |      |
|                | DAT                            |      |      |      | = 0.05                         |      |       |      |
|                | Variety x DAT                  |      |      |      | = 0.07                         |      |       |      |
|                | Treatment x DAT                |      |      |      | = 0.13                         |      |       |      |
|                | Variety x Treatment x DAT      |      |      |      | = 0.19                         |      |       |      |

**Fig-3 : Graphical presentation showing potassium content in leaves of *Romaine* and *Grand rapid* lettuce under different growing systems and media.**

treatment was noticed in treatment T<sub>5</sub> (0.58 %) as compared to other treatments.

**Potassium content present in leaves :** The mean value of potassium content in *Romaine* leaves observed was significantly increased from (0.60 to 1.29 %) with increasing the period from 12 DAT to 50 DAT. The mean value of treatments significantly increased from T<sub>0</sub> to T<sub>5</sub> (0.91 % to 1.20 %) respectively Table 3. Whereas reduction in potassium content in *Romaine* leaves was recorded in plants treated with treatment T<sub>6</sub> (0.25, 0.47, 0.88 %) followed by treatment T<sub>0</sub> (0.48, 1.05, 1.22 %) respectively at 12, 35 and 50 DAT. Treatment T<sub>4</sub> and T<sub>3</sub> also showed reduced potassium content (0.80, 1.18, 1.49) and (0.67, 1.16, 1.35 %) as compared to treatment T<sub>5</sub> (0.87, 1.21, 1.53 %) at 12, 35 and 50 DAT respectively.

The essential nutrients are nitrogen, potassium and phosphorous of *Romaine* and *Grand rapid* was significantly increased in plants that are grown hydroponically and treatment T<sub>5</sub> showed best results in

comparison to treatment T<sub>6</sub> i.e. conventional method as shown in Table 1, 2 and 3. As coco peat improves water retention, aeration and lowered the risk of soil fungus and root diseases. It also protects the crop from weed growth. Perlite acts as a terrific insulator to protect plants from heat stress. Vermiculite are rich in minerals and due to high absorbency and good bulking potential of vermicompost, this combination of media showed maximum nutrient content in the leaves part of lettuce cultivars when provided with hydroponic nutrient. In the soil, there are presence of many growth inducers which inhibit the GA biosynthesis leading to reduced root/ shoot growth ultimately reduced the fresh weight of the plant. Yomo *et al.* (1998) supporting our findings, using different hydroponic technique, the medicinal plant *Angelica acutiloba* showed best results, increased in fresh weight of about 7-9 times as compared to soil. This is due to presence of hydroponic nutrient solution. Basically nutrient solution plays an important role in increasing or decreasing the fresh weight per plant. Soundy *et al.*

(2001) reported that concentration of Phosphorous range of 35 to 50 mg/L was essential for producing high-quality lettuce seedlings in hydroponic culture. Borowski *et al.* (1994) reported that a high concentration of Nitrogen ( $\text{NH}_4^+$ ,  $\text{NO}_3^-$ ) was responsible for a significant fresh weight reduction in lettuce. In a nutrient solution of N, P, K of 140, 50, and 300 mg/L, respectively, the fresh weight of Butter crunch and Black Seeded Simpson lettuce was 245 g and 175 g reported by (Kowalczy *et al.*, 2014). In the case of treatment T<sub>6</sub>, it showed minimum content of NPK (Table-1, 2 and 3) may be due to nutrient leaching or due to plant nutrient competition.

## Conclusion

Present investigation have given a new dimension to modern agriculture. The present study was conducted to observe the effect of different growing media on essential elements of lettuce (*Lactuca sativa* L.) cultivars under different growing systems. The performance of both varieties under hydroponic treatments was also compared with the plants grown by conventional method. Nutrient film technique is helpful for maintaining nutrient balance and adequate oxygen level, also avoid soil-borne pest and diseases as well as land degradation. With these considerations and in view of the economic importance of *Romaine* and *Grand rapid* as an important salad of India as well as of the world. The nitrogen, phosphorous and potassium content in the leaves of both varieties was less in conventional method and coco peat alone (100 %) in comparison to coco peat + perlite + vermiculite + vermicompost in the ratio of 1:1:1:1. Maximum nitrogen content was noticed in *Romaine* in comparison to *Grand rapid*. Phosphorous content was higher in *Grand rapid* in comparison to *Romaine*. And also potassium content in leaves was more pronounced in *Grand rapid* in comparison to *Romaine*. Therefore application of coco peat + perlite + vermiculite + vermicompost in the ratio of 1:1:1:1 in nutrient film technique may be beneficial for quality production of *Lactuca sativa*. This combination of growing media could be recommended to farmers. Nevertheless, the positive results with reference to coco peat + perlite + vermiculite + vermicompost for *Lactuca sativa* is undoubtedly encouraging for making elaborate studies in the hydroponics with right combination of growing media and growing systems.

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## Effect of Staggered Date of Sowing and Fertilizer Application on Phenophasic Developments and Biochemical Parameters of Niger (*Guizotia abyssinica* Cass.)

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### Abstract

The present investigation was carried out at Coordinated Research Project on Sesame and Niger at JNKVV, Jabalpur during year 2019-2020 to study the Effect of staggered date of sowing and fertilizer application on phenophasic developments and biochemical parameters characters of niger (*Guizotia abyssinica* Cass.). Data revealed that Last week of August date of sowing, 100% P & K and 50% N as basal and 50% N in two split doses fertilizer dose, Combination of Last week of August sowing and RDF 50% N and 100% PK was found best for most of the phenophasic developments viz., Days to field emergence, Days to 50% flowering, Days to capitulum formation, Days to initiation of seed filling, Days to seed formation, Days to physiological maturity, Days to harvest maturity and biochemical parameters i.e. Oil Content (%), Protein content (%), Carbohydrate content (%), Fiber content (%), etc.

**Key words :** Niger, biochemical parameters, phenophasic developments.

### Introduction

India occupies a distinct position in terms of diversity in annual oilseed crops. The prevailing agro-ecological conditions are favourable for growing nine oilseeds (edible and non-edible oilseeds). An all-time record oilseed production of 25 million tonnes was attained during 1996-97 due to "The Yellow Revolution". The major oilseed crops cultivated in India are groundnut, rapeseed and mustard, soybean, sunflower, safflower, castor, sesame, niger and linseed (Narayan *et al.*, 2011). Niger (*Guizotia abyssinica* (L.f.) Cass. Asteraceae) is cultivated as oilseed crop in Ethiopia and India. It is native to Ethiopia and is known by various names such as niger seed, nigersatt, noug, nook; „Ramtil? or „Kalatil? in India and Noog in Ethiopia. It is often referred to as „Thistle seed. It constitutes about 50% of Ethiopian and 3% of Indian oilseed production. The seed has 40% oil with fatty acid composition of 75-80% linoleic acid, 7-8% palmitic and stearic acids, and 5-8% oleic acid (Getinet and Teklewold, 1995). The Indian types have 25% oleic and 55% linoleic acids (Nasirullah *et al.*, 1982).

The different cultivation applies; optimum sowing time plays an important role to exploit the full genetic potentiality of a variety as it provides optimum growing conditions such as temperature, light, humidity and rainfall (Eberhort and Russel, 1966). The time of sowing concludes the time available for vegetative growth before the onset of flowering, which is mainly influenced by photoperiod. Niger seed is used as a human food. The pale yellow oil of niger seed has a nutty taste and a pleasant odour. The traditional method for extraction of oil

from niger in Ethiopia is through a combination of warming, grinding and mixing with hot water followed by centrifugation in an ensera? (a container made of clay). The meal remaining after the oil extraction contains about 24% protein and 24% crude fibre (Seegeler, 1983).

Niger meal from India contains higher protein (30%) and lower crude fibre (17%) levels than meal from Ethiopia. Niger cake replacing linseed cake at levels of 0, 50 and 100% was fed as a nitrogen supplement for growing calves (Singh *et al.*, 1983). No significant differences in growth rate, feed efficiency and dry matter digestibility were noticed between niger and linseed cake and it was concluded that niger cake can replace linseed cake in calf rations (Singh *et al.*, 1983).

### Materials and Methods

An experiment was conducted to estimate the effect of various date of sowing and fertilizer dose on phenophasic development and productivity with biochemical traits in Niger during *Kharif* season of the year 2019-2020 at Coordinated Research Project on Sesame and Niger at JNKVV, Jabalpur (M.P.). Estimation of biochemical constituent was done in the laboratory of the Department of Plant Physiology, JNKVV, Jabalpur in split plot design (SPD) with three replications having treatments comprised of main plot, dates of sowing viz., Before RDS at sufficient moisture under pre monsoon rainfall, Recommended date of sowing [RDS], One week after RDS and Two weeks after RDS and sub plot, fertilizer applications viz., control, recommended dose of fertilizer [N,P,K] and RDF [50%N and 100% P,K was applied as basal application and 50%N was given in two split doses].

**Table-1 : Phenophasic developments and harvest index (%) of niger crop influenced by staggered dates of sowing and fertilizer application.**

| S. No.   | Treatments                                                  | Days to emergence | Days to 50% flowering | Days to Capsule formation | Days to Initiation of seed filling | Days to Seed formation | Days to physiological maturity | Days to harvest maturity | Harvest index (%) |
|----------|-------------------------------------------------------------|-------------------|-----------------------|---------------------------|------------------------------------|------------------------|--------------------------------|--------------------------|-------------------|
| <b>A</b> | <b>Dates of sowing</b>                                      |                   |                       |                           |                                    |                        |                                |                          |                   |
| D1       | Last week of July                                           | 6.07              | 63.51                 | 70.03                     | 79.00                              | 88.66                  | 98.74                          | 107.66                   | 16.017            |
| D2       | 2nd week of August                                          | 5.51              | 62.25                 | 68.18                     | 78.22                              | 87.00                  | 97.00                          | 105.59                   | 15.699            |
| D3       | Last week of August                                         | 4.66              | 59.8                  | 66.14                     | 75.66                              | 84.66                  | 94.88                          | 103.51                   | 16.877            |
| D4       | 1st week of September                                       | 3.92              | 57.25                 | 63.99                     | 72.88                              | 80.88                  | 90.85                          | 101.04                   | 14.761            |
|          | SEm+                                                        | 0.082             | 0.124                 | 0.119                     | 0.116                              | 0.255                  | 0.214                          | 0.126                    | 0.021             |
| <b>B</b> | <b>Doses of Fertilizer</b>                                  |                   |                       |                           |                                    |                        |                                |                          |                   |
| F1       | Control                                                     | 5.30              | 61.49                 | 67.91                     | 77.41                              | 86.25                  | 96.27                          | 105.24                   | 15.518            |
| F2       | 100% RDF (as basal)                                         | 5.05              | 60.66                 | 67.10                     | 76.58                              | 85.33                  | 95.33                          | 104.43                   | 15.809            |
| F3       | 100% P & K and 50% N as basal and 50% N in two split doses. | 4.77              | 60.02                 | 66.24                     | 75.33                              | 84.33                  | 94.49                          | 103.68                   | 16.188            |
|          | SEm+                                                        | 0.059             | 0.078                 | 0.124                     | 0.123                              | 0.127                  | 0.132                          | 0.086                    | 0.019             |
|          | Interaction (D×F)                                           |                   |                       |                           |                                    |                        |                                |                          |                   |
|          | D1F1                                                        | 6.33              | 63.99                 | 70.99                     | 80.00                              | 90.00                  | 100.1                          | 108.11                   | 15.910            |
|          | D1F2                                                        | 6.00              | 63.44                 | 70.10                     | 79.66                              | 88.66                  | 98.6                           | 107.66                   | 15.957            |
|          | D1F3                                                        | 5.88              | 63.11                 | 68.99                     | 77.33                              | 87.33                  | 97.4                           | 107.22                   | 16.183            |
|          | D2F1                                                        | 5.66              | 63.00                 | 68.66                     | 79.00                              | 87.33                  | 97.3                           | 106.88                   | 15.467            |
|          | D2F2                                                        | 5.55              | 62.22                 | 68.22                     | 78.00                              | 87.00                  | 97.0                           | 105.18                   | 15.760            |
|          | D2F3                                                        | 5.33              | 61.55                 | 67.66                     | 77.66                              | 86.66                  | 96.6                           | 104.71                   | 15.870            |
|          | D3F1                                                        | 5.11              | 61.00                 | 67.33                     | 77.00                              | 86.00                  | 96.0                           | 104.00                   | 16.427            |
|          | D3F2                                                        | 4.66              | 60.00                 | 66.11                     | 75.66                              | 84.66                  | 94.6                           | 103.88                   | 16.630            |
|          | D3F3                                                        | 4.22              | 58.66                 | 65.00                     | 74.33                              | 83.33                  | 94.0                           | 102.66                   | 17.573            |
|          | D4F1                                                        | 4.11              | 58.00                 | 64.66                     | 73.66                              | 81.66                  | 91.2                           | 102.00                   | 14.270            |
|          | D4F2                                                        | 4.00              | 57.00                 | 64.00                     | 73.00                              | 81.00                  | 91.0                           | 101.00                   | 14.890            |
|          | D4F3                                                        | 3.66              | 56.77                 | 63.33                     | 72.00                              | 80.00                  | 89.8                           | 100.14                   | 15.123            |
|          | SEm+                                                        | 0.127             | 0.178                 | 0.235                     | 0.231                              | 0.329                  | 0.30                           | 0.189                    | 0.038             |

**Methods :** Carbohydrates in the samples were estimated by the method as described by Sadasivam and Manickam (1992). The nitrogen content was estimated by micro-kjeldhal method (AOAC, 1965) and the fat content in the sample was estimated by Pelican Equipment Socs Plus based on principle of Soxhlets extraction method as described in AOAC (1980). The seed yield g plant<sup>-1</sup> and kg ha<sup>-1</sup> was noted after threshing, cleaning and drying the seeds. It is called as economical yield and biological yield is the total yield of crop including economic yield and the straw yield. The biological yield per plant was noted after harvesting.

## Results and Discussion

**A. Phenophasic developments :** Phenology is the study of periodic biological events in the plant world that are influenced by the environment. Temperature increase in spring season can advance the spring phases, but warming in autumn and winter may slow the fulfilment of chilling requirements and lead to later onset of spring events. In the present investigation a significant variation was noted among the dates of sowing and fertilizer application in relation to days required for their phonological developments. Treatment D1 (Last week of

July) date of sowing recorded the maximum days to emergence (6.07), days to 50% flowering (63.2), days to capsule formation (70.03), days to initiation of seed filling (79.00), days to seed formation (88.66), days to physiological maturity (98.74) and days to harvest maturity (107.66).

**B. Biochemical Parameters :** The data obtained from biochemical analysis of niger seeds revealed that biochemical properties like oil content, protein content, carbohydrate content and fibre content of niger seeds were influenced by different dates of sowing and fertilizer doses application in Niger crop.

**a. Oil Content (%) :** There was negative correlation between grain yield and oil content of grain (Kandaswami, 1973). Here, D3 (Last week of August) date of sowing exhibited highest oil content (38.25%), while the lowest was recorded in D4 (1st week of September) date of sowing (32.37 %) as compared to other dates of sowing at 45 DAS. In the present investigation, F3 (100% P & K and 50% N as basal and 50% N in two split doses) fertilizer dose exhibited highest oil content (36.89 %), while the lowest was exhibited in F1 (Control) fertilizer dose (34.14 %) than other doses of fertilizer. The combination of D3F3

Table-2 : Biochemical properties and yield attributes of Niger influenced by different dates of sowing and fertilizer application.

| S. No.   | Treatments                                                  | Oil (%) | Protein (%) | Carbohydrate (%) | Fiber (%) | Biological yield (Kg ha <sup>-1</sup> ) | Economic yield (Kg ha <sup>-1</sup> ) |
|----------|-------------------------------------------------------------|---------|-------------|------------------|-----------|-----------------------------------------|---------------------------------------|
| <b>A</b> | <b>Dates of sowing</b>                                      |         |             |                  |           |                                         |                                       |
| D1       | Last week of July                                           | 36.79   | 30.34       | 22.81            | 12.29     | 2951.354                                | 491.243                               |
| D2       | 2 <sup>nd</sup> week of August                              | 35.06   | 28.96       | 21.58            | 10.94     | 2560.172                                | 422.728                               |
| D3       | Last week of August                                         | 38.25   | 32.31       | 23.78            | 12.83     | 3255.177                                | 517.511                               |
| D4       | 1 <sup>st</sup> week of September                           | 32.37   | 27.13       | 19.68            | 9.72      | 2354.951                                | 395.062                               |
|          | SEm+                                                        | 0.142   | 0.073       | 0.094            | 0.056     | 4.132                                   | 0.270                                 |
|          | C.D(P=0.05)                                                 | 0.501   | 0.257       | 0.330            | 0.199     | 14.578                                  | 0.953                                 |
| <b>B</b> | <b>Doses of fertilizer</b>                                  |         |             |                  |           |                                         |                                       |
| F1       | Control                                                     | 34.14   | 28.53       | 21.50            | 11.04     | 2684.932                                | 455.848                               |
| F2       | 100% RDF(as basal)                                          | 35.80   | 29.66       | 21.87            | 11.31     | 2793.384                                | 456.633                               |
| F3       | 100% P & K and 50% N as basal and 50% N in two split doses. | 36.89   | 30.86       | 22.53            | 11.99     | 2862.927                                | 457.427                               |
|          | SEm+                                                        | 0.091   | 0.091       | 0.075            | 0.048     | 3.111                                   | 0.119                                 |
|          | C.D(P=0.05)                                                 | 0.275   | 0.275       | 0.227            | 0.145     | 9.407                                   | 0.358                                 |
|          | <b>Interaction (DXF)</b>                                    |         |             |                  |           |                                         |                                       |
|          | D1F1                                                        | 35.47   | 29.50       | 22.47            | 11.76     | 2871.970                                | 490.303                               |
|          | D1F2                                                        | 36.88   | 30.47       | 22.83            | 12.31     | 2985.017                                | 491.350                               |
|          | D1F3                                                        | 37.95   | 31.06       | 23.14            | 12.79     | 2997.077                                | 492.077                               |
|          | D2F1                                                        | 33.62   | 27.82       | 21.09            | 10.53     | 2484.480                                | 421.813                               |
|          | D2F2                                                        | 35.28   | 28.35       | 21.27            | 10.63     | 2534.170                                | 422.837                               |
|          | D2F3                                                        | 36.28   | 30.17       | 22.40            | 11.67     | 2661.867                                | 423.533                               |
|          | D3F1                                                        | 36.28   | 31.33       | 23.20            | 12.65     | 3140.703                                | 516.703                               |
|          | D3F2                                                        | 38.39   | 32.54       | 23.99            | 12.84     | 3278.066                                | 517.400                               |
|          | D3F3                                                        | 40.08   | 33.07       | 24.17            | 13.00     | 3346.763                                | 518.430                               |
|          | D4F1                                                        | 31.19   | 25.49       | 19.23            | 9.23      | 2242.573                                | 394.573                               |
|          | D4F2                                                        | 32.66   | 27.28       | 19.40            | 9.45      | 2376.280                                | 394.947                               |
|          | D4F3                                                        | 33.25   | 28.62       | 20.41            | 10.49     | 2446.000                                | 395.667                               |
|          | SEm+                                                        | 0.205   | 0.165       | 0.154            | 0.097     | 6.549                                   | 0.332                                 |
|          | C.D(P=0.05)                                                 | 0.671   | 0.516       | 0.495            | 0.309     | 21.116                                  | 1.116                                 |

(40.08 %) noted maximum oil content and lowest was noted in D4F1 (31.19 %). Similar result was found by Singh *et al.* (1982) where they noted that 21 November sown crop recorded more oil seed content (44.1 %) than 6 December (42.3 %) sown crop.

**b. Protein content (%) :** Highest protein (19.88%) and oil (39.93%) content was obtained by sowing Niger in 26 MW (25th June to 1st July), which proved significantly superior to the crop sown in 24 (11-17 June) or 28 (19-15 July) standard meteorological week (Talathi *et al.*, 2007). In the present experiment, D3 (Last week of August) date of sowing recorded highest protein content (32.31 %), and lowest was recorded in D4 (1st week of September) date of sowing (27.13 %) as compared to other dates of sowing. Here, F3 (100% P & K and 50% N as basal and 50% N in two split doses) fertilizer dose recorded significantly maximum protein content (30.86 %), and

minimum was recorded in F1 (Control) fertilizer dose (28.53 %). The interaction of D3F3 (33.07 %) noted significantly highest protein content and lowest was noted in D4F1 (25.49 %).

**c. Carbohydrate content (%) :** In plants, carbohydrates produced by photosynthesis are well known for their essential role as vital sources of energy and carbon skeletons for organic compounds and storage components. In this experiment, D3 (Last week of August) date of sowing recorded highest carbohydrate content (23.78 %) and the lowest was recorded in D4 (1st week of September) date of sowing (19.68 %). F3 (100% P & K and 50% N as basal and 50% N in two split doses) fertilizer dose recorded higher carbohydrate content (22.53 %) and the lower was noted in F1 (Control) fertilizer dose (21.50 %) as compared to other doses of fertilizer. The interaction of D3F3 exhibited the highest carbohydrate content (24.17

%) and lowest was noted in D4F1 (19.23 %). Similar result was recorded by Naik *et al.* (2009) they found that the niger seed contains up to 20.9% carbohydrate.

**d. Fiber content (%) :** Seeds are great source of fiber. Niger seeds contain decent amount of fiber. The different dates of sowing affected fiber content significantly. D3 (Last week of August) date of sowing recorded maximum fiber content (12.83 %) and D4 (1st week of September) date of sowing noted lowest fiber content (9.72 %) than rest of the dates of sowing in niger crop. The data of fertilizer application of fiber content revealed that F3 (100% P & K and 50% N as basal and 50% N in two split doses) fertilizer dose recorded highest fiber content (11.99 %), however, the lowest fiber content was revealed in F1 (Control) fertilizer dose (11.04 %) than other doses of fertilizer. The combination D3F3 (13.00 %) attained highest fiber content and lowest fiber content was noted in D4F1 (9.23 %). The result was in confirmation with Bhardwaj and Gupta (1997) they reported that niger seed contain 9–13% fiber.

**e. Biological yield ( $\text{Kg ha}^{-1}$ ) :** Biological yield is the resulting of the interplay of a cultivar to phonological, physiological and biochemical aspects which depend upon genetically controlled ability of the plants to synthesis translocate and store yield relevant substances. Biological yield is a function of growth duration and crop growth rate at successive growth stages. It indicates the source capacity of the crop plant. Here, F3 (100% P & K and 50% N as basal and 50% N in two split doses) fertilizer dose had higher biological yield (2862.927) and lesser was recorded in F1 (Control) fertilizer dose (2684.932). Among the different dates of sowing, D3 (Last week of August) date of sowing attained highest biological yield (3255.177), while the lowest was attained by D4 (1st week of September) date of sowing (2354.951) as compared to other dates of sowing. The biological yield was highest in combination D3F3 (3346.763) and lowest was noted in D4F1 (2242.573).

**f. Economic yield ( $\text{Kg ha}^{-1}$ ) :** Economic yield is important parameter to determine the yield of crop. In the present investigation, D3 (Last week of August) date of sowing exhibited the higher value (517.511). The minimum was noted in D4 (1st week of September) date of sowing (395.062). F3 (100% P & K and 50% N as basal and 50% N in two split doses) fertilizer dose had highest economic yield (457.427) and minimum was recorded in F1 (Control) fertilizer dose (455.848). The interaction of D3F3 (518.430) and lowest economic yield was noted in D4F1 (395.667). The result was in confirmation with Sarkar (1976) he reported that seed yields of yields of niger with NPK and without were 466 and 236  $\text{kg ha}^{-1}$  respectively.

**g. Harvest Index (%) :** The harvest index is controlled by

partitioning of photosynthesis between harvested and non-harvested organ during plant growth cycle. It is most significant indicator of photosynthetic and translocation efficiency for translation of economic yield.

In the present investigation the main treatment affected harvest index significantly. D3 (Last week of August) date of sowing recorded maximum harvest index (16.877) and the minimum was recorded in D4 (1st week of September) date of sowing (14.761) as compared to other dates of sowing. F3 (100% P & K and 50% N as basal and 50% N in two split doses) fertilizer dose had maximum harvest index (16.188), while, the minimum was recorded in F1 (Control) fertilizer dose (15.518) as compared to other doses of fertilizer. The main and sub treatment interaction significantly influenced harvest index. The combination of D3F3 exhibited maximum harvest index (17.573). Minimum harvest index was noted in D4F1 (Table-1).

## Conclusions

Investigation exhibited that the phenological development as days to emergence, days to 50% flowering, days to capsule formation, days to initiation of seed filling, days to seed formation, days to physiological maturity and days to harvest maturity had attained in shorter duration in D4 (1st week of September) date of sowing, F3 (100% P & K and 50% N as basal and 50% N in two split doses) fertilizer dose and interaction D4F3.

The result associated with present investigation exhibited that biochemical analysis of niger seeds showed higher values of oil content, protein content, carbohydrate content and fiber content of niger seeds in D3 (Last week of August) date of sowing, F3 (100% P & K and 50% N as basal and 50% N in two split doses) fertilizer dose and interaction D3F3. These components of seeds were influenced by different dates of sowing and fertilizer doses application in niger crop.

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## Studies on Pruning Intensity and Foliar Application of $\text{KNO}_3$ on Yield Attributes in Guava cv. Allahabad Safeda

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### Abstract

The failure to manipulate the production periods is a common problem for guava production in India. As a possible management to overcome it the present investigation was conducted in the guava orchard of Department of Horticulture, JNKVV, Jabalpur Fruit Research Station, Imalia, to study the effect of pruning intensity and time on yield and quality of winter guava cv Allahabad Safeda. Different pruning levels and time of pruning viz., No pruning, 10 cm, 20 cm, 30 cm and one leaf pair pruning of apical shoots during last week July comprised the treatment combinations. The experiment was laid out in Factorial Randomized Block Design. The results of the study revealed that among the various pruning treatments the pruning of one leaf pair pruning of apical shoots on last week of July proved to be the best in increasing the yield and yield attributes in terms of number of fruits per tree and also fruit size, fruit length weight and yield. It also improved the fruit quality by increasing TSS, sugars, ascorbic acid and pectin content of guava fruits. Hence the pruning of one leaf pair pruning of apical shoots during last July can be recommended for commercial fruit production with enhanced yield and good quality in guava cv.

**Key words :** Apical shoots, pruning, pruning intensity, yield attributes.

### Introduction

Guava (*Psidium guajava* L.) is the most important commercial fruit crop grown in tropical and sub-tropical region of the Indian subcontinent and is known as apple of tropics [1]. It occupies an important place in the horticultural wealth of our nation [2]. It belongs to family Myrtaceae and is indigenous to tropical America stretching from Mexico to Peru. Guava is an ideal fruit crop for nutritional security in India. It possess a high nutritive value as it is a good source of carbohydrates, minerals, iron, calcium and phosphorous. It is rich in dietary vitamin C with moderate levels of folic acid. Having a generally low calorie profile of essential nutrients a single common guava fruit contains four times the amount of vitamin C [3]. It is also a rich source of vitamin A, riboflavin (B2) thiamine (B1) calcium, fair source of phosphorus and a good source of iron. It also contains antioxidant pigments, carotenoids and polyphenols giving them relatively high dietary antioxidant value among the foods [4]. Therefore, pruning could prove to be the most effective method for eliminating rainy season crop and production of winter season guava which is superior in quality free from diseases and fetches high price as compared to rainy season crop [5]. Pruning is defined as the art and science of cutting away a portion of the plant to improve the shape, vegetative growth, flowering, fruitfulness and to improve the quality of the product. Several workers have reported an increased yield, fruit size and qualitative attributes of guava as a result of pruning at different time intervals thus

improvement is attributed to better light penetration into fruit bearing portions of the tree canopy.

Guava crop plant is a pruning responsive crop. The shoot pruning has been reported to be successful in regulating bahar in guava. Shoot pruning is also helpful in reducing the tree size and improving the fruit quality and provide opportunity to increase the number of trees per unit area.

The importance of supply of nutrient elements for good growth has been largely neglected for guava plant trees. The trees grown under field condition are subjected to nutrient deficiencies which affect the growth, tissue composition, fruit production and quality. The foliar feeding of fruit trees has gained much importance in recent year, as fertilizers applied through soil are needed in greater quantity because some portion leaches down and some does not become available to the plant due to complex chemical reactions. The composition of various plant tissues, especially in so far as their mineral composition are concerned, has been found to be influenced considerably by the character of the soil in which they grow. Foliar application of potassium during fruit development can be advantageous for fruit crops, since this growth stage often coincide with high potassium element during the time of declining root activity and nutrient uptake. Potassium increases the fruit quality and yield of fruit crops. There might be hidden hunger for macronutrients affecting growth, yield and quality of guava.

## Materials and Methods

The present investigation was carried out during 2015-16 on 4 year old guava orchard of cv. Allahabad Safeda planted at a spacing of 6m x 6m. The experiment was conducted at Fruit Research Station, Imalia, Department of Horticulture, College of Agriculture, Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur (M.P.). The experiment was laid out in 2-factor Factorial Randomized Block Design with 15 treatment combinations with three Foliar application (1% KNO<sub>3</sub>, 2% KNO<sub>3</sub> and 3% KNO<sub>3</sub>) and five pruning intensities (No pruning, 10 cm, 20 cm, 30 cm and one leaf pair of shoot length replicated thrice with four replication. The treatment details are as follows:

### Factor-1 (Pruning intensity)

A1 = No pruning

A2 = Shoot pruning 10 cm pruning

A3 = Shoot pruning 20 cm pruning

A4 = Shoot pruning 30 cm pruning

A5 = One leaf pair pruning

### Factor-2 (Foliar Application of KNO<sub>3</sub>)

B1 = 1% KNO<sub>3</sub>

B2 = 2% KNO<sub>3</sub>

B3 = 3% KNO<sub>3</sub>

### Treatment combinations

T1 = A1B1 - (No pruning-control) + 1% KNO<sub>3</sub>

T2 = A1B2 - (No pruning-control) + 2% KNO<sub>3</sub>

T3 = A1B3 - (No pruning-control) + 3% KNO<sub>3</sub>

T4 = A2B1 - (Shoot pruning-10cm) + 1% KNO<sub>3</sub>

T5 = A2B2 - (Shoot pruning-10cm) + 2% KNO<sub>3</sub>

T6 = A2B3 - (Shoot pruning-10cm) + 3% KNO<sub>3</sub>

T7 = A3B1 - (Shoot pruning-20cm) + 1% KNO<sub>3</sub>

T8 = A3B2 - (Shoot pruning-20cm) + 2% KNO<sub>3</sub>

T9 = A3B3 - (Shoot pruning-20cm) + 3% KNO<sub>3</sub>

T10 = A4B1 - (Shoot pruning-30cm) + 1% KNO<sub>3</sub>

T11 = A4B2 - (Shoot pruning-30cm) + 2% KNO<sub>3</sub>

T12 = A4B3 - (Shoot pruning-30cm) + 3% KNO<sub>3</sub>

T13 = A5B1 - (One leaf pair pruning) + 1% KNO<sub>3</sub>

T14 = A5B2 - (One leaf pair pruning) + 2% KNO<sub>3</sub>

T15 = A5B3 - (One leaf pair pruning) + 3% KNO<sub>3</sub>

The plant protection and other cultural operations were uniformly given as and when required. Various observations regarding flowering, fruiting, yield and

biochemical traits were recorded at regular intervals throughout the whole study.

**Number of flower :** Tagged flower were used for counting the number of flower lets and average flower lets was computed.

**Days to 50% flowering :** The day to bloom was recorded when 50% of the flowers appeared completely open. Number of days counted between date of first flower and 50% of flowering

**Fruit set (%) :** Fruit set per flower was calculated by following formula :

$$\frac{\text{Number of fruits at pre - harvested stage}}{\text{Number of fruits at initial stage}} \times 100$$

**Fruit Yield kg/plant :** Fruit yield of each treatment was recorded in kg/tree with the help of weighing balance.

**Yield (t/ha) :** Fruit yield of each treatment was recorded in q/ha with the help of weighing balance.

## Results and Discussion

**Number of flowers :** The data pertaining to number of flowers was computed and statistically analyzed. The results are presented in Table-1. In foliar application of B<sub>3</sub> has shown the maximum number of flowers were recorded in (8.71) which showed superiority over B<sub>2</sub> and B<sub>1</sub>, respectively. The minimum number of flowers (8.25) were found in B<sub>1</sub>. Pruning intensity also had significant effect on the number of flowers. Pruning intensity of one pair leaf pruning (10.24) was superior over the rest of the treatments. The minimum number of flowers (6.28) were observed in A<sub>1</sub>. The interaction of pruning intensity and foliar application of KNO<sub>3</sub> showed significant effect on number of flowers. However, data revealed that the maximum number of flowers was recorded under A5B3 (10.24) and the minimum under A1B1 (6.02).

**Table-1 : Effect of Pruning Intensity and Foliar Application of KNO<sub>3</sub> on Number of Flowers.**

| Treatment                               | Number of flowers |                   |                   |       |
|-----------------------------------------|-------------------|-------------------|-------------------|-------|
|                                         | (B <sub>1</sub> ) | (B <sub>2</sub> ) | (B <sub>3</sub> ) | Mean  |
| No pruning (A <sub>1</sub> )            | 6.02              | 6.30              | 6.51              | 6.28  |
| 10 cm pruning (A <sub>2</sub> )         | 7.94              | 8.08              | 8.24              | 8.09  |
| 20 cm pruning (A <sub>3</sub> )         | 8.64              | 8.75              | 8.94              | 8.77  |
| 30 cm pruning (A <sub>4</sub> )         | 8.94              | 9.14              | 9.30              | 9.13  |
| One pair leaf pruning (A <sub>5</sub> ) | 9.71              | 10.45             | 10.56             | 10.24 |
| Mean                                    | 8.25              | 8.55              | 8.71              |       |
|                                         | B                 | A                 | A x B             |       |
| SE(m)±                                  | 0.004             | 0.006             | 0.01              |       |
| CD at 5%                                | 0.013             | 0.016             | 0.028             |       |

**Days to 50% flowering :** The data pertaining days to 50% flowering indicates that B<sub>3</sub> recorded significantly the minimum days to 50% flowering (47.48 days) followed by B<sub>2</sub> (47.66 days) Whereas, the maximum days taken to

50% flowering was recorded under  $B_1$  (47.82 days) (Table-2). Pruning intensity showed significant effect on days to 50% flowering. The minimum days (41.67) days was recorded under  $A_5$  while the maximum days to 50% flowering (54.41) was recorded under  $A_1$ . The interaction effect of pruning intensity and foliar application of  $KNO_3$  did not show significant effect on days to 50% flowering.

**Table-2 : Effect of Pruning Intensity and Foliar Application of  $KNO_3$  on Days to 50% Flowering.**

| Days to 50% flowering           |           |           |           |       |
|---------------------------------|-----------|-----------|-----------|-------|
| Treatment                       | ( $B_1$ ) | ( $B_2$ ) | ( $B_3$ ) | Mean  |
| No pruning ( $A_1$ )            | 54.60     | 54.42     | 54.23     | 54.41 |
| 10 cm pruning ( $A_2$ )         | 50.56     | 50.43     | 50.26     | 50.42 |
| 20 cm pruning ( $A_3$ )         | 47.60     | 47.46     | 47.31     | 47.45 |
| 30 cm pruning ( $A_4$ )         | 44.49     | 44.32     | 44.14     | 44.32 |
| One pair leaf pruning ( $A_5$ ) | 41.86     | 41.69     | 41.47     | 41.67 |
| Mean                            | 47.82     | 47.66     | 47.48     |       |
|                                 | B         | A         | A x B     |       |
| SE(m)±                          | 0.007     | 0.009     | 0.015     |       |
| CD at 5%                        | 0.019     | 0.025     | NS        |       |

**Fruit Set (%) :** It is clear from Table-3 that pruning intensity and foliar spray of  $KNO_3$  significantly influenced towards the fruit set. The maximum fruit set (%) (88.14) recorded under  $B_3$  (3%  $KNO_3$ ), which showed significant superiority over rest of treatments and the minimum fruit set (%) of 84.43 was recorded under  $B_1$ . As regards to the pruning intensity, the maximum fruit set (%) (96.25) was recorded when it was subjected to one pair leaf pruning ( $A_5$ ) which was significantly superior to rest of the treatments. Whereas, minimum fruit set (%) (6.34) was recorded under ( $A_1$ ) no pruning. The interaction of pruning intensity and foliar application of  $KNO_3$  showed significant effect on fruit set. However, the maximum fruit set (%) was recorded under  $A_5B_3$  (97.29) while the minimum was observed under  $A_1B_1$  (74.26).

**Table-3 : Effect of Pruning Intensity and Foliar Application of  $KNO_3$  on Fruit Set (%).**

| Fruit set (%)                   |           |           |           |       |
|---------------------------------|-----------|-----------|-----------|-------|
| Treatment                       | ( $B_1$ ) | ( $B_2$ ) | ( $B_3$ ) | Mean  |
| No pruning ( $A_1$ )            | 74.26     | 76.77     | 79.54     | 76.86 |
| 10 cm pruning ( $A_2$ )         | 88.89     | 91.72     | 93.87     | 91.49 |
| 20 cm pruning ( $A_3$ )         | 80.45     | 81.57     | 82.60     | 81.54 |
| 30 cm pruning ( $A_4$ )         | 83.57     | 85.26     | 87.38     | 85.40 |
| One pair leaf pruning ( $A_5$ ) | 94.98     | 96.50     | 97.29     | 96.25 |
| Mean                            | 84.43     | 86.36     | 88.14     |       |
|                                 | B         | A         | A x B     |       |
| SE(m)±                          | 0.189     | 0.243     | 0.422     |       |
| CD at 5%                        | 0.54      | 0.697     | 1.208     |       |

**Yield (kg/plant) :** Yield (kg/plant) was recorded and presented in. The data revealed that foliar spray of  $KNO_3$  significantly increased the Yield (kg/plant) and the maximum yield (6.76) was recorded under  $B_3$  and the minimum (4.52) was recorded under  $B_1$  Table-4. As

regards to the pruning intensity, the maximum yield kg/plant (8.44) was recorded under  $A_5$  while it was the minimum (4.71) under  $A_1$ . The interaction of pruning intensity and foliar application of  $KNO_3$  showed significant effect on yield kg/plant. and, the maximum was recorded under  $A_5B_3$  (8.74) and was minimum under  $A_1B_1$  (4.52).

**Table 4 : Effect of Pruning Intensity and Foliar Application of  $KNO_3$  on Yield (kg/plant).**

| Yield (kg/plant)                |           |           |           |      |
|---------------------------------|-----------|-----------|-----------|------|
| Treatment                       | ( $B_1$ ) | ( $B_2$ ) | ( $B_3$ ) | Mean |
| No pruning ( $A_1$ )            | 4.52      | 4.71      | 4.89      | 4.71 |
| 10 cm pruning ( $A_2$ )         | 7.17      | 7.40      | 7.66      | 7.41 |
| 20 cm pruning ( $A_3$ )         | 5.26      | 5.47      | 5.66      | 5.46 |
| 30 cm pruning ( $A_4$ )         | 6.40      | 6.61      | 6.85      | 6.62 |
| One pair leaf pruning ( $A_5$ ) | 8.13      | 8.46      | 8.74      | 8.44 |
| Mean                            | 6.29      | 6.53      | 6.76      |      |
|                                 | B         | A         | A x B     |      |
| SE(m)±                          | 0.007     | 0.009     | 0.016     |      |
| CD at 5%                        | 0.02      | 0.026     | 0.045     |      |

**Yield (t/ha) :** Yield (t/ha) was computed and presented in Table-5. The data showed that foliar spray of  $KNO_3$  and pruning intensity significantly influenced the Yield/ha. The maximum yield/ (3.56) was recorded under  $B_3$  comprising  $KNO_3$  3% spray and the minimum (3.28) under  $B_1$ . Pruning intensity had significant effect on Yield t/ha. The maximum (4.44) was recorded under  $A_5$  whereas the minimum (2.45) was noted under  $A_1$ . The interaction of pruning intensity and foliar spray of  $KNO_3$  did not show significant effect on yield t/ha.

**Table-5 : Effect of Pruning Intensity and Foliar Application of  $KNO_3$  on Yield (t/ha).**

| Yield (t/ha)                    |           |           |           |      |
|---------------------------------|-----------|-----------|-----------|------|
| Treatment                       | ( $B_1$ ) | ( $B_2$ ) | ( $B_3$ ) | Mean |
| No pruning ( $A_1$ )            | 2.33      | 2.46      | 2.56      | 2.45 |
| 10 cm pruning ( $A_2$ )         | 2.71      | 2.89      | 2.97      | 2.86 |
| 20 cm pruning ( $A_3$ )         | 3.32      | 3.42      | 3.66      | 3.47 |
| 30 cm pruning ( $A_4$ )         | 3.77      | 3.84      | 4.01      | 3.87 |
| One pair leaf pruning ( $A_5$ ) | 4.26      | 4.45      | 4.60      | 4.44 |
| Mean                            | 3.28      | 3.41      | 3.56      |      |
|                                 | B         | A         | A x B     |      |
| SE(m)±                          | 0.025     | 0.032     | 0.056     |      |
| CD at 5%                        | 0.072     | 0.093     | NS        |      |

## Conclusion

From the results of the present study it can be concluded that different time of pruning and severity of pruning significantly affected the flowering, fruit set and yield. Pruning of One leaf pair pruning in was last week oh July found to be the best among all the treatments for increasing yield of guava cv. Allahabad Safeda in subtropical climate of Jabalpur. Hence, the yield of guava for commercial production can be manipulated easily by appropriate pruning intensity and spray of  $KNO_3$ .

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## **Assessment of Training Needs among Dairy Livestock Farmers in Shivpuri District**

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### **Abstract**

The training needs of dairy livestock farmers in Shivpuri District, Madhya Pradesh were assessed. A well-structured interview schedule was used to obtain information from 120 respondents. Data were collected on demographic profile of the respondents, their dairy livestock production and their training needs which were ascertained in four major areas of livestock production: feeding, breeding, housing and management, Health management. Data were subjected to Descriptive research design statistics and the collected data was classified, tabulated and analyzed with the help of statistical tools like- percentage, simple mean, SD, correlation coefficient. Results revealed that more than 50.00% of dairy livestock farmers perceived the training needs in feeding as most important. Breeding aspect of livestock production, 40.83% of respondents determined training need in medium level while Housing and management aspect of livestock production, 49.16% respondents determined training need in low level while 27.50% respondents determine training need in medium level and Health management the data indicates maximum number of dairy farmers 60.00% determine training need in high level. Based on the result of this study, it was concluded that feeding, breeding and were perceived as the "most needed" training by the respondents. Although, training need in health care management, as well as housing and management were also perceived as important.

**Key words :** *livestock, dairy farmers, production, training needs.*

### **Introduction**

National development is not possible without developing the very important and substantial section of our society i.e. the farmers. Dairy farming is an integral part of Indian agriculture. India's livestock sector has had a significant impact on the growth of country's economy. The contribution of this sector is 17per cent of the world milk production. It is principle source of drought power and generating steady rural employment .India is the world's second largest producer of livestock products. Cattle and buffaloes are commonly reared in every farm household because their production plays an important role in rural household economy besides possessing vast employment potential. Most of the milk and meat in our country is produced by cattle and buffaloes. These are considered as back bone of commercial dairying due to their rich production potential. Milk and milk products alone make about two-third of total income from livestock. India has witnessed a rapid increase in milk production during last two and half decades and now holds the first position in the world by producing about 86 metric million tons of milk per annum. In India, a network of various institutes is involved in conducting various training programmes which are designed based on the clientele problems and their interest and needs. The new and innovative technology in agriculture and allied field is transferred through imparting vocational training programme to the farmers, farmwomen, rural youth and grass root level extension workers in broad agricultural production by these institutes. The emphasis is given to

provide critical skill so that participant may confidently use the new technology to increase the productivity and also become economically self-reliant through gainful self-employment.

### **Materials and Methods**

The study was conducted in Shivpuri district of Madhya Pradesh state. Shivpuri district lies between latitude 25.4358<sup>0</sup> to north and longitude 77.657990<sup>0</sup> east. It is surrounded by Gwalior district in north, Ashoknagar district in South, Jhansi district (U.P.) in East, and Baran district of Rajasthan in West. The district consists of 7 Blocks/Tehsils, 8 Janpad Panchayat, 604 Gram Panchayat and 1424 villages. The total geographical area of Shivpuri district is 10298sq Km. including 18139 forest area and 4642.15 as cultivated area with Shivpuri District has crossbred cattle, non-descript cattle and buffaloes in milk, producing around 170.5 million tons of milk annually, and buffaloes are contributing the major share and The average annual rainfall is about 863mm, most of which is received during monsoon months. The climate is warm and temperate. The average temperature is 24.6<sup>0</sup>c while the maximum temperature is 43<sup>0</sup>c and minimum temperature is 15<sup>0</sup>c And Shivpuri District has crossbred cattle, non-descript cattle and buffaloes in milk, producing around 170.5 million tons of milk annually, and buffaloes are contributing the major share.

**Assessment of the training needs of the dairy farmers:** Training need assessment is one of the crucial steps towards identifying the area of farmers' interest, design and development of curriculum that can best suit to

the existing rural conditions of farmers. Training need assessment process helps determine the priority of changes in knowledge, skill, altitude and behavior that will provide the greatest impact on achieving organizational and individual goals.

#### **Distribution of the dairy farmers according to overall training needs in livestock production activities :**

Training needs are the skill, knowledge, and attitude an individual requires in overcoming problem as well as avoiding problem creating situation. Table 1 depicts the categorization of respondents on the basis of their training needs. It was seen from the table-1, that out of 120 respondents, 54.17 per cent had medium, 33.33 per cent had high and only 12.50 per cent had low level of training needs. Thus, it can be concluded that majority of respondents were having medium level of training needs.

**Table-1 : Distribution of the respondents according to overall training needs in livestock production activities.** n=120

| S. No. | Categories     | Frequency | Percentage |
|--------|----------------|-----------|------------|
| 1.     | Low (<34)      | 15        | 12.50      |
| 2.     | Medium (34-44) | 65        | 54.17      |
| 3.     | High (>44)     | 40        | 33.33      |

These findings are in line with those of Asif (2006) and Mandloi ((2013). The results may be due to the fact that in our villages dairy is still practiced as secondary occupation and that too on traditional methods of livestock rearing. Therefore the respondents lack interest and awareness to take up dairy as an profitable enterprise.

#### **Distribution of the dairy farmers according to training needs in different thematic areas of livestock production activities :**

Table-2 shows the training needs of the dairy farmers in different thematic areas of livestock production activities.

**Table-2 : Distribution of the respondents according to training needs in different thematic areas of livestock production activities.** n=120

| S. No. | Thematic Area        | Training needs |           |           |
|--------|----------------------|----------------|-----------|-----------|
|        |                      | Low            | Medium    | High      |
| 1.     | Feeding              | 35(29.16)      | 60(50.00) | 25(20.84) |
| 2.     | Breeding             | 38(31.67)      | 49(40.83) | 33(27.50) |
| 3.     | Housing & management | 59(49.16)      | 33(27.50) | 28(23.34) |
| 4.     | Health management    | 18(15.00)      | 30(25.00) | 72(60.00) |

(Figure in parentheses indicates percentage)

As clearly indicated in table-2, about half of the respondents 50.00% determined training needs in medium level whereas 29.16% respondents determine training in low level and only 20.84% respondents determined training needs in high level in “feeding” aspect of livestock production.

Similarly, in “Breeding” aspect of livestock production, 40.83% of respondents determined training

need in medium level, whereas 31.67% respondents determine training need in low level and only 27.50% respondents determined high level of training need.

In “Housing and management” aspect of livestock production, 49.16% respondents determined training need in low level while 27.50% respondents determine training need in medium level and about 23.34% of respondents determined training need in high level.

In case of “Health management” the data indicates maximum number of dairy farmers 60.00% determine training need in high level, while 25.00% dairy farmers determine medium level of training need and only 15.00% dairy farmers determined low level of training need. The results are in line with the study conducted by Lal (2004).

#### **Distribution of the dairy farmers according to training needs in different aspects of livestock feeding activities :**

Table-3 shows the training needs of the dairy farmers in different thematic areas of livestock feeding activities. As clearly indicated in the table 3 most of the respondents i.e. (45.00%) showed training needs in medium level in “colostrums feeding to new born” whereas (26.67%) showed in low level of training needs and only (28.33%) showed high level of training need on the same aspect. Similarly in “Dry fodder”, (37.50%) respondents showed low level of training need whereas (35.83%) showed training need in medium level and (26.67%) respondents showed high level of training need.

**Table-3 : Distribution of the dairy farmers according to training needs in feeding activities.** n=120

| S. No. | Thematic Area                                | Training Needs |           |           |
|--------|----------------------------------------------|----------------|-----------|-----------|
|        |                                              | Low            | Medium    | High      |
| 1.     | Colostrum's feeding to new born              | 32(26.67)      | 54(45.00) | 34(28.33) |
| 2.     | Dry fodder                                   | 45(37.50)      | 43(35.83) | 32(26.67) |
| 3.     | Green fodder                                 | 28(23.33)      | 45(37.50) | 47(39.17) |
| 4.     | Concentrate feeding                          | 40(33.33)      | 50(41.67) | 30(25.00) |
| 5.     | Additive Mineral mixture, salt, vitamin etc. | 39(32.50)      | 45(37.50) | 36(30.00) |

(Figure in parentheses indicates percentage)

In “Green fodder”, (39.17%) respondents showed high level of training need whereas (37.50%) respondents showed medium level of training needs and (23.33%) respondents were in low level of training need.

In “Concentrate feeding”, most of the respondents (41.67%) were in medium level of training need whereas (33.33%) respondents were in low level of training need and (25.00%) respondents determined high level of training need.

In “Additive (Mineral mixture, salt, vitamin etc)”, (37.50%) respondents determined in medium level of training need and (32.50%) respondents determined low level of training need and (30.00%) respondents determined high level of training need.

### Distribution of the dairy farmers according to training needs in different aspects of livestock breeding activities :

Table-4 shows the training needs of the dairy farmers in different thematic areas of livestock breeding activities. As clearly indicated in the table-4 in “Knowledge of cross breed animal” aspect, most of the respondents (60.00%) showed high level of training needs whereas (25.84%) respondents were in medium level and (14.16%) respondents were in low level of training need. In “Breed improvement of cross breed animal”, high level of training need was observed in approximately half i.e. (49.16%) respondents whereas (31.67%) respondents were in medium level and merely (19.17%) respondents were in low level of training need. In “Reproduction related works”, medium level of training need was observed in half (50.00%) of the respondents whereas (25.00%), (25.00%) respondents were in low level and high level of training need each respectively.

**Table-4 : Distribution of the dairy farmers according to training needs in breeding activities.** n=120

| S. No. | Thematic Area                   | Training Needs |           |           |
|--------|---------------------------------|----------------|-----------|-----------|
|        |                                 | Low            | Medium    | High      |
| 1.     | Knowledge of cross breed animal | 17(14.16)      | 31(25.84) | 72(60.00) |
| 2.     | Breed improvement programme     | 23(19.17)      | 38(31.67) | 59(49.16) |
| 3.     | Reproduction related works      | 30(25.00)      | 60(50.00) | 30(25.00) |
| 4.     | Artificial insemination         | 41(34.17)      | 46(38.33) | 33(27.50) |

(Figure in parentheses indicates percentage)

In “Artificial insemination” aspect, (38.33%) respondents determined training needs in medium level whereas (34.17%) respondents were in low level and (27.50%) in high level of training need.

### Distribution of the dairy farmers according to training needs in different aspects of livestock Housing and management activities :

Table-5 shows the training needs of the dairy farmers in different thematic areas of livestock Housing and management activities. As clearly indicated in the table-5 “Space requirement” aspect was observed in medium level of training need by (37.50%) respondents while (33.33%) respondents showed low level and (29.17%) respondents showed high level of training need.

In “Protection during different season” aspect, (41.67%) respondents determined training needs in high level whereas (33.33%) respondents were in medium level and (25.00%) respondents were in high level of training need.

In “Animal maintenance”, (43.33%) respondents showed medium level of training needs whereas (33.33%) showed low level and (23.33%) showed high level of training need.

**Table-5 : Distribution of the dairy farmers according to training needs in housing and management activities.** n=120

| S. No. | Thematic Area                           | Training Needs |           |           |
|--------|-----------------------------------------|----------------|-----------|-----------|
|        |                                         | Low            | Medium    | High      |
| 1.     | Space requirement                       | 40(33.33)      | 45(37.50) | 35(29.17) |
| 2.     | Protection during different season      | 50(41.67)      | 40(33.33) | 30(25.00) |
| 3.     | Animal maintenance                      | 40(33.33)      | 52(43.33) | 28(23.33) |
| 4.     | Cleaning of shed/ utensils/persons etc. | 53(44.17)      | 43(35.83) | 24(20.00) |

(Figure in parentheses indicates percentage)

In “Cleaning of shed/utensils/persons”, (44.17%) respondents determined training needs in high level whereas (35.83%) respondents were in medium level and (20.00%) respondents were in high level of training need

### Distribution of the dairy farmers according to training needs in different aspects of livestock Health management activities :

Table-6 shows the training needs of the dairy farmers in different thematic areas of livestock Health management activities.

As clearly indicated in the table-6 “Vaccination” was observed in medium level of training needs by (47.50%) respondents whereas (30.83%) respondents showed low level and (21.67%) respondents were in high level of training need.

In “Dosing” aspect, (43.33%) respondents determined training needs in medium level whereas (28.33%) respondents were in low level and (28.33%) respondents were in high level of training need.

**Table-6 : Distribution of the dairy farmers according to training needs in health management activities.** n=120

| S. No. | Thematic Area | Training Needs |           |           |
|--------|---------------|----------------|-----------|-----------|
|        |               | Low            | Medium    | High      |
| 1.     | Vaccination   | 37(30.83)      | 57(47.50) | 26(21.67) |
| 2.     | Dosing        | 34(28.33)      | 52(43.33) | 34(28.33) |
| 3.     | Sanitation    | 52(43.33)      | 44(36.67) | 24(20.00) |

(Figure in parentheses indicates percentage)

In “Sanitation”, high level of training need was seen in low category (43.33%) respondents whereas (36.67%) respondents were in medium level and (20.00%) respondents were in high level of training need.

Thus, it can be concluded that the majority of the respondents were under medium level training needs regarding improved dairy farming practices. The results may be due to the fact that less educated dairy farmers lack sufficient knowledge about improved breeds, breeding practice and scientific practices in the field of health care etc. Also the veterinary officers charge high fees for doorstep service.

## Conclusion

Based on the result of this study, it was concluded that health management was perceived as the “most needed” training by the respondents. while, training need in housing and management was perceived as secondly most needed training by the respondents and training need in breeding was third most needed training by the respondents and feeding was the lastly needed training by the respondents. Furthermore, in feeding activity Additive Mineral mixture, salt, vitamin was most needed training by the respondents. In breeding activity Knowledge of cross breed animal was the most needed training by the respondents and in housing and management activity space requirement was the most needed training by the respondents and in health management activity dosing was the most needed training by the respondents. It is therefore recommended that there is need for establishment of famers’ training Institute specifically for dairy production to assess the training needs of dairy farmers’ holistically.

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## Studies on Assessment of Avoidable Yield Loss Caused by Purple Blotch of Onion

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### Abstract

The experiment was conducted at Dr. B.R. Ambedkar Samajik Vigyan Kendra Bordhi, Rehti under the Dr. B.R. Ambedkar University of Social Science (Mhow) Indore. The field experiment was laid down in randomized block design with eight treatment and three replication. During the experiment in 2019-20 the avoidable bulb yield loss was calculated after harvesting, the minimum significant avoidable onion bulb yield loss was recorded in the treatment T<sub>2</sub> (25.25 q/ha) while the maximum avoidable onion bulb yield was recorded in the treatment T<sub>6</sub> (51.51 q/ha). In the year of 2020-21, the avoidable bulb yield loss, the minimum significant avoidable onion bulb yield loss was recorded in the treatment T<sub>2</sub> (25.25 q/ha) while the maximum avoidable onion bulb yield was recorded in the treatment T<sub>6</sub> (51.51 q/ha).

**Key words :** Avoidable yield loss, yield and *Alternaria porri*.

### Introduction

Onion (*Allium cepa* L.) is one of the most important vegetable cash crop grown for vegetable in green stage as well as for mature bulb. Onion has called as “Queen of Kitchen” (Selviraj, 1976). Onion is one of the important commercial vegetable crops grown in India and worldwide. It is an ancient crop being cultivated since the earliest period of the history. It belongs to the family *Aliaceae*. This *aliaceous* crop has been known for its various uses in Egypt, since 3200 BC and in India, since 600 B.C and its cultivation have been mentioned in the “Charaka Samhita”. It extremely important vegetable crop not only for internal consumption but also as highest foreign exchange earner among the fruits and vegetables.

Onion crop is sensitive to a variety of diseases viz., Purple blotch [*Alternaria porri* (Ellis) Ciferri], Downy mildew [*Peronospora destructor* (Bark) Cosp], onion smut [*Urocystis cepulae* (Frost)], Basal rot [*Fusarium oxysporum* f. sp. *cepae* (Schlecht), Mrlhatt], Stemphylium blight [*Stemphylium vesicarium* (Wall) Toth.]. The pathogen has wide host range, infecting crop like onion, garlic, shallot and other *Allium* spp. High relative humidity (80 to 90%) and optimum temperature (24±1°C) are favour for further development of purple blotch disease and causing considerable yield losses. Shahanaz *et al.* (2007) reported losses about 50 to 100 per cent due to purple blotch disease. Typical symptoms of the disease appeared on foliage and foliage sheath. They are small and white sunken spots develop on the leaves which enlarge, become zonate and under moist conditions turn purple. These are also prominent on the inflorescence and stalks. Infection can cause a semi watery rot on necks of bulbs that turn yellow red in colour. Infected bulb tissues eventually become papery. These diseases take a

handsomely heavy toll every year. Among purple blotch is the major problem in all onion growing areas including Jharkhand.

### Materials and Methods

This investigation was carried out in *rabi* season during the period of 2019-20 and 2020-21 at the Dr. B.R. Ambedkar samajik vigyan Kendra, Bordi, Rehti, Dr. B.R. Ambedkar university of Social science, Dr, Ambedkar Nagar. The eight treatments were evaluated on avoidable yield of onion.

### Results and Discussion

The Assessment of avoidable yield loss due to fungus *Alternaria porri* was calculated after harvesting of onion bulb and is shown in table-2 and figure-1. During 2019-20 the avoidable bulb yield loss was calculated and the minimum significant avoidable onion bulb yield loss was recorded in the treatment T<sub>2</sub> (25.25 q/ha) while the maximum avoidable onion bulb yield was recorded in the treatment control T<sub>8</sub> (63.35 q/ha).

During the year of 2020-21 the avoidable bulb yield loss, the minimum significant avoidable onion bulb yield loss was recorded in the treatment T<sub>2</sub> (32.48q/ha) followed by treatment T<sub>3</sub> while the maximum avoidable onion bulb yield was recorded in the treatment control T<sub>6</sub> (68.46q/ha). The above finding is closely related to Haq *et al.*, (1998), Haq *et al.* (1999), Gupta *et al.*, (1991) and Dr. Sarnobat D H *et al.*, (2020) reported 21.54 per cent yield loss due to the fungus *Alternaria porri* (purple blotch) of garlic under unprotected or open condition of the research field.

### Conclusions

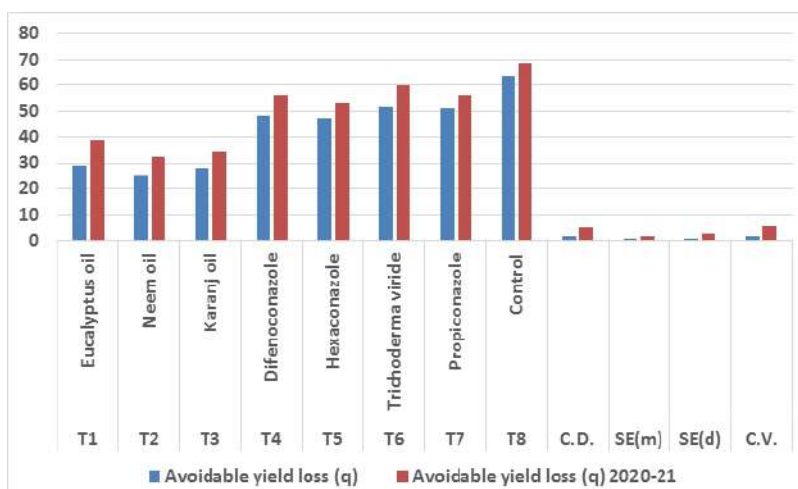
It is concluded that the yield loss is directly related to

Table-1 : Treatment details.

| Sr. No. | Common name       | Trade name            | Active ingredient | Dose (%/kg/g/l/ac) | Manufacture                       |
|---------|-------------------|-----------------------|-------------------|--------------------|-----------------------------------|
| 1.      | Eucalyptus oil    | Eucalyptus oil        | -                 | 5%                 | Anveya Pvt. India                 |
| 2.      | Neem oil          | Neem oil              | -                 | 5%                 | Global-Interprise, India          |
| 3.      | Karanj oil        | Pure karanja seed oil | -                 | 5%                 | Deve Herbes, India                |
| 4.      | Difenoconazole    | Score                 | 25 EC             | 250 g/lit          | Syngenta India Ltd., Mumbai       |
| 5.      | Hexaconazole      | Contaf                | 5 EC              | 300 ml/ac          | Rallis and Tata Ltd., Mumbai      |
| 6.      | Tricoderma viride | Trichoz-P             | -                 | 2kg/ac             | Utkarsh Agrochem Pvt. Ltd., India |
| 7.      | Propiconazole     | Tilt                  | 25 EC             | 250 g/lit          | Syngenta India Ltd., Mumbai       |
| 8.      | Control           | -                     | -                 | -                  | -                                 |

Table-2 : Performance of different treatments against *Alternaria porri* in field condition during rabi 2019-20 and 2020-21.

|                | Treatments         | Avoidable yield loss (q/ha) 2019-20 | Avoidable yield loss (q/ha) 2020-21 |
|----------------|--------------------|-------------------------------------|-------------------------------------|
| T <sub>1</sub> | Eucalyptus oil     | 29.16                               | 38.74                               |
| T <sub>2</sub> | Neem oil           | 25.25                               | 32.48                               |
| T <sub>3</sub> | Karanj oil         | 27.98                               | 34.42                               |
| T <sub>4</sub> | Difenoconazole     | 48.33                               | 55.99                               |
| T <sub>5</sub> | Hexaconazole       | 47.21                               | 53.11                               |
| T <sub>6</sub> | Trichoderma viride | 51.51                               | 60.00                               |
| T <sub>7</sub> | Propiconazole      | 51.11                               | 55.92                               |
| T <sub>8</sub> | Control            | 63.35                               | 68.46                               |
| C.D.           |                    | 1.34                                | 5.19                                |
| SE(m)          |                    | 0.43                                | 1.69                                |
| SE(d)          |                    | 0.62                                | 2.39                                |
| C.V.           |                    | 1.76                                | 5.88                                |

Fig.-1 : Performance of different treatments against *Alternaria porri* in field condition during rabi 2019-20 and 2020-21.

economic loss of the crop here the treatment T2 is best in relation to minimum bulb yield loss.

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## Growth Performance and Instability of Major Oilseeds in Selected States of India

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### Abstract

Present study is an attempt to know the comparative growth performance and instability in groundnut, soybean and castor oilseeds using secondary data from 2004-2020. The results of the study indicated that area and productivity of groundnut and castor in Karnataka were significantly decreased, whereas growth of production for soybean in Karnataka and castor in Gujarat was positive and significant. Productivity growths were positive and significant for all the three crops except soybean in Maharashtra and castor in Karnataka. Area and production of groundnut in Rajasthan, soybean and castor in Karnataka were found to be most unstable compared to other oilseed crops. Area was found to be the major contributor to the production of soybean in Maharashtra and Madhya Pradesh, whereas productivity was the major contributor to the production of soybean in Madhya Pradesh, Karnataka and groundnut in Rajasthan. Both area and productivity together contributed for growth in production of castor in Karnataka, soybean in Madhya Pradesh and Groundnut in Rajasthan.

**Key words :** Oilseeds, growth, production, yield, instability.

### Introduction

The oilseeds sector has been one of the most dynamic mechanism of world agriculture in the past three decades with annual growth rate of more than four per cent per annum surpassing the growth of agriculture and livestock products. The performance of oilseeds on the domestic front during the last two decades has been commendable braving the vagaries of weather conditions, the global price peculiarity and the ever increasing domestic demand.

Oilseeds and edible oils are one of the most sensitive essential commodities and had gone through several phases of development policies since 1980 mainly driven by consumer interests. This sector occupies an important position in the agricultural economy of the country. Oilseed crops accounts for 13 per cent of gross cropped area, three per cent of gross national product, ten per cent of total value of output from agricultural crops and six per cent of value of output from agriculture and allied sector. In terms of acreage, production and economic value, these crops are second only to food grains. Indian vegetable oil economy is the world's fourth largest after USA, China and Brazil. India accounts for about 14 per cent of global oilseeds area, eight percent of oil crops production, 6-7 per cent of vegetable oils production, 13.5 per cent of vegetable oils import, 6.5 per cent of oilcakes export and 10.7 per cent of the global edible oils consumption. The per capita availability of edible oils had increased from 3.5 kg/person/year in 1970-71 to 15.8 kg in 2012-13 (Government of India, 2014).

Low productivity of oilseed crops, fragmented and

under-utilized processing facilities, and lack of technological inputs hampered the oilseeds production in the country, resulting in heavy reliance on imports of edible oils. Country has now become the largest oilseeds importer, and import of edible oils emerged as the second largest items of country's imports after petroleum products. The cultivation of oilseeds in the country is mostly in high risk regions with minimum use of productive inputs. They are mostly grown under rain-fed conditions which are characterized with extreme variations in rainfall both in time and space, poor soil quality, etc. It has resulted in a high degree of variation in production of oilseeds annually.

The efforts were continuously being diverted by government towards increasing the production and productivity of oilseeds in the country to enhance availability of oilseeds. The efforts include both developmental policies targeted towards increasing and sustaining yield levels of oilseeds through technological interventions, and through trade policies to meet the growing edible oil demand of the consumers. As the demand of edible oils is highly income elastic, the increase in per capita income pushes demand significantly (Chand *et al.*, 2004).

To increase the availability of edible oils for the ever increasing population, enduring policy efforts were initiated by government through TMO, OPP, ISOPOM, etc. with an overall view to increase oilseed productivity. Under this backdrop, this paper intends to review oilseed production and policy scenario, pricing, and international trade and their role in changing oilseeds scenario in India.

**Table-1 : Compound growth rates of area, production and productivity oilseeds in major producing states.**

| Sl. No.   | States         | Per cent growth rates of |            |              |
|-----------|----------------|--------------------------|------------|--------------|
|           |                | Area                     | Production | Productivity |
| Groundnut |                |                          |            |              |
| 1.        | Gujarat        | -1.60*                   | 1.51NS     | 3.19 NS      |
| 2.        | Rajasthan      | 6.87***                  | 5.30 NS    | 3.11***      |
| 3.        | Karnataka      | -4.31***                 | -2.22 NS   | 2.04*        |
| Soybean   |                |                          |            |              |
| 1.        | Madhya Pradesh | 1.32**                   | 1.38 NS    | 0.04 NS      |
| 2.        | Maharashtra    | 3.98***                  | 2.43 NS    | -1.43 NS     |
| 3.        | Karnataka      | 7.43***                  | 10.32***   | 2.69 NS      |
| Castor    |                |                          |            |              |
| 1.        | Gujarat        | 6.33***                  | 5.81***    | 0.44 NS      |
| 2.        | Rajasthan      | 4.25**                   | 5.19*      | 0.18 NS      |
| 3.        | Karnataka      | -11.76**<br>*            | -14.36***  | -3.34***     |

(Area in '000'ha, production Qtls and yield kgs/ha)

Note : \*\*\*, \*\* and \* indicates significance at one %, five % and ten

**Table-2 : Instability of area, production and productivity of oilseed crops.**

| Sl. No.   | States         | Instability of |            |              |
|-----------|----------------|----------------|------------|--------------|
|           |                | Area           | Production | Productivity |
| Groundnut |                |                |            |              |
| 1.        | Gujarat        | 12.00          | 38.05      | 35.50        |
| 2.        | Rajasthan      | 29.54          | 50.40      | 17.22        |
| 3.        | Karnataka      | 21.06          | 24.65      | 17.77        |
| Soybean   |                |                |            |              |
| 1.        | Madhya Pradesh | 9.91           | 15.59      | 12.62        |
| 2.        | Maharashtra    | 16.69          | 28.74      | 28.13        |
| 3.        | Karnataka      | 31.77          | 43.44      | 27.25        |
| Castor    |                |                |            |              |
| 1.        | Gujarat        | 33.95          | 33.76      | 5.43         |
| 2.        | Rajasthan      | 31.07          | 43.43      | 15.29        |
| 3.        | Karnataka      | 44.69          | 59.44      | 21.70        |

## Materials and methods

**Nature and sources of data :** The paper is mainly based on secondary data on area, production and productivity of oilseeds in Karnataka and selected oilseeds producing states in the country. The data on area, production and yield of oilseeds and other requisite information were collected from publications and website of the Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India. Growth and instability of oilseeds were analyzed during 2004-05 to 2019-20 in different states of the country for selected crops, Compound annual growth rates for different crops in selected states were also calculated.

**Table-3 : Contribution of area and productivity towards production of oilseeds.**

| Sl. No.          | States         | Area   | Productivity | Interaction |
|------------------|----------------|--------|--------------|-------------|
| <b>Groundnut</b> |                |        |              |             |
| 1.               | Gujarat        | -62.42 | -68.78       | 12.67       |
| 2.               | Rajasthan      | -54.71 | 16.09        | 17.75       |
| 3.               | Karnataka      | -34.33 | 10.92        | -5.51       |
| <b>Soybean</b>   |                |        |              |             |
| 1.               | Madhya Pradesh | 123.15 | 73.61        | 20.13       |
| 2.               | Maharashtra    | 186.10 | 12.09        | 9.50        |
| 3.               | Karnataka      | 6.19   | 66.50        | 5.80        |
| <b>Castor</b>    |                |        |              |             |
| 1.               | Gujarat        | 34.99  | -4.59        | -2.43       |
| 2.               | Rajasthan      | 4.45   | -1.33        | -0.44       |
| 3.               | Karnataka      | -237.6 | -118.75      | 104.5       |

Among the nine oilseed crops grown in the country, seven are edible oils (groundnut, soybean, rapeseed-mustard, sunflower, safflower, sesame and niger) and two are non-edible oils (castor and linseed). India ranks first in production of castor about 85 per cent of global production, second in groundnut production and fifth in soybean production based on this criteria these oilseed crops were selected for the study among the different states of the country.

To measure the relative contribution of area and yield to the total output change for individual crop, the component analysis model was followed (Narula and Vidysagar, 1973; Singh and Sisodia, 1989; Bastine and Palanisami, 1994; Gaddi *et al*, 1999; and Singhand Ashokan, 2000)

**Analytical tools :** The growth performance of the study crops was attempted using the compound growth using the following exponential form of the function.

$$Y = ab^t e^u$$

Where, Y is the dependent variable (area/production/productivity), a is Intercept, b is the Regression coefficient, t denotes the Time period in years and  $e^u$  is the error term.

The above function was estimated by transforming into the logarithmic form and coefficients were estimated using the Ordinary Least Squares (OLS) procedures.

$$\log Y = \log a + t \log b + u$$

The Compound annual growth rate (g) was then computed using the following formula and expressed in percent.

$$g = (r - 1) \times 100$$

Where, g is the compound annual growth rate (%) and 'r' is the antilog of log b. The significance of the CAGR was tested using 't' test.

Further to examine the stability in the growth of oilseeds across states, the Coefficient of Variation (CV) was estimated using the following procedure.

$$CV = \frac{SD}{\mu} \times 100$$

SD = Standard Deviation

$\mu$  = mean

To measure the contribution of area and productivity to production of oilseeds concerned, the following methodology was used

$$P = A_o(Y_n - Y_o) + Y_o(A_n - A_o) + A \cdot Y$$

$$P = (P_n - P_o) = \text{change in production}$$

$$A_o = \text{Area in the base period}$$

$$Y_o = \text{Yield in the base period}$$

$$A_n = \text{Area in the current period}$$

$$Y_n = \text{Yield in the current period}$$

$$A = (A_n - A_o) = \text{Change in area}$$

$$Y = (Y_n - Y_o) = \text{Change in yield}$$

$$P = A_o \cdot Y + Y_o \cdot A + A \cdot Y$$

Where the first term on the right hand side indicates productivity contribution, the second term indicates area contribution and the last term shows interaction.

## Results and Discussion

The growth performance of major oilseeds, viz., groundnut, soybean and castor seed in Karnataka and selected states with respect to area, production and yield was analyzed and results are presented in Table-1.

The crop wise growth rates of area presented in table-1 reveals the highest per annum decrease in groundnut area in Karnataka (-4.31%) followed by Gujarat (-1.60%), and these growth rates were significant. While area under groundnut in Rajasthan registered the highest per annum growth rate (6.78%) and was highly significant at one per cent level. Even though groundnut is leading oilseed crop, its production registered a negative growth in Karnataka. Rajasthan registered relatively higher growth rate (5.3%) compared to Gujarat and Karnataka, but was non significant. Gujarat shows higher productivity growth rate of 3.19 per cent per annum compare to Rajasthan and Karnataka for groundnut, however, it was non significant.

The spill in the area under groundnut can be attributed to, which is affected by adverse climatic changes, lack of availability of HYV and hybrids, high seed multiplication rate and drought tolerance along with revivability after prolonged period of drought, leads decline in area under groundnut in Karnataka and

Gujarat. The increase in area under Groundnut in Rajasthan could be attributed to the introduction of the technology mission on oilseeds, institutional support given by the Government and remunerative prices.

Similarly, outcomes for Soybean crop (table-1), reveals that area under soybean cultivation in Karnataka showed remarkable increase of 7.43 per cent per annum, followed by Maharashtra (3.98%) and these growth rate were highly significant at one per cent level. With respect production also Karnataka exhibited massive increase in production with annual growth rate of 10.32 per cent, which was highly significant, soybean production growth rates in Maharashtra and Madhya Pradesh was non significant. The productivity of soybean was increasing but growth rate was not significant in Karnataka (2.69%), whereas, Maharashtra experienced decreasing productivity but again found to be non significant (-1.43%).

The growth of soybean production can be attributed to improvement in productivity, area increase might be attributable to decreasing area under cereals, millets and other non-remunerative crops and partly from slight increased cropping intensity. Besides market intervention operations of KOF (Karnataka Oilseed Federations) and establishment of private oilseed industries created a conducive macro policy environment to soybean production.

It is also clear from table-1, that Gujarat showed the highest increase of 6.33 per cent per annum with respect area of castor which was highly significant at one per cent level followed by Rajasthan (5.81%), but Karnataka exhibited large decline in area under castor (-11.76%). Gujarat also leads in terms of growth rate of production of castor (5.81%) followed by Rajasthan (5.19%) but again Karnataka showed significant decline in production of castor (-14.36%). There was increase in productivity of castor in both Gujarat and Rajasthan states but were non-significant, but highly significant decline was noticed in the case of Karnataka (-3.34%).

The significant decrease in area, production and productivity of castor in Karnataka may be due to various reasons like it is being grown on smaller area as it has the least importance in human consumption. cultivation of low yielding varieties under rain fed situations, large scale shift in cultivation practices towards pulses and other commercial crops.

The improvement in the productivity of oilseeds which can be attributed to increase in irrigated area under these crops, adoption of improved varieties and other components of production technology such as quality seeds, fertilizers and nutrient management in Gujarat and Rajasthan.

Agriculture sector, as it depends on climatic factors, subjected to a large degree of uncertainty, though it is said that growth with stability is ideal, but growth with instability is more often the reality. Growth rates generally fail to explain fluctuation or instability in the time series data, so the co-efficient of variation (CV) was used as a measure of instability in area, production and productivity and the results are presented in Table-2.

Instability was noticed in all the selected oilseed crops, the production instabilities were higher compared to yield and area instabilities for selected oilseed crops. The area instability was found to be more for castor (44.69%) in Karnataka, followed by Gujarat (33.95%), while groundnut and soybean showed lesser instability in Gujarat and Madhya Pradesh. The instability in area could be attributed to the climatic conditions, allocation of land and other production resources for other crops depending on the price structure of the crop and its competing crops grown in the region.

With respect to production, all the crops showed instability, the magnitude of production instability was found to be the highest in the case of castor in Karnataka (59.44%) followed by groundnut in Rajasthan (50.40%). This production instability was due to variability in both area and productivity of different oilseed crops.

It was found that the productivity of all the oilseed crops was unstable in selected states of the country. The highest yield instability of 35.50 per cent was noticed for groundnut in Gujarat followed by soybean in Maharashtra (28.13%). In other crops it was comparatively less, these instabilities may be attributable to climatic variations, lack of non-adoption of modern cultivation practices, lack of irrigation facility, quantity and quality of inputs such as seeds, fertilizers and chemicals, incidence of insect pest and diseases. Thus quality production inputs like improved seeds, along with timely adoption of all practices are practiced under the condition of assured irrigation, it would promote growth with stability.

Contribution of area and productivity towards production were worked and results are presented in table 3. It could be observed that the area was the major contributor in case of soybean (186.1%) and (123.15%) in Maharashtra and Madhya Pradesh, respectively, while in Karnataka, castor (-237.6%) exhibited the highest negative contribution of area. The contribution of productivity was remarkable for soybean (73.61%) in Madhya Pradesh, followed by Karnataka (66.50%), and castor in Karnataka shows (-118.75%) negative contribution of productivity, both the area and productivity together influenced the production in case of castor (104.5%) in Karnataka, soybean (20.13%) in Madhya Pradesh and groundnut (17.75%) in Rajasthan.

## Conclusion

The study highlights that, the productivity of the selected oilseeds showed positive growth rate except soybean in Maharashtra and castor in Karnataka, whereas, the productivity growth rates were fairly good in the case of groundnut. Productivity was the major contributor towards production of groundnut and soybean. Supply of various inputs and provision of good marketing facilities are important to provide remunerative prices to farmers and achieve stability in production and would help to save the lot of foreign exchange revenue being spent on import of edible oil.

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## Relative Toxicity of Insecticides to Ladybird Beetle, *Cheilomenes sexmaculata* (Fabricius)

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### Abstract

An investigation was carried out to evaluate the relative toxicity of different stages of ladybird beetle, *Cheilomenes sexmaculata* (Fabricius) at Department of Agricultural Entomology, B.A. College of Agriculture, Anand Agricultural University, Anand (Gujarat) during the year 2019-20. A total of nine insecticides, viz.; acetamiprid (0.006%), buprofezin (0.05%), fipronil (0.01%), flonicamid (0.015%), imidacloprid (0.089%), spinosad (0.0135%), spiromesifen (0.0229%), thiacloprid (0.013%) and thiamethoxam (0.01%) were evaluated. The analysis of relative toxicity of insecticides against eggs, grubs and adults of *C. sexmaculata* showed that acetamiprid, thiacloprid and spinosad showed more than 50 % mortality. Imidacloprid, spiromesifen and fipronil were relatively less toxic to the predator than spinosad. While flonicamid, buprofezin and thiamethoxam proved safer insecticides to the adults of *C. sexmaculata*.

### Introduction

Biological control is the most economical, eco-friendly and effective approach involving the utilization of natural enemies such as predators, parasitoids and pathogens. It has long been recognized as core component of IPM and has assumed significance. DeBach (1964) defined biological control as “the action of parasitoids, predators and pathogens in maintaining other organism density at a lower average than would occur in their absence.” Suppression of pest population through predation is known to mankind since ancient times. The predators are important natural enemies of crop pests, which directly attack and kill the other species (prey or host). It is the corner stone of IPM, along with host-plant resistance is central to the pest management paradigm (Ananthakrishnan, 1996). The first spectacular achievement in the field of biological control was the use of *Rodolia cardinalis* Muls. for controlling cottony cushion scale, *Icerya purchasi* Mask. in citrus orchards (Doutt, 1964). *Cheilomenes sexmaculata* is a predominant species in middle Gujarat (Patel *et. al.*, 1976) which plays a very important role in checking aphid population in groundnut. According to them, because of the activities of the natural predators, the peak incidence of aphid virtually disappeared after a week. Due to this, there is no need of application of insecticide in summer groundnut to control the aphid infestation, if ladybird beetles are present in the crop (Butani and Bharodia, 1984). The indiscriminate use of pesticides causes phytotoxicity and death of beneficial organisms such as parasites, parasitoids, micro-organisms and pollinators (Southwood and Henderson, 2000). There is an urgent need to develop suitable and safer insecticides against *C. sexmaculata*. Thus to understand the safety of some insecticides this research was carried out.

### Research Methodology

A laboratory study was conducted at Department of Agricultural Entomology, Anand Agricultural University, Anand, Gujarat, to determine the relative toxicity of some insecticides against grubs and adults of *C. sexmaculata*. Initial culture of predatory coccinellid was collected from different field crops and maintained on their host (aphids). The insecticides were evaluated for their ovicidal, larvicidal and adulticidal action. Susceptibility of eggs was evaluated by egg dipping method while, grubs and adults towards different insecticides was evaluated by topical application method. Mortality was recorded at 24, 48 and 72 hrs. after treatment. Three sets consisting of 10 eggs in each were taken for each insecticidal treatment. A set of two days old 10 eggs in each was delicately dipped for about one minute in the spray fluid of respective insecticide and then taken out, air dried and kept in individual plastic vials (4.5×3.5 cm). Eggs dipped in water were kept as control (check). Treated eggs were observed daily till all the eggs hatch out in control treatment (up to 5 days). A set of 10 second instar (4 days old) grubs of predatory coccinellid were kept in glass Petri dish (7.5 × 2.5 cm) and topically sprayed with respective insecticidal spray fluid by using hand atomizer with fine mist spray.

The treated grubs were then transferred individually into plastic vials, provided with nymphs of aphids as food and covered with lid. Each treatment was replicated thrice. Food was provided daily in the morning and per cent mortality was worked out by following Abbott's formula (Abbott, 1925).

$$P = \frac{P_1 - C}{100 - C} \times 100$$

Where, P = Corrected per cent mortality

P1 = Observed per cent mortality in treatment

C = Per cent mortality in control

The data recorded on various parameters were compiled and analyzed as per the ANOVA technique following appropriate transformation as suggested by Steel and Torrie (1980).

**Table-1 : Details of insecticides used to determine their relative toxicity to *C. sexmaculata*.**

| Technical name       | Conc. (%) | Dose (g or ml/lit.) |
|----------------------|-----------|---------------------|
| Acetamiprid 20 SP    | 0.006     | 0.3                 |
| Buprofezin 25 SC     | 0.05      | 2.0                 |
| Fipronil 5 SC        | 0.01      | 2.0                 |
| Flonicamid 50 WG     | 0.015     | 0.3                 |
| Imidacloprid 17.8 SL | 0.0089    | 0.5                 |
| Spinosad 45 SC       | 0.0135    | 0.3                 |
| Spiromesifen 22.9 SC | 0.0229    | 1.0                 |
| Thiacloprid 21.7 SL  | 0.013     | 0.6                 |
| Thiamethoxam 25 WG   | 0.01      | 0.4                 |
| Water (control)      | -         | -                   |

## Results and Discussion

**(i) Ovicidal action :** The data on corrected per cent mortality presented in Table-2 and depicted in figure 4.3 indicated that there was a significant difference among the insecticides. The toxicity of flonicamid, buprofezin and thiamethoxam showed significantly less toxic to other treatments. On the other hand eggs treated with flonicamid (10.36%) exhibited significantly relatively lower mortality over rest of the insecticides. The chronological order of toxicity of various insecticides based on egg mortality was acetamiprid (60.37%) > thiacloprid (53.52%) > spinosad (37.75%) > imidacloprid (31.77%) > spiromesifen (31.10%) > fipronil (22.37%) > thiamethoxam (20.73%) > buprofezin (18.86%) > flonicamid (10.36%). The highest (60.37%) mortality was found in acetamiprid followed by thiacloprid (53.52%). These findings closely matched with the findings of Basappa (2007), who concluded that among six insecticides tested, carbosulfan found to be highly toxic to *C. sexmaculata* followed by acetamiprid. Similar results were also obtained by Awasthi *et al.* (2013). However, in contrast to this, Chakraborty (2012) and Tank (2006) who reported that the acetamiprid was relatively safer to the eggs of *C. sexmaculata*. Such discrepancy in toxicity to eggs may be accounted for variations in concentration of insecticides or method of evaluation used while bioassay.

**Table-2 : Toxicity of various insecticidal treatments to eggs of *C. sexmaculata***

| Sr. No.              | Treatments                     | Corrected mortality (%)         |
|----------------------|--------------------------------|---------------------------------|
| 1.                   | Acetamiprid 20 SP (0.006%)     | 50.99 <sup>a</sup><br>(60.37)** |
| 2.                   | Buprofezin 25 SC (0.05%)       | 25.74 <sup>e</sup><br>(18.86)   |
| 3.                   | Fipronil 5 SC (0.01%)          | 28.23 <sup>e</sup><br>(22.37)   |
| 4.                   | Flonicamid 50 WG (0.015%)      | 18.78 <sup>f</sup><br>(10.36)   |
| 5.                   | Imidacloprid 17.8 SL (0.0089%) | 34.31 <sup>cd</sup><br>(31.77)  |
| 6.                   | Spinosad 45 SC (0.0135%)       | 37.91 <sup>c</sup><br>(37.75)   |
| 7.                   | Spiromesifen 22.9 SC (0.0229%) | 33.90 <sup>d</sup><br>(31.10)   |
| 8.                   | Thiacloprid 21.7 SL (0.013%)   | 47.02 <sup>b</sup><br>(53.52)   |
| 9.                   | Thiamethoxam 25 WG (0.01%)     | 27.09 <sup>e</sup><br>(20.73)   |
| S. Em. ±             |                                | 0.79                            |
| F test for treatment |                                | Sig.                            |
| C.V. (%)             |                                | 4.08                            |

**Notes :** (1) \*Treatment means with common letter(s) are/is not significant at 5% level of significance by DNMRT.

(2) \*\*Figures in the parentheses are re-transformed values and those outside are arc-sin transformed values.

**(ii) Larvicidal action :** Observations of grub mortality (Table-3) recorded at 24 hrs. after treatment revealed that significantly least (0.02%) mortality of *C. sexmaculata* grubs was registered in flonicamid than rest of insecticidal treatments. Highest mortality of grubs was found in acetamiprid (51.86%). Thiacloprid ranked second in position by exhibiting 41.47% mortality followed by spinosad which showed 34.39% mortality. Spinosad was also found at par with imidacloprid with 31.10 % mortality. With respect to grub mortality, spiromesifen (29.25%) and imidacloprid (31.30%) found to be at par and proved moderately toxic as compared to others. Next to spiromesifen stood fipronil showed 20.73 % mortality which was significantly different as compared to other treatments. Buprofezin and thiamethoxam (10.36%) registered significantly lesser toxic to the grubs in comparison to other insecticides.

Mortality data (Table-3) recorded at 48 hrs. after treatment indicated that acetamiprid exhibited maximum (65.56%) mortality followed by thiacloprid (60.37%). Among the insecticides evaluated significantly lower mortality of *C. sexmaculata* grubs were recorded in the treatment of flonicamid (10.02%) and buprofezin (10.36%). Both these treatments were significantly at par with each other. Thiacloprid found to be at par with spinosad (55.19%), while significantly different from acetamiprid. The result of spinosad was non-significantly

Table-3 : Toxicity of various insecticidal treatments on grubs of *C. sexmaculata* through topical application method.

| Sr. No.              | Treatments                     | Corrected mortality (%) at indicated intervals (hrs.) |                                |                               |
|----------------------|--------------------------------|-------------------------------------------------------|--------------------------------|-------------------------------|
|                      |                                | 24                                                    | 48                             | 72                            |
| 1.                   | Acetamiprid 20 SP (0.006%)     | 46.06 <sup>a</sup><br>(51.86) <sup>**</sup>           | 54.07 <sup>a</sup><br>(65.56)  | 84.85 <sup>a</sup><br>(99.19) |
| 2.                   | Buprofezin 25 SC (0.05%)       | 18.77 <sup>f</sup><br>(10.36)                         | 18.78 <sup>f</sup><br>(10.36)  | 19.12 <sup>g</sup><br>(10.73) |
| 3.                   | Fipronil 5 SC (0.01%)          | 27.09 <sup>e</sup><br>(20.73)                         | 34.91 <sup>d</sup><br>(32.76)  | 40.95 <sup>e</sup><br>(42.95) |
| 4.                   | Flonicamid 50 WG (0.015%)      | 0.91 <sup>g</sup><br>(0.02)                           | 18.45 <sup>f</sup><br>(10.02)  | 18.45 <sup>g</sup><br>(10.02) |
| 5.                   | Imidacloprid 17.8 SL (0.0089%) | 33.89 <sup>cd</sup><br>(31.10)                        | 45.64 <sup>bc</sup><br>(51.11) | 54.40 <sup>c</sup><br>(66.12) |
| 6.                   | Spinosad 45 SC (0.0135%)       | 35.90 <sup>c</sup><br>(34.39)                         | 47.98 <sup>b</sup><br>(55.19)  | 59.94 <sup>b</sup><br>(74.90) |
| 7.                   | Spiromesifen 22.9 SC (0.0229%) | 32.74 <sup>d</sup><br>(29.25)                         | 42.02 <sup>c</sup><br>(44.81)  | 46.06 <sup>d</sup><br>(51.86) |
| 8.                   | Thiacloprid 21.7 SL (0.013%)   | 40.09 <sup>b</sup><br>(41.47)                         | 50.99 <sup>ab</sup><br>(60.37) | 61.25 <sup>b</sup><br>(76.86) |
| 9.                   | Thiamethoxam 25 WG (0.01%)     | 18.77 <sup>f</sup><br>(10.36)                         | 27.09 <sup>e</sup><br>(20.74)  | 27.61 <sup>f</sup><br>(21.48) |
| S. Em. ±             |                                | 0.83                                                  | 0.69                           | 1.73                          |
| F test for treatment |                                | Sig.                                                  | Sig.                           | Sig.                          |
| C.V. (%)             |                                | 5.08                                                  | 3.20                           | 6.57                          |

Notes : (1) \*Treatment means with common letter(s) are/is not significant at 5% level of significance by DNMR.T.

(2) \*\*Figures in the parentheses are re-transformed values and those outside are arc-sin transformed values.

Table-4 : Effect of insecticidal treatments on adults of *C. sexmaculata* through topical application method.

| Sr. No.              | Treatments                     | Corrected mortality (%) at indicated intervals (hrs.) |                                |                               |
|----------------------|--------------------------------|-------------------------------------------------------|--------------------------------|-------------------------------|
|                      |                                | 24                                                    | 48                             | 72                            |
| 1.                   | Acetamiprid 20 SP (0.006%)     | 48.94 <sup>a</sup><br>(56.86) <sup>**</sup>           | 53.87 <sup>a</sup><br>(65.23)  | 55.16 <sup>a</sup><br>(67.37) |
| 2.                   | Buprofezin 25 SC (0.05%)       | 18.78 <sup>f</sup><br>(10.36)                         | 19.13 <sup>f</sup><br>(10.73)  | 19.88 <sup>g</sup><br>(11.56) |
| 3.                   | Fipronil 5 SC (0.01%)          | 29.38 <sup>de</sup><br>(24.06)                        | 34.58 <sup>d</sup><br>(32.20)  | 36.10 <sup>e</sup><br>(34.70) |
| 4.                   | Flonicamid 50 WG (0.015%)      | 0.91 <sup>g</sup><br>(0.02)                           | 0.91 <sup>g</sup><br>(0.02)    | 18.44 <sup>g</sup><br>(10.00) |
| 5.                   | Imidacloprid 17.8 SL (0.0089%) | 35.00 <sup>c</sup><br>(32.90)                         | 38.80 <sup>bc</sup><br>(39.25) | 42.74 <sup>c</sup><br>(46.06) |
| 6.                   | Spinosad 45 SC (0.0135%)       | 40.09 <sup>b</sup><br>(41.47)                         | 40.34 <sup>d</sup><br>(41.90)  | 42.53 <sup>c</sup><br>(45.69) |
| 7.                   | Spiromesifen 22.9 SC (0.0229%) | 31.52 <sup>cd</sup><br>(27.32)                        | 36.59 <sup>cd</sup><br>(35.52) | 39.38 <sup>d</sup><br>(40.26) |
| 8.                   | Thiacloprid 21.7 SL (0.013%)   | 46.06 <sup>a</sup><br>(51.85)                         | 50.77 <sup>a</sup><br>(60.00)  | 51.04 <sup>b</sup><br>(60.47) |
| 9.                   | Thiamethoxam 25 WG (0.01%)     | 27.09 <sup>e</sup><br>(20.73)                         | 27.61 <sup>e</sup><br>(21.47)  | 28.31 <sup>f</sup><br>(22.48) |
| S. Em. ±             |                                | 1.03                                                  | 0.96                           | 0.86                          |
| F test for treatment |                                | Sig.                                                  | Sig.                           | Sig.                          |
| C.V. (%)             |                                | 5.78                                                  | 4.96                           | 4.08                          |

Notes : (1) \*Treatment means with common letter(s) are/is not significant at 5% level of significance by DNMR.T.

(2) \*\*Figures in the parentheses are re-transformed values and those outside are arc-sin transformed values.

different from imidacloprid (51.11%). Also spiromesifen (44.81%) was at par with imidacloprid, but was significantly different from spinosad.

The superiority of flonicamid (10.02%) and buprofezin (10.73%) to *C. sexmaculata* grubs for their safety was also noticed even at 72 hrs. after treatment.

Both these treatments were at par with each other. Among the insecticides evaluated, acetamiprid showed significantly higher (99.19%) mortality. Acetamiprid was followed by thiacloprid, spinosad, imidacloprid, spiromesifen, and fipronil with 76.86, 74.90, 66.12, 51.86 and 42.95 %, respectively.

From the above results on toxicity of various insecticides evaluated in laboratory through topical application method it can be concluded that flonicamid (0.015%) and buprofezin (0.05%) considered to be relatively less toxic whereas, acetamiprid (0.006%), thiacloprid (0.013%) and spinosad (0.0135%) proved to be most toxic to grubs of *C. sexmaculata*. Imidacloprid (0.0089%), spiromesifen (0.0229%) and fipronil (0.01%) found moderately toxic to the grubs. Sheela and Shinde (2019) observed the least mortality of *C. sexmaculata* grubs at different interval of flonicamid after 12, 24, 48 and 72 hrs. Similarly, Jalali *et al.* (2009) also revealed that less mortality was found in flonicamid. According to the Sanghani *et al.* (2018) the buprofezin caused the lowest mortality at 24, 48 and 72 hrs. after treatment, of all stages tested, hence it can be considered as safer insecticide. Toxic effect of spinosad was noticed in present study. In contrast, Raguraman and Uthamasamy (2005) reported this insecticide to be safer for natural enemies. The difference in the results may be due to the difference in concentrations. Basappa (2007) and Awasthi *et al.* (2013) observed the toxic effect of acetamiprid which are similar to the results obtained. Similar results also found by Pirasanna *et al.* (2012).

Further, results revealed that acetamiprid found to be most toxic to ladybird beetles. But, in contrast Tank (2006), observed that acetamiprid and endosulfan proved safer insecticides. In contrast, Chakraborty (2012) reported that buprofezin, clothianidin and emamectin benzoate proved moderately toxic to adults of *C. sexmaculata* wherein they registered 67.61 to 71.56 % mortality. This might be due to the comparisons with more toxic insecticides and different concentrations.

Mortality data (Table-4) recorded at 24 hrs. after treatment indicated that minimum (0.02%) hazard was found in flonicamid followed by buprofezin (10.36%) and thiamethoxam (20.73%). These two treatments registered significantly lower mortality of *C. sexmaculata* over other insecticides evaluated. Imidacloprid, spiromesifen and fipronil proved moderately toxic to the adults of *C. sexmaculata*, as compared to others, by registering 32.90, 27.32 and 24.06 % mortality, respectively within 24 hrs. of exposure. More or less similar trend of mortality in different treatments was noticed even after 48 hrs. of exposure period with slight increase in mortality level. The treatment of acetamiprid (65.23%) and thiacloprid (60.00%) showed increase in the level of mortality after 48 hrs. of treatment. A significant increase in mortality was recorded in imidacloprid (39.25%), spiromesifen (35.52%) and fipronil (32.20%) indicating its most toxic nature to the adults of *C. sexmaculata*. The treatments of flonicamid (0.02%), buprofezin (10.73%) and thiamethoxam (21.47%) registered significantly low mortality of the predator. After 72 hrs. of exposure, flonicamid (10.00%)

and buprofezin (11.56%) proved less toxic to the adults. The next among the less toxic, following flonicamid and buprofezin was thiamethoxam with 22.48 % mortality. The treatments of acetamiprid and thiacloprid proved to be the higher level of mortality (67.37% and 60.47%), but differed significantly.

From aforesaid results, it revealed that amongst the different insecticides evaluated, acetamiprid proved most toxic chemical to the adults of *C. sexmaculata*. This is in accordance with the report of Basappa (2007), Pirasanna *et al.* (2012) and Awasthi *et al.* (2013). In contrast to the present findings, Tank (2006) and Sheela and Shinde (2019) found acetamiprid as safer insecticide. Similarly, flonicamid and buprofezin found to have almost negligible effect to the predatory beetles. Similar results were found by Sheela and Shinde (2019), Sanghani *et al.* (2018), Pirasanna *et al.* (2012) and Jalali *et al.* (2009). However, in contrast to above, Chakraborty (2012) found that buprofezin was moderately toxic to *C. sexmaculata*.

## Conclusion

The results that were observed in the results of bioefficacy of insecticides against adults showing acetamiprid, thiacloprid and spinosad had more than 50 % mortality. Imidacloprid, spiromesifen and fipronil found relatively less toxic to the adults than above mentioned insecticides. While flonicamid, buprofezin and thiamethoxam proved safer insecticides to the adults of *C. sexmaculata*. On the basis of toxic potential of insecticides to *C. sexmaculata*, the insecticides evaluated can be arranged in descending order as: acetamiprid > thiacloprid > spinosad > imidacloprid > spiromesifen > fipronil > thiamethoxam > buprofezin > flonicamid.

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## Effect of Bt Cotton on Seasonal Incidence of Target and Non-Target Pests Under Irrigated Condition in Maharashtra

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### Abstract

Performance of Bt cotton hybrid (BG II) along with non Bt cultivar was evaluated against pest complex under irrigated condition at Cotton Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra (India) during *kharif* 2018. The results revealed that there were no difference between the transgenic and non-transgenic hybrid in their relative susceptibility to cotton jassids, *Amrasca biguttula biguttula*, thrips, *Thrips tabaci*, aphids *Aphis gossypii* and white fly, *Bemesia tabaci*. Thus, the transgenic hybrid does not afford any protection to sucking pests of cotton and their tolerance or resistance is mainly dependent on the morphological or genetic base. Bollworm incidence due to *Helicoverpa armigera* and *Earias vittella* was not observed in transgenic cotton hybrid. While pink bollworm (*Pectinophora gossypiella*) infestation was recorded in fruiting bodies and green bolls. Non-transgenic hybrid recorded higher damage (1.61 to 87.52%) which was differed from transgenic hybrid (15.00 to 85.00 %). Besides this, significant difference in seed cotton yield was also observed during the cropping season. Seed cotton yield of transgenic hybrid (19.50 q/ha) was significantly greater than that of the non-transgenic hybrid (14.20 q/ha) under protected condition. The results suggested that transgenic hybrid cannot control sucking pests of cotton and there was no difference in sucking pests incidence in transgenic hybrid and non-transgenic hybrid. The major bollworms *Helicoverpa armigera* and *Earias vittella* were effectively controlled in transgenic hybrid except *Pectinophora gossypiella* as it developed resistance against Cry1Ac and Cry2Ab. Thus, transgenic hybrid can play a major role in combating *H. armigera* and *E. vittella* pest thereby reducing insecticide usage in cotton ecosystem which helps to maintain eco balance by conserving natural enemies.

**Key words :** Bt Cotton, seasonal incidence sucking pests, bollworms, natural enemies.

### Introduction

Cotton is an important commercial crop in India playing a major role in agricultural economy. Before introduction of transgenic Bt cotton, farmers of India witnessed instability in cotton production due to frequent crop failures because of outbreaks of insect pests. Among the pests problems, bollworms especially American Bollworm, *H. armigera* and Pink bollworm *P. gossypiella* cause considerable damage to the cotton crop. *Helicoverpa* alone cause significant losses to the tune of Rs.1000 crores in the country annually warranting insecticides applications which many a times exceeds 20 sprays especially in epidemic years (Prasad *et al.*, 2009). The excessive and indiscriminate use of insecticides in cotton ecosystem has led to development of resistance to insecticides in *Helicoverpa*, resurgence of minor pests and elimination of natural enemies leading to control failures with insecticides. In order to reduce the dependence on chemical insecticides and resultant effect on non target organisms, tools of biotechnology have been applied to develop cotton that can withstand certain problematic and insecticide resistant pests more efficiently.

Transgenic Bt cotton technology for plant protection enables transgenic cotton plant to express a crystal (Cry)

toxin called Cry 1Ac+Cry 2Ab, originally derived from the soil bacterium *B.thuringiensis* which is a natural enemy of bollworm pest and the endotoxins produced by bacteria have proved effective against lepidopteran insects (Kennedy, 2008). When the target pest oviposit on the transgenic plant, the larvae hatching from such eggs feed and ingest Cry protein along with plant tissue. The protein acts immediately on the inner linings of digestive system and the young larvae cease feeding and die within 2 to 3 days. As the pest is killed in its early stage, any potential damage to crop is prevented. Transgenic Bt cotton containing Cry 1Ac+Cry 2Ab gene which offers resistance to major bollworms was first commercially released in the world in 1996 (Choudhary and Gaur, 2010; Hui-Lin Yu *et al.*, 2011) and during 2002 in India. The introduction of Bt cotton in India, the infestation levels of PBW, was under control. In 2010, PBW resistance to Cry1Ac was confirmed in four districts of Gujarat (Dhurua and Gujar 2011) the genetically based decreases in susceptibility of field populations of PBW to Bt toxins Cry1Ac and Cry2Ab. In the present study, the second generation transgenic Bt cotton which was commercialized in India was studied for their reaction to different pests of cotton.

### Materials and Methods

The field trials were conducted during 2018-19 to evaluate

Table-1 : Population dynamics of key pests of DCH-32 cotton in relation to climatic conditions.

| Standard<br>MW | Sucking pests       |                      |                     |                       | LBB/<br>plant | Chrysopa/<br>plant | Spider/<br>plant | Predators<br>/ plant | Abiotic factors  |         |                       |         |                  |
|----------------|---------------------|----------------------|---------------------|-----------------------|---------------|--------------------|------------------|----------------------|------------------|---------|-----------------------|---------|------------------|
|                | Aphids/<br>3 leaves | Jassids/<br>3 leaves | Thrips/ 3<br>leaves | Whitefly/<br>3 leaves |               |                    |                  |                      | Temperature (°C) |         | Relative humidity (%) |         | Rainfall<br>(mm) |
|                |                     |                      |                     |                       |               |                    |                  |                      | Maximum          | Minimum | Morning               | Evening |                  |
| 28             | 5.22                | 1.80                 | 0.58                | 0.00                  | 0.24          | 0.00               | 0.12             | 0.36                 | 28.26            | 22.83   | 80.00                 | 69.71   | 14.60            |
| 29             | 9.54                | 2.18                 | 1.00                | 0.00                  | 0.21          | 0.00               | 0.23             | 0.44                 | 29.40            | 22.99   | 76.71                 | 64.71   | 4.40             |
| 30             | 13.32               | 2.70                 | 0.88                | 1.70                  | 0.94          | 0.10               | 0.16             | 1.20                 | 28.66            | 22.73   | 75.14                 | 62.29   | 0.00             |
| 31             | 34.48               | 7.48                 | 7.44                | 1.26                  | 4.92          | 1.20               | 1.32             | 7.44                 | 31.34            | 23.27   | 71.71                 | 53.29   | 0.00             |
| 32             | 49.52               | 9.16                 | 10.80               | 1.6                   | 5.10          | 1.10               | 1.00             | 7.20                 | 29.99            | 22.99   | 75.14                 | 62.57   | 0.00             |
| 33             | 17.64               | 6.25                 | 27.32               | 1.98                  | 1.42          | 1.02               | 1.12             | 3.56                 | 27.86            | 22.53   | 80.43                 | 72.86   | 58.00            |
| 34             | 16.24               | 9.34                 | 58.42               | 5.44                  | 2.10          | 0.52               | 1.08             | 3.70                 | 27.94            | 21.49   | 80.00                 | 70.57   | 24.02            |
| 35             | 18.14               | 7.20                 | 117.84              | 5.00                  | 1.54          | 0.48               | 0.96             | 2.98                 | 29.66            | 21.43   | 74.71                 | 61.14   | 6.40             |
| 36             | 16.00               | 4.38                 | 127.28              | 3.98                  | 1.48          | 0.38               | 0.88             | 2.74                 | 30.09            | 19.64   | 70.51                 | 53.14   | 0.00             |
| 37             | 10.08               | 12.70                | 86.28               | 8.94                  | 2.52          | 0.42               | 1.24             | 4.18                 | 32.60            | 19.61   | 69.14                 | 50.14   | 0.00             |
| 38             | 12.50               | 13.18                | 24.90               | 8.52                  | 1.24          | 0.60               | 0.96             | 2.80                 | 31.94            | 22.23   | 61.14                 | 45.14   | 3.8              |
| 39             | 13.12               | 10.32                | 18.80               | 9.58                  | 1.88          | 0.70               | 1.26             | 3.84                 | 33.69            | 22.33   | 71.43                 | 44.43   | 0.00             |
| 40             | 10.66               | 14.88                | 7.68                | 6.76                  | 1.26          | 1.14               | 1.16             | 3.56                 | 34.03            | 21.54   | 67.29                 | 42.86   | 0.00             |
| 41             | 8.24                | 12.74                | 4.98                | 4.22                  | 1.16          | 0.74               | 0.94             | 2.84                 | 34.03            | 18.37   | 54.71                 | 29.86   | 0.00             |
| 42             | 8.40                | 16.62                | 6.34                | 7.62                  | 0.48          | 0.74               | 0.82             | 2.04                 | 33.49            | 18.57   | 50.00                 | 30.14   | 0.00             |
| 43             | 19.94               | 11.68                | 6.48                | 8.06                  | 1.58          | 0.86               | 1.22             | 3.66                 | 34.00            | 16.86   | 46.00                 | 30.14   | 0.00             |
| 44             | 15.54               | 12.74                | 2.88                | 8.52                  | 1.06          | 0.86               | 1.04             | 2.96                 | 31.74            | 14.51   | 58.14                 | 38.71   | 0.29             |
| 45             | 92.04               | 7.12                 | 1.42                | 6.22                  | 1.50          | 0.60               | 0.94             | 3.04                 | 33.11            | 16.87   | 58.71                 | 37.29   | 0.00             |
| 46             | 95.16               | 9.74                 | 1.96                | 6.90                  | 1.40          | 0.60               | 0.82             | 2.82                 | 30.29            | 13.74   | 43.43                 | 23.29   | 0.00             |
| 47             | 121.40              | 7.70                 | 1.42                | 6.92                  | 1.74          | 0.40               | 0.92             | 3.06                 | 23.66            | 21.20   | 61.14                 | 46.43   | 0.00             |
| 48             | 138.20              | 5.17                 | 1.54                | 10.50                 | 2.68          | 0.78               | 1.10             | 4.56                 |                  |         |                       |         |                  |

Bt hybrid RCH 2Bt along with non Bt hybrid of *G.barbadense* DCH-32 at Cotton Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri, Maharashtra. India under unprotected irrigated conditions for pest incidence and under protected irrigated condition for yield record. The plot size of each hybrid was 2000 sq.m which were sown at a spacing of 90 x 90 cm row to row and plant to plant distance, respectively. The *Bt* cotton genotype RCH 2Bt and non-Bt cotton genotype DCH-32 were sown in the third week of June and all the agronomic practices such as fertilizer application and intercultural operations were similar in these two cotton hybrids. These test hybrids were raised under unprotected condition. Weekly observations on incidence of sucking pests and bollworms were recorded at 10 randomly selected spots on 5 plants along with weather parameters. The sucking pests such as aphids, jassids, thrips and whiteflies were recorded from three leaves, each one from top, middle and bottom canopies of the plant. The american bollworm and spotted bollworm larvae along with per cent square damage and green boll damage were recorded from whole plant. The incidence of pink bollworm larvae was observed through destructive sampling of 20 randomly collected green bolls from each treatment and per cent damage in green bolls were recorded. Thus, the data obtained was subjected to statistical analysis after applying suitable transformations.

## Results and Discussion

**Effect of transgenic cotton on sucking pests incidence and natural enemies :** Transgenic Bt cotton RCH-2Bt along with non Bt cotton DCH-32 were evaluated against pest complex of cotton under unprotected conditions and the results are presented in Table 1 to 4. The population of jassid on cotton ranged between 1.80 to 18.58/ 3 leaves during the season. The first incidence of jassids was noticed during 28 MW. The higher infestation level of 12.70 to 12.74 leaf hoppers/3 leaves was observed from 37 to 44 MWs. The population of jassids crossed the ETL during this period and peaked at 36 MW. The infestation aphids on cotton ranged between 5.22 to 138.20/ 3 leaves during the season. The first incidence of aphids was noticed during 28 MW. The higher infestation level of 92.04 to 121.40 aphids/3 leaves were observed from 45 to 48 MWs. The population of

Table-2 : Population dynamics of key pests of RCH 2 Bt cotton in relation to climatic conditions.

| Standard<br>MW | Sucking pests       |                      |                     |                       | LBB/<br>plant | Chrysopa/<br>plant | Spider/<br>plant | Predators<br>/ plant | PBW<br>larve /<br>20 green<br>bolls | Fruiting<br>body<br>damage<br>% | Abiotic factors  |         |                       |         | Rainfall<br>(mm) |
|----------------|---------------------|----------------------|---------------------|-----------------------|---------------|--------------------|------------------|----------------------|-------------------------------------|---------------------------------|------------------|---------|-----------------------|---------|------------------|
|                | Aphids/<br>3 leaves | Jassids/<br>3 leaves | Thrips/<br>3 leaves | Whitefly/<br>3 leaves |               |                    |                  |                      |                                     |                                 | Temperature (°C) |         | Relative humidity (%) |         |                  |
|                |                     |                      |                     |                       |               |                    |                  |                      |                                     |                                 | Maximum          | Minimum | Morning               | Evening |                  |
|                |                     |                      |                     |                       |               |                    |                  |                      |                                     |                                 |                  |         |                       |         |                  |
| 28             | 6.05                | 1.38                 | 0.00                | 0.00                  | 0.42          | 0.00               | 0.25             | 0.67                 | —                                   | —                               | 28.26            | 22.83   | 80.00                 | 69.71   | 14.60            |
| 29             | 11.32               | 2.85                 | 0.00                | 0.00                  | 0.68          | 0.00               | 0.42             | 1.10                 | —                                   | —                               | 29.40            | 22.99   | 76.71                 | 64.71   | 4.40             |
| 30             | 18.96               | 4.32                 | 2.06                | 0.92                  | 1.00          | 0.62               | 0.56             | 2.18                 | —                                   | —                               | 28.66            | 22.73   | 75.14                 | 62.29   | 0.00             |
| 31             | 37.38               | 5.60                 | 6.04                | 01.64                 | 6.96          | 0.94               | 1.12             | 9.02                 | —                                   | —                               | 31.34            | 23.27   | 71.71                 | 53.29   | 0.00             |
| 32             | 46.32               | 9.88                 | 9.78                | 1.78                  | 4.36          | 1.02               | 1.12             | 6.50                 | —                                   | —                               | 29.99            | 22.99   | 75.14                 | 62.57   | 0.00             |
| 33             | 19.92               | 8.74                 | 29.06               | 2.56                  | 1.58          | 0.88               | 0.96             | 3.42                 | —                                   | —                               | 27.86            | 22.53   | 80.43                 | 72.86   | 58.00            |
| 34             | 15.22               | 9.34                 | 55.84               | 4.16                  | 1.40          | 0.24               | 0.88             | 2.52                 | —                                   | —                               | 27.94            | 21.49   | 80.00                 | 70.57   | 24.02            |
| 35             | 18.32               | 6.42                 | 118.20              | 4.38                  | 1.22          | 0.28               | 0.74             | 2.24                 | —                                   | —                               | 29.66            | 21.43   | 74.71                 | 61.14   | 6.40             |
| 36             | 16.58               | 3.84                 | 126.96              | 3.40                  | 1.28          | 0.48               | 0.92             | 2.68                 | —                                   | —                               | 30.09            | 19.64   | 70.51                 | 53.14   | 0.00             |
| 37             | 7.96                | 3.80                 | 87.48               | 8.10                  | 0.92          | 0.52               | 0.64             | 2.08                 | —                                   | —                               | 32.60            | 19.61   | 69.14                 | 50.14   | 0.00             |
| 38             | 13.06               | 11.18                | 25.82               | 7.90                  | 2.70          | 1.30               | 1.20             | 5.20                 | —                                   | —                               | 31.94            | 22.23   | 61.14                 | 45.14   | 3.8              |
| 39             | 10.04               | 10.42                | 17.32               | 9.78                  | 1.98          | 0.72               | 0.98             | 3.68                 | —                                   | —                               | 33.69            | 22.33   | 71.43                 | 44.43   | 0.00             |
| 40             | 13.26               | 13.82                | 10.62               | 5.50                  | 1.32          | 0.98               | 1.04             | 3.34                 | 3.80                                | 15.00                           | 34.03            | 21.54   | 67.29                 | 42.86   | 0.00             |
| 41             | 8.58                | 18.58                | 9.32                | 5.16                  | 1.60          | 0.68               | 0.84             | 3.12                 | 9.50                                | 17.00                           | 34.03            | 18.37   | 54.71                 | 29.86   | 0.00             |
| 42             | 8.14                | 15.16                | 5.46                | 8.42                  | 1.16          | 0.80               | 0.76             | 2.72                 | 11.60                               | 48.00                           | 33.49            | 18.57   | 50.00                 | 30.14   | 0.00             |
| 43             | 12.96               | 12.02                | 7.12                | 8.96                  | 1.41          | 0.58               | 0.56             | 2.55                 | 16.20                               | 53.00                           | 34.00            | 16.86   | 46.00                 | 30.14   | 0.00             |
| 44             | 18.80               | 11.32                | 4.86                | 9.64                  | 1.10          | 0.74               | 0.80             | 2.64                 | 19.40                               | 60.00                           | 31.74            | 14.51   | 58.14                 | 38.71   | 0.29             |
| 45             | 58.40               | 6.18                 | 3.56                | 7.56                  | 1.52          | 0.72               | 0.78             | 3.02                 | 23.80                               | 68.00                           | 33.11            | 16.87   | 58.71                 | 37.29   | 0.00             |
| 46             | 99.78               | 8.42                 | 2.94                | 8.24                  | 1.78          | 0.56               | 0.84             | 3.18                 | 25.10                               | 71.00                           | 30.29            | 13.74   | 43.43                 | 23.29   | 0.00             |
| 47             | 135.62              | 7.60                 | 2.46                | 8.66                  | 1.42          | 0.48               | 0.78             | 2.68                 | 27.30                               | 77.00                           | 23.66            | 21.20   | 61.14                 | 46.43   | 0.00             |
| 48             | 141.20              | 4.94                 | 1.80                | 11.28                 | 2.84          | 0.56               |                  | 3.40                 | 29.70                               | 85.00                           | —                | —       |                       | —       | —                |

aphids crossed the ETL during this period and peaked at 48 MW. The incidence of thrips on cotton ranged between 0.58 to 127.58/ 3 leaves during the season. The first incidence was observed during 28 MW. The high population level of 27.32 to 127.28 thrips/3 leaves was noticed during 33 to 38 MW. The population was peaked at 36 MW. The infestation whitefly on cotton ranged between 1.60 to 10.50/ 3 leaves during the season. The first incidence was noticed during 30 MW. The higher incidence of 7.62 to 10.50 whiteflies/3 leaves was observed during 42 to 48 MW during, which population peaked at 48 MW.

The population of natural enemies viz., Coccinellids, Chrysopids, Apanteles, Anagrus, Cryptolaemus, syrphids and spiders varied from 0.36 to 7.44 predators/ plant.

In the similar type of study Muhammad and Suhail (2010) compared the seasonal dynamics of sucking pests on transgenic Bt cotton and non transgenic cotton. There was no significant difference in population density of sucking in Bt and non Bt cotton. However, insecticide application effectively controlled these pests in both Bt and non Bt cotton and concluded there is no difference in transgenic Bt and non Bt cotton for sucking pests attack. Aggrawal, N. and Dhawan, A.K., (2009) reported that transgenic Bt cotton does not afford any protection to sucking pests of cotton and their relative tolerance or resistance is mainly dependent on the morphological or genetic base which is in accordance with Bhute et al. (2012) Studied on population dynamics of major pests of Bt cotton which clearly indicate that aphids, jassids, thrips and whiteflies are the predominant sucking pests of Bt cotton as their incidence recorded throughout the season. The predators were present throughout the cropping period when there was incidence of sucking pests.

**Effect of transgenic cotton on bollworms density and fruiting body damage :** The infestation of *E. vittella*, *H. armigera*, *P. gossypiella* and *S. litura* was

Table-3 : Population dynamics of key pests of cotton in relation to climatic conditions.

| Standard<br>MW | <i>H. armigera</i> |                    | Earias<br>spp.<br>larvae/<br>5plants | PBW<br>larvae/<br>20 green<br>bolls | <i>S. litura</i><br>larvae/5<br>plants | Fruiting<br>body<br>damage<br>% | Trap catches/week      |     |     |                  |
|----------------|--------------------|--------------------|--------------------------------------|-------------------------------------|----------------------------------------|---------------------------------|------------------------|-----|-----|------------------|
|                | Egg/5<br>plants    | Larvae/5<br>plants |                                      |                                     |                                        |                                 | <i>H.<br/>armigera</i> | PBW | SBW | <i>S. litura</i> |
| 28             | -                  | -                  | -                                    | -                                   | -                                      | -                               | 0                      | 0   | 8   | 0                |
| 29             | 0                  | 0                  | 0.64                                 | -                                   | -                                      | 1.61                            | 2                      | 0   | 17  | 0                |
| 30             | 0.84               | 0                  | 0.98                                 | -                                   | -                                      | 2.29                            | 6                      | 0   | 13  | 0                |
| 31             | 0.62               | 0.72               | 1.07                                 | -                                   | -                                      | 4.37                            | 12                     | 0   | 9   | 0                |
| 32             | 0.99               | 0.53               | 1.15                                 | -                                   | -                                      | 7.66                            | 10                     | 0   | 3   | 0                |
| 33             | 1.17               | 0.92               | 2.43                                 | -                                   | -                                      | 11.84                           | 3                      | 0   | 2   | 0                |
| 34             | 0.96               | 1.12               | 2.85                                 | -                                   | -                                      | 11.56                           | 5                      | 0   | 8   | 52               |
| 35             | 0.87               | 1.06               | 3.14                                 | -                                   | -                                      | 11.57                           | 2                      | 0   | 2   | 48               |
| 36             | 0.74               | 0.92               | 2.17                                 | -                                   | -                                      | 7.57                            | 1                      | 0   | 6   | 20               |
| 37             | 0.56               | 0.82               | 1.92                                 | -                                   | -                                      | 6.01                            | 3                      | 5   | 5   | 62               |
| 38             | -                  | 0.42               | 1.65                                 | -                                   | -                                      | 3.99                            | 2                      | 3   | 5   | 55               |
| 39             | -                  | -                  | 1.15                                 | -                                   | -                                      | 2.49                            | 2                      | 9   | 3   | 23               |
| 40             | -                  | -                  | 0.87                                 | 4.30                                | -                                      | 7.63                            | 1                      | 12  | 7   | 42               |
| 41             | -                  | -                  | -                                    | 10.80                               | -                                      | 10.8                            | 0                      | 5   | 2   | 26               |
| 42             | -                  | -                  | -                                    | 13.60                               | -                                      | 25.62                           | 0                      | 7   | 1   | 42               |
| 43             | -                  | -                  | -                                    | 19.90                               | -                                      | 49.56                           | 0                      | 9   | 0   | 55               |
| 44             | -                  | -                  | -                                    | 22.60                               | -                                      | 54.76                           | 0                      | 13  | 0   | 61               |
| 45             | -                  | -                  | -                                    | 23.80                               | -                                      | 62.53                           | 0                      | 15  | 0   | 26               |
| 46             | -                  | -                  | -                                    | 28.40                               | -                                      | 79.24                           | 0                      | 21  | 0   | 14               |
| 47             | -                  | -                  | -                                    | 39.20                               | -                                      | 83.17                           | 0                      | 18  | 0   | 11               |
| 48             | -                  | -                  | -                                    | 34.70                               | -                                      | 87.52                           | 0                      | 13  | 0   | 6                |

observed during the season. The number of *Helicoverpa* eggs recorded on cotton crop varied from 0.84 to 1.17 eggs/5 plants during the season. The larval population varied from 0.42 to 1.12 larvae/5 plants. The higher incidence of 1.12 larvae/5 plants was noticed during 34 MW. The infestation on green fruiting bodies ranged from 1.61 to 87.52 per cent during the season.

The number of spotted bollworm larvae varied from 0.64 to 3.14 larvae/5 plants. But the higher larval incidence of 1.07 to 3.14 larvae/5 plants was noticed during 31 to 35 MW. The incidence on green fruiting bodies ranged between 1.15 and 9.19 per cent during the season.

The number of pink bollworm larvae observed in 20 infested green bolls varied from 4.30 to 39.20 larvae. The higher incidence of PBW larvae was observed during 40 to 48 MW during the season. The open boll and locule damage varied from 5.89 to 87.52 and 2.95 to 43.76 per cent, respectively, during the season.

The adults of *S. litura* were trapped in pheromone traps but incidence of larvae was not observed in cotton field throughout the season.

In RCH 2Bt, the incidence of american bollworm, *H.*

*armigera* and spotted bollworm *E.vitella* were completely absent, as no square damage and green boll damage was observed. However, open boll damage was recorded upto 15.00 to 85.00 % by pink bollworm *P. gossypiella* which was lower than the non-Bt cotton hybrid DCH-32 (1.61-87.52). Comparatively, the highest green boll damage, open boll damage and open boll damage was observed in DCH-32.

The results clearly indicate that transgenic Bt cotton is effective against the most problematic bollworms, *H.armigera* and spotted bollworm *E.vitella* in cotton which has developed many fold resistance to chemical insecticides. The results are in accordance with findings of Hugar *et al.*, (2006) who reported that fruiting damage to pink bollworm was 3.2% in RCH 2Bt as against 18.72% in NCH 145 non Bt cotton. Pink bollworm is not visible on the plant and completes most of the life cycle in the unopen boll itself and the damage in the form of stained and discoloured kapas is seen only after bursting of the boll. Since the damage is not visible before boll opening it is very difficult to time the application of insecticides for taking control measures. The transgenic Bt cotton with *Cry 1Ac+Cry 2Ab* toxin can able to control pink bollworm, as toxins are expressed in the plant parts itself and mostly

Table-4 : Population dynamics of key pests of cotton in relation to climatic conditions.

| Std. MW | <i>H. armigera</i> av. % infes. on GFB | <i>E. vittella</i> av. % infes. on GFB | <i>S.l itura</i> av. % infes. on GFB & leaves | <i>P. gossypiella</i> av. % infes. on |        | Temperature (°C) |         | Relative humidity (%) |         | Rainfall (mm) |
|---------|----------------------------------------|----------------------------------------|-----------------------------------------------|---------------------------------------|--------|------------------|---------|-----------------------|---------|---------------|
|         |                                        |                                        |                                               | GFB & open boll                       | Locule | Maximum          | Minimum | Morning               | Evening |               |
| 28      | -                                      | -                                      | -                                             | -                                     | -      | 28.26            | 22.83   | 80.00                 | 69.71   | 14.60         |
| 29      | 0                                      | 1.61                                   | -                                             | -                                     | -      | 29.40            | 22.99   | 76.71                 | 64.71   | 4.40          |
| 30      | 0                                      | 2.29                                   | -                                             | -                                     | -      | 28.66            | 22.73   | 75.14                 | 62.29   | 0.00          |
| 31      | 1.56                                   | 2.81                                   | -                                             | -                                     | -      | 31.34            | 23.27   | 71.71                 | 53.29   | 0.00          |
| 32      | 1.18                                   | 6.48                                   | -                                             | -                                     | -      | 29.99            | 22.99   | 75.14                 | 62.57   | 0.00          |
| 33      | 3.41                                   | 8.43                                   | -                                             | -                                     | -      | 27.86            | 22.53   | 80.43                 | 72.86   | 58.00         |
| 34      | 2.37                                   | 9.19                                   | -                                             | -                                     | -      | 27.94            | 21.49   | 80.00                 | 70.57   | 24.02         |
| 35      | 3.76                                   | 7.81                                   | -                                             | -                                     | -      | 29.66            | 21.43   | 74.71                 | 61.14   | 6.40          |
| 36      | 2.23                                   | 5.34                                   | -                                             | -                                     | -      | 30.09            | 19.64   | 70.51                 | 53.14   | 0.00          |
| 37      | 1.33                                   | 4.68                                   | -                                             | -                                     | -      | 32.60            | 19.61   | 69.14                 | 50.14   | 0.00          |
| 38      | 0.57                                   | 3.42                                   | -                                             | -                                     | -      | 31.94            | 22.23   | 61.14                 | 45.14   | 3.8           |
| 39      | -                                      | 2.49                                   | -                                             | -                                     | -      | 33.69            | 22.33   | 71.43                 | 44.43   | 0.00          |
| 40      | -                                      | 1.74                                   | -                                             | 5.89                                  | 2.95   | 34.03            | 21.54   | 67.29                 | 42.86   | 0.00          |
| 41      | -                                      | 1.15                                   | -                                             | 9.65                                  | 4.83   | 34.03            | 18.37   | 54.71                 | 29.86   | 0.00          |
| 42      | -                                      | -                                      | -                                             | 25.62                                 | 12.81  | 33.49            | 18.57   | 50.00                 | 30.14   | 0.00          |
| 43      | -                                      | -                                      | -                                             | 49.56                                 | 24.78  | 34.00            | 16.86   | 46.00                 | 30.14   | 0.00          |
| 44      | -                                      | -                                      | -                                             | 54.76                                 | 27.38  | 31.74            | 14.51   | 58.14                 | 38.71   | 0.29          |
| 45      | -                                      | -                                      | -                                             | 62.53                                 | 31.27  | 33.11            | 16.87   | 58.71                 | 37.29   | 0.00          |
| 46      | -                                      | -                                      | -                                             | 79.24                                 | 39.62  | 30.29            | 13.74   | 43.43                 | 23.29   | 0.00          |
| 47      | -                                      | -                                      | -                                             | 83.17                                 | 41.59  | 23.66            | 21.20   | 61.14                 | 46.43   | 0.00          |
| 48      |                                        |                                        |                                               | 87.52                                 | 43.76  |                  |         |                       |         |               |

prevents insecticide application and problems of decision making for control options (More, *et.al.* (2009), Desai, *et.al.* (2009). The resistance of Bt hybrids against pink bollworm was proved earlier by many scientists which are in accordance with the present results. The PBW survival was first reported in a small patch of Gujarat in 2010 after 8 years of introduction of Bt cotton in India (Dhurua and Gujar 2011). The PBW infestation to Bollgard continued in Gujarat, and many Bollgard fields in the adjoining states of Maharashtra and Madhya Pradesh showed high-level infestation by the pest (Mohan *et al.* 2016; Naik *et al.* 2017).

**Effect of transgenic cotton on yield :** Seed cotton yield from fully opened bolls was picked up manually, dried in the sun, weighed and expressed as kilogram per hectare. There were 2-3 pickings in each season, depending upon the length of the growing season. Seed cotton yield was recorded separately for the first, second and third pickings. The results revealed that under protected condition, the RCH-2Bt produced the highest seed cotton yield (19.50 q/ha); which was significantly greater than non-transgenic cotton hybrid DCH-32 (14.20 q/ha). Under

completely unprotected condition, the transgenic RCH-2Bt recorded 6.38 q/ha; while non-transgenic cotton DCH-32 produced only 3.25 q/ha seed cotton yield. Thus, there was significant difference in seed cotton yield of Bt and non-Bt cotton under protected and unprotected irrigated condition. The seed cotton yield of Bt cotton in all picking were significantly greater than non-Bt cotton under both unprotected and protected conditions.

## Conclusion

From the present findings, it can be concluded that Bt cotton cannot control sucking pests of cotton and there is no difference in sucking pests incidence in Bt and non Bt cotton hybrid. The major bollworms *H.armigera* and *E.vitella* are effectively controlled in Bt cotton hybrids. But *P. gossypiella* developed resistance against both Cry 1 Ac and Cry 2 Ab genes. The transgenic Bt cotton can play a major role in combating bollworms specially *H.armigera* and *E.vitella* pest problem, thereby reducing the insecticide usage on cotton ecosystem and helps to maintain eco balance by conserving natural enemies.

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## Potentiality of Biologicals against *Rhizoctonia Solani* Causing Sheath Blight in Rice

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### Abstract

Inhibitory effect of few cruciferous plant extracts were tested by poisoned food technique. At 1:1 dilution the highest inhibition of 51.1% was observed in cabbage and the least inhibition of 21.93% over control was observed in case of radish. At 1:100 and 1:1000 dilutions none of the plants extracts were effective against *Rhizoctonia solani*. At 1:1 dilution only cabbage was found effective. The inhibitory effect of bio fumigants plants were tested against *R. solani* by following sealed Petri plate technique. Mustard completely inhibited the growth of the pathogen whereas cauliflower showed least inhibition with 44.8 mm radial growth of the pathogen. A total of six bioagents were tested for the antagonistic effect against *R. solani* by dual culture technique. The highest inhibition was observed in native *Trichoderma viride* (38.88%) and the least inhibition was noticed in case of commercial *Pseudomonas fluorescens* and *Bacillus subtilis* which recorded 18.88% inhibition over control.

**Key words** : Plant extract, mustard, dual culture, bioagent, *Rhizoctonia solani*.

### Introduction

Rice (*Oryza sativa* L.) is second most important cereal and the staple food for more than half of the world's population. Rice is the most prominent crop of India as it is the staple food for most of the people of the country. In India rice crop is being cultivated in an area of 44.10 m ha, with production of 105.3 m tonnes and productivity of 2.38 tonnes ha<sup>-1</sup> and in Karnataka it occupies an area of 4.08 m ha, production of 12.8 m tonnes and productivity of 3149 kg ha<sup>-1</sup> (4).

Rice is attacked by number of fungal, bacterial, viral and nematode diseases. Among all pathogenic organisms, fungal pathogens are limiting the rice productivity to great extent. Several out-break of diseases such as blast, sheath blight and bacterial blight have been reported from many rice growing areas of India. Worldwide the annual losses due to rice diseases is estimated to 10-15 per cent, depending upon the age of the plant, time of infection and severity, diseases caused yield loss to the extent of 5.9 to 69 per cent (19, 9).

Sheath blight is one of the major biotic constraints that affects rice production in India and is considered economically important disease of rice in the world (6, 21). The disease is caused by *Rhizoctonia solani* Kuhn (teleomorph: *Thanatophorus cucumeris* (Frank) Donk). The Sheath blight is becoming most destructive, being second only to rice blast disease among the rice diseases constraining rice productivity, (10). The disease is endemic to areas where temperature and relative humidity are high and cultivation is intensive. The pathogen is polyphagous competitive saprophyte and has a wide host range. Continuous rice cropping, high density

and heavy canopy associated with high nitrogen management favours disease build up from tillering to panicle initiation (1).

The incidence of rice sheath blight disease has increased in recent years, because of the unavailability of resistant cultivars or any other suitable economic disease management measures. The yield losses due to this disease is reported to range from 5.2 to 50 per cent, depending on environmental conditions, crop stages at which the disease appears, cultivation practices and cultivars in India (12, 14).

The management of sheath blight through fungicide application is the most common approach among the farmers. Because of the disadvantages of using the fungicides, it has become necessary to adopt eco-friendly approaches for enhancing crop yield and better crop health. The use of biological methods for the management of this disease is scarce. It is necessary to evaluate the biological methods including use of bioagents, bio fumigants, botanicals etc., to manage the disease effectively to avoid resistance developments in pathogen and minimize the fungicidal residues for ecological sustainability. In view of the importance of the crop and seriousness of the sheath blight disease an investigation was undertaken under *in-vitro* condition to evaluate bioagents and bio fumigants for their inhibitory effect.

### Materials and Methods

The investigations were conducted during 2018 in the Department of Plant Pathology, College of Agriculture, V.C. Farm, Mandya.

### **In-vitro evaluation of bioagents against *R. solani* causing rice sheath blight**

A total of six bioagents viz., *Trichoderma viride* (native and commercial), *Pseudomonas fluorescens* (native and commercial), *Bacillus subtilis* and *Trichoderma harzianum* were tested for their antagonistic effect against *Rhizoctonia solani*. Twenty ml of sterilized and cooled molten PDA medium was poured into sterile Petri plates and allowed to solidify. For evaluation of fungal bioagents, 5mm mycelial disc of the pathogen was inoculated at one end of the Petri plate and antagonistic fungus disc was placed opposite to it on the other end. In case of bacterial antagonist 5 mm mycelia disc of the pathogen was inoculated at the periphery of the Petri plate and bacterial antagonist was streaked in the form of straight line in the centre of the same plate. Three replications were maintained for each treatment. The plates were incubated at  $27\pm 1^{\circ}\text{C}$ . After required period of incubation i.e., when the growth in control plate recorded 90 mm in diameter, the radial growth of the pathogen was measured and zone of inhibition was recorded by measuring the clear distance between the margin of the test fungus and antagonistic organism. The percent inhibition of growth of the pathogen was calculated by using the formula suggested by (20).

Where,

I = per cent inhibition

C = growth in control

T = growth in treatment

### **In-vitro evaluation of cruciferous plant extracts against *R. solani* causing rice sheath blight**

#### **Preparation of water extracts from cruciferous plants**

The leaves of the cruciferous plants viz., mustard, radish, cabbage and cauliflower were used for the purpose of extraction. 50g of leaves were taken and cut into small pieces under aseptic condition. The sample was put into waring blender containing 50ml sterilized distilled water at a ratio 1:1 (water: plant material). The sample was spun at low speed for 10-15 minutes in a warring blender till the material formed to fine texture. The blended material was then squeezed through a sterilized muslin cloth so as to get a crude liquid extract. The crude extract was filtered through Whatman no 1 filter paper followed by sterilized Seitz filter. The sterilized filtrate was collected in sterilized glass tubes and was kept at  $4^{\circ}\text{C}$  in a refrigerator for further use.

**Poisoned food technique** : Potato dextrose agar (PDA) medium was prepared in flasks sterilized. Different concentrations of plant extracts (1:1, 1:10, 1:100 and 1:1000) were prepared by mixing with medium with constant stirring. The medium was then poured into

sterilized Petri plate and allowed to solidify. A disc of 5 mm diameter of the pathogen grown on a solid medium was cut with the help of a sterilized cork borer and placed aseptically in the centre of the Petri plate containing medium. The plates were incubated at  $27\pm 1^{\circ}\text{C}$ . After required period of incubation i.e., when the growth in control plate recorded 90 mm in diameter, the radial growth of the pathogen was measured and the percent inhibition of growth of the pathogen was calculated.

**In vitro evaluation of bio-fumigant cruciferous plants against *R. solani* causing rice sheath blight** : The test was carried out by the sealed Petri plate technique described by (2). Two Petri plate bases (90mm) were sealed together by an adhesive tape with the bottom plate containing macerated plant material and the upper plate containing 20ml of solidified PDA medium. The set up was left undisturbed overnight to allow the medium on the upper plate to absorb any volatile compounds produced, if any, by the macerated plant material. The upper PDA plates after the required exposure to the macerated plant material was carefully removed and inoculated with 5 mm disc of the pathogen. Three replications were maintained for each treatment. The plates were incubated at  $27\pm 1^{\circ}\text{C}$ . After required period of incubation i.e., when the growth in control plate recorded 90 mm in diameter, the radial growth of the pathogen was measured and the per cent inhibition of growth of the pathogen was calculated.

The data obtained in different experiments were statistically analysed by following Complete Randomized Design (CRD) as per the procedures suggested by (16, 11). The data pertaining to percentage were transformed into arc sin transformation, as it is required before statistical analysis.

## **Results and Discussion**

### **In vitro evaluation of bioagents against *R. solani* causing rice sheath blight**

Evaluation of bioagents was carried out against *R. solani* by standard dual cultured technique and the data is presented in table-1 and figure-1. A total of 6 bioagents viz., *Trichoderma viride* (native and commercial), *Pseudomonas fluorescens* (native and commercial), *Bacillus subtilis* and *T. harzianum* were tested for their antagonistic effect against *R. solani*. All the bioagents showed inhibitory effect. The highest inhibition was observed in native *T. viride* (38.88%) followed by commercial *T. viride* (36.44%) and *T. harzianum* (34.11%) when compared to control. The least inhibition was noticed in case of commercial *P. fluorescens* and *Bacillus subtilis* which recorded 18.88% inhibition. After 4 days of incubation native *T. viride* showed 31.66% inhibition over control and the least inhibition was observed in case of *Bacillus subtilis* (14.44%). It was found that native *T. viride* was more

Table-1 : *In vitro* evaluation of bioagents against rice sheath blight pathogen *R. solani*.

| Treatment      | Bioagent                             | Mean mycelia growth (mm) |              |      |              |
|----------------|--------------------------------------|--------------------------|--------------|------|--------------|
|                |                                      | Days after incubation    |              |      |              |
|                |                                      | 2                        | % inhibition | 4    | % inhibition |
| T <sub>1</sub> | <i>Trichoderma viride</i>            | 55.0                     | 38.88        | 61.5 | 31.66        |
| T <sub>2</sub> | <i>Trichoderma viride</i> (com)      | 57.2                     | 36.44        | 64.3 | 28.55        |
| T <sub>3</sub> | <i>Pseudomonas fluorescens</i>       | 68.5                     | 23.88        | 72.5 | 19.44        |
| T <sub>4</sub> | <i>Pseudomonas fluorescens</i> (com) | 73.0                     | 18.88        | 76.8 | 14.66        |
| T <sub>5</sub> | <i>Bacillus subtilis</i>             | 73.0                     | 18.88        | 77.0 | 14.44        |
| T <sub>6</sub> | <i>Trichoderma harzianum</i>         | 59.3                     | 34.11        | 65.2 | 27.55        |
| T <sub>7</sub> | Control                              | 90.0                     |              | 90.0 |              |
|                | S.Em ±                               | 0.47                     |              | 0.43 |              |
|                | C.D. (0.01)                          | 1.45                     |              | 1.33 |              |

Table-2 : *In vitro* evaluation of cruciferous plant extracts against rice sheath blight pathogen *R. solani*.

| Dilution | Mean percent inhibition of <i>R. solani</i> mycelia growth |                   |                   |               |               |
|----------|------------------------------------------------------------|-------------------|-------------------|---------------|---------------|
|          | Plant extracts                                             |                   |                   |               |               |
|          | Radish                                                     | Cauliflower       | Cabbage           | Mustard       | Mean          |
| 1:1      | 21.93 (27.91)                                              | 27.80 (31.81)     | 51.10 (45.62)     | 23.03 (28.67) | 30.96 (33.50) |
| 1:10     | 0.00 (0.00)                                                | 0.00 (0.00)       | 21.38 (27.53)     | 0.00 (0.00)   | 5.34 (6.88)   |
| 1:100    | 0.00 (0.00)                                                | 0.00 (0.00)       | 0.00 (0.00)       | 0.00 (0.00)   | 0.00 (0.00)   |
| 1:1000   | 0.00 (0.00)                                                | 0.00 (0.00)       | 0.00 (0.00)       | 0.00 (0.00)   | 0.00 (0.00)   |
|          |                                                            | Plant extract (P) | Concentration (C) | P X C         |               |
|          | S.Em ±                                                     | 0.10              | 0.10              | 0.20          |               |
|          | C.D. (0.01)                                                | 0.38              | 0.38              | 0.76          |               |

Figures in parenthesis are arcsine transformed values.

effective followed by commercial *T. viride* and *T. harzianum*.

The antagonistic nature of bioagents against *R. solani* was reported by various workers. The culture filtrate of *T. harzianum* and *T. virens* at 50% concentration showed 76.3% and 70% inhibition of mycelial growth of the test pathogen respectively (5). 7 evaluated the potential of indigenous *Trichoderma* strains against *R. solani* *in vitro* and found that the strains isolated from the soil, plant debris and the phyllosphere in rice field showed significant bio control. 18 evaluated native isolates of *T. viride*, *T. harzianum* and *Pseudomonas fluorescens* against *R. solani* *in vitro*. The result showed that the bioagents significantly inhibited mycelial growth of the test pathogen over untreated control and *T. viride* was more effective than *T. harzianum* and *P. fluorescens*. 13 evaluated 325 isolates consisting of *P. fluorescens*, *P. aeruginosa* and *P. asplenii* which were found to be antagonistic to *R. solani* and showed 48.22% to 68.44% fungal growth inhibition. 8 isolated and tested the effect of 29 bacterial isolates against *R. solani* *in vitro* and found that *Bacillus subtilis* var. *amyloliquefaciens* cost 36% inhibition over the control.

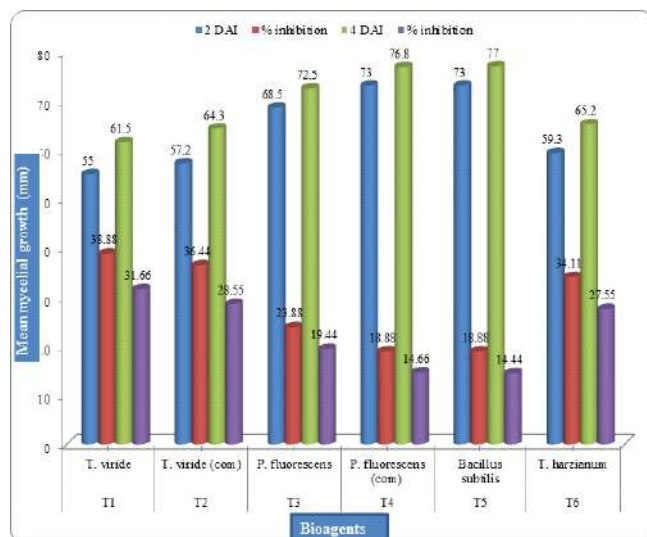
***In vitro* evaluation of cruciferous plant extracts against *R. solani* causing rice sheath blight :** The extracts obtained from commonly cultivated cruciferous

plants viz., radish, cauliflower, cabbage and mustard were tested for their inhibitory effect against *R. solani*. The water extracts with 4 dilutions viz., 1:1, 1:10, 1:100 and 1:1000 were used in the study. The radial growth of the pathogen was recorded when the growth of the pathogen was 90 mm in the untreated control by following poisoned food technique. At 1:1 dilution all the extracts showed inhibitory effect. The highest per cent inhibition was recorded in cabbage (51.1%) followed by cauliflower (27.8%) and mustard (23.03%). The least inhibition at 1:1 dilution was noticed in case of radish (21.93%). Only cabbage (21.38%) showed the inhibitory effect at 1:10 dilution. None of the plants showed inhibitory effect against the pathogen at 1:100 and 1:1000 dilutions (Table-2).

Ten botanicals were tested under *in vitro* conditions against *R. solani* and found that garlic and ginger extracts recorded 100% inhibition followed by neem (70%), *Pongamia glabra*, *Prosopis juliflora* and *Thevetia peruviana* (15). 18 evaluated nine botanicals and found Drek extract was most effective inhibiting 46.5% of mycelial growth of *R. solani* followed by Bhang, Onion, Tulsi, Bael, Paanch phooli, Cury leaves, Congress grass and Eucalyptus. Among thirteen plant extracts tested against *R. solani*, garlic extract was most effective in

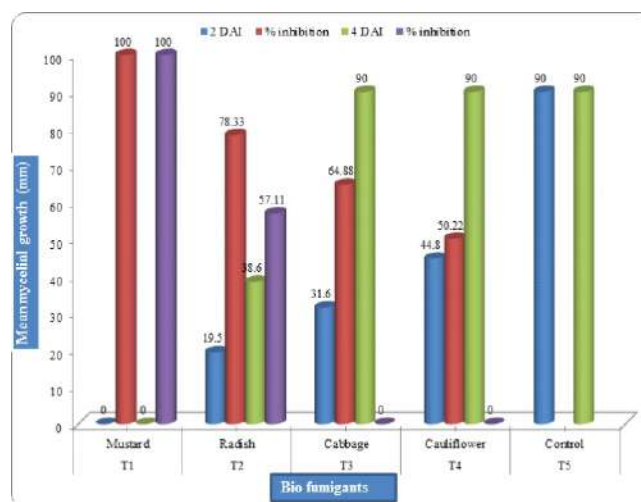
Table-3 : *In vitro* evaluation of bio-fumigants against rice sheath blight pathogen *R. solani*.

| Treatment      | Bio fumigant plant | Mean mycelia growth of <i>R. solani</i> (mm) |              |      |              |
|----------------|--------------------|----------------------------------------------|--------------|------|--------------|
|                |                    | Days after incubation                        |              |      |              |
|                |                    | 2                                            | % inhibition | 4    | % inhibition |
| T <sub>1</sub> | Mustard            | 0.0                                          | 100.00       | 0.0  | 100.00       |
| T <sub>2</sub> | Radish             | 19.5                                         | 78.33        | 38.6 | 57.11        |
| T <sub>3</sub> | Cabbage            | 31.6                                         | 64.88        | 90.0 | 0.00         |
| T <sub>4</sub> | Cauliflower        | 44.8                                         | 50.22        | 90.0 | 0.00         |
| T <sub>5</sub> | Control            | 90.0                                         |              | 90.0 |              |
|                | S.Em ±             | 0.98                                         |              | 1.05 |              |
|                | C.D. (0.01)        | 3.02                                         |              | 3.22 |              |

Fig-1 : *In vitro* evaluation of bioagents against rice sheath blight pathogen *R. solani*.

inhibiting the growth of fungus followed by *Calotropis* sp. at 10% concentration (17).

***In-vitro* evaluation of bio fumigants against *R. solani* causing rice sheath blight :** Investigation was carried out to study the effect of bio-fumigants plants viz., mustard, radish, cabbage and cauliflower for their inhibitory effect against Mandya isolate of *R. solani* by producing volatile inhibitory compounds. The test was carried out by sealed Petri plate technique by measuring the radial growth of the pathogen in the treatments when the growth in the control plate was recorded 90 mm in diameter. At 2 days after incubation all the treatments showed inhibitory effect. Mustard completely inhibited the growth of the pathogen whereas cauliflower exhibited least inhibition with 44.8 mm radial growth of the pathogen. Radish and cabbage showed 78.33% and 64.88% inhibition over control. At 4 days after incubation only mustard and radish showed the inhibitory effect whereas cabbage and cauliflower were ineffective in inhibiting the growth of the pathogen. No growth of the pathogen was observed in case of mustard with 100%

Fig-2 : *In vitro* evaluation of bio-fumigants against rice sheath blight pathogen *R. solani*

inhibition whereas 38.6 mm growth with 57.11% inhibition was observed in case of radish (Table-3 and Fig.-2).

The soil bio-fumigants are rich in glucosinolates and are used for control of soil borne pathogens. Biocidal effects are attributed to volatile allyl isothiocyanate released upon hydrolysis of glucosinolates. The present finding was in accordance with (3) who evaluated bio-fumigation activity of nine *Brassicaceae* plants and other related species *in vitro* and it was found that all plants evaluated significantly suppressed the mycelial growth of *R. solani*. Further, mustard provided the highest mycelial inhibition while sunhemp and Chinese cabbage had the least suppressive effect.

Currently, there is no resistance rice cultivars against sheath blight disease, which warrants the use of chemical fungicides for the management of the disease. Development of alternative eco friendly strategies like identifying suitable strain of bio agent and employing them and using bio fumigants needs to be explored and adopted for sustainable management of the disease. Hence, plant products and bio control agents identified in

the present study can be used for the integrated management of rice sheath blight disease.

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## Evaluation of Plant Oils against Rice Moth *Corcyra Cephalonica* (Stainton) Infesting Stored Groundnut

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### Abstract

Laboratory experiment was conducted to study the efficacy of different nine plant oils @ 1.0 ml/100 g groundnut kernels against *Corcyra cephalonica* (Stainton). Among different plant oils, neem oil proved to be the most effective as it recorded highest oviposition deterrence of 96.17 %, percent reduction of adult emergence of 97.86 %, lowest longevity of male (2.53 days) and female (2.53 days) moths, lowest female fecundity (26.54 eggs) and lowest egg viability (47.96 %). The next best effective treatments were karanj oil and castor oil. There was no adverse effect on the germination of groundnut seeds treated with different plant oils during storage period of up to 120 days.

**Key words :** Groundnut, rice moth, *Corcyra cephalonica*, plant oils, neem oil, oviposition deterrence and percent reduction of adult emergence, fecundity, egg viability.

### Introduction

Groundnut, *Arachis hypogaea* Linnaeus is an important leguminous crop plant. It is widely cultivated tropics and subtropics regions of world which known for its high-oil edible seeds. It is the fourth most important source of edible oil and largest source of vegetable protein in the world. More than 100 species of insect pests were reported to infest stored groundnuts (Delinger and Davis, 1982). Among the major insect pests of stored groundnut, rice moth, *Corcyra cephalonica* (Stainton) is considered to be an important pest (Menge *et al.*, 2018). The damaging stage of this pest is larva which attacks groundnut, rice, wheat, maize, sorghum, cotton seeds, coffee, spices, chocolate, dried fruit, biscuits and seeds under various storage conditions which also made spin dense silken tubes and web the grain kernels into the walls of the tubes (Atwal and Dhaliwal, 2008). Approximately 6 to 10 % of groundnut kernels are destroyed by insect pests stored in bags (FAO, 2002). It is now widely known that the chemical method has a number of problems, including health risks to end users and consumers of stored grain (Pandey *et al.*, 1976). It causes residual toxicity, environmental pollution and pesticide resistance to insect pests. Persistent pesticides are sometimes accumulated in the higher food chain of both wildlife and humans which may create bio magnification over a time (Metcalf, 1994). In this alarming situation, there is an increasing need to explore alternatives to the use of traditional plant oils in grain storage, so that botanicals have received renewed interest over the last decade to protect stored grains against insect pests. Hence, keeping the view of above facts the present experiment was undertaken to evaluate

plant oils against *C. cephalonica* in stored groundnut kernels under laboratory condition.

### Materials and Methods

The laboratory experiment was carried out at Department of Entomology, B.A. College of Agriculture, AAU, Anand during 2019-20. In order to study the efficacy of different nine plant oils viz., mustard oil, sunflower oil, karanj oil, castor oil, neem oil, coconut oil, eucalyptus oil, sesamum oil and safflower oil @ 1 ml/100 g groundnut kernels (GG-20) as seed protectant for safe storage of groundnut against *C. Cephalonica* including control. The groundnut kernels were sterilized in a hot air oven at 55 °C for a period of four hours. The moisture content of the kernels was adjusted between 14 to 16 per cent by putting the seeds inside a desiccator at high humidity level after sterilization. Groundnut kernels were mixed with plant oils @ 1 ml/100 g of kernels. These treated kernels were stored in plastic jars (diameter 10.0 cm and height 8.0 cm) by covering fine muslin cloth tied with rubber bands. Each treatment was repeated thrice by using completely randomized design. All the jars were kept in the laboratory at room temperature for further laboratory study aspects viz., oviposition deterrent (%), reduction in adult emergence (%), longevity of male and female emerged, fecundity and egg viability of rice moth. The germination (%) of treated and untreated groundnut seeds was also recorded after 120 days of storage as per the standard procedure. The data on per cent germination was subjected to ANOVA after transforming them to arc sin (Steel and Torrie, 1980).

For oviposition deterrent study, 500 g seeds of groundnut were taken in a conical flask and mixed with

Table-1 : Impact of plant oils on growth and development of rice moth infesting groundnut (GG-20).

| Treatment                          | *Mean Oviposition deterrence (%) | *Mean Reduction in adult emergence (%) | **Longevity (Days)           |                             | **Fecundity                    | *Egg viability (%)             | *Germination (%)   |
|------------------------------------|----------------------------------|----------------------------------------|------------------------------|-----------------------------|--------------------------------|--------------------------------|--------------------|
|                                    |                                  |                                        | Male                         | Female                      |                                |                                |                    |
| T <sub>1</sub>                     | 69.77 <sup>d</sup><br>(88.04)    | 72.85 <sup>de</sup><br>(91.30)         | 2.17 <sup>de</sup><br>(4.21) | 2.41 <sup>b</sup><br>(5.31) | 8.11 <sup>d</sup><br>(65.27)   | 58.45 <sup>d</sup><br>(77.62)  | 63.42<br>(79.98)   |
| T <sub>2</sub>                     | 64.25 <sup>f</sup><br>(81.13)    | 66.68 <sup>g</sup><br>(84.33)          | 2.66 <sup>b</sup><br>(6.58)  | 2.81 <sup>b</sup><br>(7.40) | 10.42 <sup>b</sup><br>(108.08) | 66.42 <sup>b</sup><br>(84.00)  | 63.00<br>(79.39)   |
| T <sub>3</sub>                     | 75.31 <sup>b</sup><br>(93.57)    | 78.98 <sup>b</sup><br>(96.35)          | 1.85 <sup>g</sup><br>(2.92)  | 1.93 <sup>f</sup><br>(3.22) | 5.67 <sup>f</sup><br>(31.65)   | 46.12 <sup>gh</sup><br>(51.95) | 65.91<br>(83.34)   |
| T <sub>4</sub>                     | 73.03 <sup>c</sup><br>(91.48)    | 76.80 <sup>c</sup><br>(94.79)          | 1.99 <sup>f</sup><br>(3.46)  | 2.02 <sup>f</sup><br>(3.58) | 6.70 <sup>e</sup><br>(44.39)   | 47.27 <sup>fg</sup><br>(53.96) | 64.92<br>(82.03)   |
| T <sub>5</sub>                     | 78.71 <sup>a</sup><br>(96.17)    | 81.58 <sup>a</sup><br>(97.86)          | 1.74 <sup>g</sup><br>(2.53)  | 1.74 <sup>g</sup><br>(2.53) | 5.20 <sup>f</sup><br>(26.54)   | 43.83 <sup>h</sup><br>(47.96)  | 65.94<br>(83.38)   |
| T <sub>6</sub>                     | 67.49 <sup>e</sup><br>(85.34)    | 69.43 <sup>f</sup><br>(87.66)          | 2.45 <sup>c</sup><br>(5.50)  | 2.57 <sup>c</sup><br>(6.10) | 9.30 <sup>c</sup><br>(58.99)   | 62.01 <sup>c</sup><br>(77.97)  | 63.45<br>(80.02)   |
| T <sub>7</sub>                     | 70.74 <sup>d</sup><br>(89.12)    | 74.69 <sup>d</sup><br>(93.03)          | 2.05 <sup>ef</sup><br>(3.70) | 2.14 <sup>e</sup><br>(4.08) | 7.19 <sup>e</sup><br>(51.20)   | 49.22 <sup>f</sup><br>(57.34)  | 65.94<br>(83.38)   |
| T <sub>8</sub>                     | 69.10 <sup>de</sup><br>(87.27)   | 71.39 <sup>e</sup><br>(89.82)          | 2.28 <sup>d</sup><br>(4.70)  | 2.51 <sup>c</sup><br>(5.80) | 8.66 <sup>d</sup><br>(74.50)   | 53.91 <sup>e</sup><br>(65.30)  | 66.45<br>(84.04)   |
| T <sub>9</sub>                     | 65.56 <sup>f</sup><br>(82.88)    | 68.42 <sup>fg</sup><br>(86.47)         | 2.50 <sup>c</sup><br>(5.75)  | 2.72 <sup>b</sup><br>(6.90) | 10.00 <sup>b</sup><br>(99.50)  | 61.12 <sup>cd</sup><br>(76.67) | 63.00<br>(79.39)   |
| T <sub>10</sub> Control            | 05.22 <sup>g</sup><br>(00.83)    | 05.22 <sup>h</sup><br>(00.83)          | 3.05 <sup>a</sup><br>(8.80)  | 3.09 <sup>a</sup><br>(9.05) | 14.77 <sup>a</sup><br>(217.65) | 75.92 <sup>a</sup><br>(94.08)  | 66.45<br>(84.04)   |
| S. Em. ±<br>C.D (at 5 %)<br>C.V. % | 0.55<br>Sig.<br>1.50             | 0.60<br>Sig.<br>1.56                   | 0.03<br>Sig.<br>2.53         | 0.04<br>Sig.<br>3.29        | 0.16<br>Sig.<br>3.35           | 0.87<br>Sig.<br>2.68           | 0.96<br>NS<br>2.57 |

Treatment details T<sub>1</sub> : Mustard oil @ 1 ml/100 g seeds, T<sub>2</sub> : Sunflower oil @ 1 ml/100 g seeds,  
T<sub>3</sub> : Karanj oil @ 1 ml/100 g seeds, T<sub>4</sub> : Castor oil @ 1 ml/100 g seeds,  
T<sub>5</sub> : Neem oil @ 1 ml/100 g seeds, T<sub>6</sub> : Coconut oil @ 1 ml/100 g seeds,  
T<sub>7</sub> : Eucalyptus oil @ 1 ml/100 g seeds, T<sub>8</sub> : Sesamum oil @ 1 ml/100 g seeds  
T<sub>9</sub> : Safflower oil @ 1 ml/100 g seeds

**Note** : 1. Figures in parentheses are retransformed values, whereas figures outside the parentheses indicate \*angular transformed values and \*\* square root transformed values.

2. Treatment mean(s) with letter(s) in common are non-significant by DNMR at 5%

plant oils while seeds without treatment were used as control. After proper mixing the seeds were shade dried and separated into three lots each having 100 seeds which were stored in plastic containers (10 × 8 cm). Five pairs of newly emerged adults of rice moth were introduced in each container. The control treatment was maintained separately for each repetition. After 3 days, number of eggs laid in treated seeds (T<sub>s</sub>) and control seeds (C<sub>s</sub>) were recorded and the percentage of oviposition deterrence (POD) was calculated by following formulae given by Pradyuman Singh and Jakhmola (2011).

$$POD = \frac{C_s - T_s}{C_s} \times 100$$

Where,

T<sub>s</sub> = Number of eggs laid in treated seeds

C<sub>s</sub> = Number of eggs laid in control seeds

POD = Per cent oviposition deterrence

The eggs were counted from each repeated treatments for recording adult emergence (%). The number of F<sub>1</sub> adults emerged from the control seeds (A<sub>c</sub>) and treated seeds (A<sub>t</sub>) was recorded by putting the experimental set undisturbed. The percentage reduction in F<sub>1</sub> adult (PRA) emergence was calculated by following formula given by Pradyuman Singh and Jakhmola (2011).

$$PRA = \frac{A_c - A_t}{A_c} \times 100$$

Where,

A<sub>c</sub> = Number of F<sub>1</sub> adults emerged from the control seeds

A<sub>t</sub> = Number of F<sub>1</sub> adults emerged from the treated seeds

PRA = Per cent reduction in adult emergence

Total number of male and female moths emerged from each treatment were recorded along with their

longevity. The freshly emerged adults from the larvae reared on treated and control food were kept in separate jars for fecundity study (egg laying). The total numbers of eggs were laid counted daily till the death of the female in each treatment for calculating female fecundity. For egg viability study, the random samples of 50 eggs were taken from each replication and placed in petriplate. The hatched or unhatched eggs were counted with the help of stereomicroscope.

## Results and Discussion

The results given on various aspects of rice moth infesting groundnut kernels were recorded and discussed as per the followings (Table-1). The maximum oviposition deterrence was found in neem oil @ 1.0 ml/100 g kernels (96.15%) which was significantly differed from other treatments. The karanj oil (93.57 %), castor oil (91.48 %) and eucalyptus oil (89.12 %) were found next effective treatments for reduction of oviposition of rice moth. More or less similar finding was also reported by Dulera *et al.* (2016) that karanj oil @ 1 ml/100 g kernels was effective in deterring oviposition by rice moth which was at par with neem oil (98.01) and castor oil (97.28) @ 1 ml/100 g kernels. Senguttuvan *et al.* (1995) also found that neem oil was most effective in managing rice moth in stored groundnut. The highest (97.86 %) PRA (Per cent reduction in adult emergence) was observed in neem oil which was significantly different from other treatments. The similar trend was observed as per the oviposition deterrent (%) findings in the experiment. The present findings are giving conformity with the results found by Senguttuvan *et al.* (1995), Meena and Bhargava (2003), Pathak and Pandey (2011), Dulera *et al.* (2016), Menge *et al.* (2018) and Sharma *et al.* (2018). The lowest longevity of male and female moth was observed in seeds treated with neem oil (2.53 days). The karanj oil (2.92 and 3.22 days) and castor oil (3.46 and 3.58 days) were next effective plant oils for reduction of longevity of male and female adults which remained statistically at par with each other. However, the control treatment recorded highest longevity of male and female rice moth adults (3.05 and 3.09 days) as compared to all other plant oils. Meena and Bhargava (2003) observed that karanj and neem oil were very effective in reducing the longevity of adult rice moth. Sharma *et al.* (2018) reported that neem oil @ 10 ml/kg completely inhibited the adult emergence of pulse beetle. The present findings are more or less similar from earlier past finding workers.

Neem oil was significantly the most effective in reducing the fecundity (26.54 eggs) followed by karanj oil (31.65 eggs) and castor oil (44.39 eggs). These results are in accordance with those of Dulera *et al.*, (2016) and Menge *et al.*, (2018). All the plant oils were significantly

reducing the egg viability over control (94.08 %). The minimum egg viability (43.83 %) was observed on groundnut seeds treated with neem oil @ 1.0 ml/100 g seeds which was statistically at par with karanj oil (51.95 %) and castor oil (53.96 %). The similar results were also reported by Pathak and Pandey (2011), Dulera *et al.* (2016) and Menge *et al.*, (2018). The maximum germination was observed in control (84.04 %) followed by neem oil (83.38 %), karanj oil (83.34 %) and castor oil (82.03 %). The lowest germination percentage was observed in safflower oil (79.39 %) and sunflower oil (79.39 %). The difference in germination was non-significant which indicated uniform germination of kernels in all the treatments after 120 days of storage. Hence, it is evident that none of the plant oils evaluated had adverse effect on the germination of groundnut seeds. The results obtained were in close association with Dulera *et al.*, (2016) who observed cent per cent germination of groundnut seeds in all the treatments including control after storage for 120 days.

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## Heterosis for Yield and Yield Components in Maize (*Zea mays* L.)

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### Abstract

Heterosis over mid and better parent for 15 quantitative characters studied during rabi indicated that magnitude and direction of heterosis varied from hybrid to hybrid and from character to character. Most of the hybrids studied registered significant heterosis in desirable direction for yield and yield components. Maximum heterosis was recorded for kernel yield followed by 100 kernel weight and number of kernels per row while low for days to 50 % tasseling, days to 50% silking, anthesis to silking interval, days to maturity, plant height, specific leaf weight and harvest index. Heterosis for kernel yield varied from 45.43 to 100.60 per cent over mid-parent and from 33.35 to 95.87 per cent over better parent among the hybrids. Among the top five hybrids identified based on mean performance for kernel yield out of 45 hybrids studied, three hybrids viz., BML 6 × PDM 1474, BML15 × PDM 1452 and BML 15 × PDM 1474 registered higher and significant positive heterosis for kernel yield and also for most of the yield contributing characters. Hence these hybrids may be better utilized in heterosis breeding for developing superior hybrids. The remaining two high yielding hybrids out of top five hybrids viz., BML 7 × DFTY and Heypool × PDM 1474 which recorded moderate heterosis may be exploited through pedigree breeding to evolve high yielding varieties.

### Introduction

Maize is an important cereal crop after wheat and rice in India. Commercial exploitation of heterosis was maximum in maize compared to all other agriculturally important crops. As the crop exhibits great potential for heterosis expression and its utilisation, hybrids in maize are under extensive cultivation. Heterosis increases yield potential and improves adaptation to stress. It is mostly grown as a kharif crop under different agro-climatic situations in the country. Single cross hybrids are successful over varieties, synthetics, composites and three way or double cross hybrids due to easiness in seed production, high yield potential and uniformity of the crop than multi-parent hybrids (vassal et al., 1995). In Andhra Pradesh maize is predominantly cultivated in rabi season but the opportunities for cultivation round the year are more because of good market facility, high yield potential, duration, easiness in seed production and its multiple uses viz; food, feed and energy (Ethanol). Mostly private maize hybrids occupy sizeable area in the state. The public hybrid DHM 117 released by ANGRAU in 2010 is under cultivation to a certain extent. As development of high yielding varieties/hybrids is a continuous process to replace the old/obsolete hybrids to increase productivity, an attempt has been made to identify single cross hybrids with high yield potential suitable for the major growing season (rabi).

### Materials and Methods

The experimental material comprised of 45 hybrids produced by crossing ten inbred lines viz., BML 2, BML 6, BML 7, BML 15, DFTY, Heypool, PDM 1416, PDM 1428,

PDM 1452 and PDM 1474. All the 45 hybrids along with 10 inbreds were raised at the S.V. Agricultural College farm, Tirupati during rabi, 2016-17. Each genotype was raised in a row of five metres length with a spacing of 60×20 cm. The design adopted was randomised block design with three replications. All the recommended package of practices were followed in raising a healthy crop. Data were recorded on randomly selected five sample plants for plant height (cm), SPAD chlorophyll meter reading (SCMR), specific leaf area (cm<sup>2</sup>/g), specific leaf weight (mg/cm<sup>2</sup>), number of kernel rows per cob, number of kernels per row, 100 kernel weight and kernel yield per plant (g). Anthesis-silking interval, specific leaf area, specific leaf weight and harvest index were computed following the standard formulae. Data on days to 50% tasseling, days to 50% silking and days to maturity were recorded on plot basis. Statistical analysis was performed as per the procedure suggested by Panse and Sukhatme (1985). Estimation of heterosis over mid and (Fonseca and Patterson, 1968), better parent (Liang *et al.*, 1971) and testing of its significance was carried out as per the procedures (Snedecor and Cochran, 1967 and Paschal and Wilcox, 1975).

### Results and Discussion

Analysis of variance indicated that inbred lines and hybrids tested differed significantly for the characters studied revealing the existence of variability among the inbred lines and hybrids for all the characters studied.

**Mean performance of hybrids for yield and yield components :** Mean and the range of variation for the yield and yield components among the 45 hybrids and the

Table-1 : Mean and range of variation for yield and yield components among 45 hybrids and top five hybrids identified for yield and yield components.

| S. No. | Character                     | Mean   | Range            | Top five crosses                                                                              |
|--------|-------------------------------|--------|------------------|-----------------------------------------------------------------------------------------------|
| 1.     | Days to 50% tasseling         | 61.86  | 59.67 to 65.33   | BML 15 × PDM 1452, PDM 1416 × PDM 1452, BML 2 × DFTY, BML 15 × PDM 1474, Heypool × PDM 1474   |
| 2.     | Days to 50% silking           | 65.21  | 62.33 to 69.67   | BML 15 × PDM 1452, BML 2 × DFTY, BML 6 × PDM 1452, Heypool × PDM 1416, PDM 1416 × PDM 1452    |
| 3.     | Anthesis-Silking interval     | 3.40   | 1.00 to 5.00     | BML 6 × PDM 1452, Heypool × PDM 1416, DFTY × Heypool, PDM 1428 × PDM 1474, BML 2 × DFTY       |
| 4.     | Days to maturity              | 101.94 | 98.00 to 106.67  | BML 6 × Heypool, BML 6 × PDM 1452, BML 2 × PDM 1452, BML 15 × PDM 1452                        |
| 5.     | Plant height (cm)             | 191.12 | 173.29 to 212.53 | BML 6 × PDM 1428, BML 6 × PDM 1474, BML 7 × PDM 1416, DFTY × PDM 1428, Heypool × PDM 1474     |
| 6.     | SCMR                          | 51.48  | 48.07 to 54.92   | DFTY × Heypool, BML 6 × PDM 1428, BML 7 × DFTY, Heypool × PDM 1452, BML 6 × PDM 1474          |
| 7.     | SLA (cm <sup>2</sup> /g)      | 87.70  | 82.50 to 94.29   | BML 6 × BML 7, BML 15 × PDM 1428, BML 15 × PDM 1416, PDM 1416 × PDM 1474, PDM 1428 × PDM 1452 |
| 8.     | SLW (mg/ cm <sup>2</sup> )    | 1.14   | 1.06 to 1.21     | PDM 1428 × PDM 1452, BML 6 × BML 7, BML 15 × PDM 1416, BML 15 × PDM 1428, BML 2 × PDM 1416    |
| 9.     | Cob length (cm)               | 17.80  | 16.00 to 19.53   | BML 6 × PDM 1474, DFTY × Heypool, DFTY × PDM 1452, BML 15 × PDM 1474, Heypool × PDM 1428      |
| 10.    | Cob girth (cm)                | 15.01  | 13.86 to 16.18   | BML 6 × PDM 1474, BML 15 × PDM 1474, BML 2 × Heypool, DFTY × PDM 1452, PDM 1452 × PDM 1474    |
| 11.    | Number of kernel rows per cob | 14.59  | 13.60 to 15.94   | BML 2 × PDM 1474, BML 15 × PDM 1474, DFTY × PDM 1452, Heypool × PDM 1474, PDM 1452 × PDM 1474 |
| 12.    | Number of kernels per row     | 39.17  | 33.00 to 43.00   | BML 6 × PDM 1474, BML 7 × DFTY, BML 15 × PDM 1474, DFTY × Heypool, DFTY × PDM 1452            |
| 13.    | 100 kernel weight (g)         | 34.71  | 31.57 to 37.90   | BML 15 × PDM 1452, BML 15 × PDM 1474, DFTY × Heypool, DFTY × PDM 1474, PDM 1452 × PDM 1474    |
| 14.    | Harvest index (%)             | 37.87  | 36.11 to 38.99   | BML 6 × PDM 1474, BML 7 × DFTY, BML 15 × PDM 1452, BML 15 × PDM 1474, DFTY × PDM 1416         |
| 15.    | Kernel yield per plant (g)    | 129.90 | 103.93 to 146.70 | BML 6 × PDM 1474, BML 7 × DFTY, BML 15 × PDM 1452, Heypool × PDM 1474, BML 15 × PDM 1474      |

list of top five performing hybrids identified for each character was presented in the Table-2. Results obtained indicated that range of variation among hybrids for 15 characters indicated that maximum variability was observed for kernel yield followed by plant height while it was moderate for number of kernels per row, 100 kernel weight, specific leaf area, SPAD chlorophyll meter reading (SCMR), days to 50% tasseling, days to 50 % silking, days to maturity and low for anthesis-silking interval, specific leaf weight, cob length, cob girth, harvest index and number of kernel rows per cob (Table-1).

Performance of hybrids for kernel yield among 45 hybrids varied from 103.93 (BML15 × PDM 1428) to 146.70 (BML 7 × DFTY) with a general hybrid mean of 129.90 g. Eleven hybrids recorded significantly higher kernel yield over the general mean of hybrids. The top five hybrids among 45 hybrids recorded significantly higher kernel yield viz., BML 7 × DFTY (146.70 g), BML 6 × PDM 1474 (145.83 g), Heypool × PDM 1474 (145.77 g), BML

15 × PDM 1452 (144.73 g) and BML 15 × PDM 1474 (143.77 g) compared to all other hybrids tested. All these five top yielding hybrids registered higher mean values for most if the yield components (Table-2).

Kernel yield is a complex character and is influenced by other yield components in maize. Among the top five hybrids, BML 6 × PDM 1454 with higher kernel yield also recorded higher mean values for plant height, SCMR, cob length, cob girth, number of kernels per row and harvest index while BML 15 × PDM 1454 besides higher kernel yield also registered higher mean values for cob length, cob girth, number of kernel rows per cob, number of kernels per row and 100 kernel weight. These two best hybrids could be utilized in heterosis breeding to evolve high yielding hybrids. The hybrid BML15 × PDM 1452 with low mean values for days to 50% tasseling, days to 50% silking and days to maturity recorded higher mean performance for number of kernels per row, harvest index. This hybrid may be exploited in the development of high

**Table-2 : Performance of top five hybrids for yield and yield components during rabi season (2016-17).**

| Character (s)                 | BML 7 × DFTY | BML 6 × PDM1474 | Heypool × PDM 1474 | BML15 × PDM 1452 | BML15 × PDM 1474 | Mean   | C.D at 5 % | C.V. (%) |
|-------------------------------|--------------|-----------------|--------------------|------------------|------------------|--------|------------|----------|
| Days to 50% tasseling         | 61.00        | 60.67           | 60.33              | 59.67            | 60.33            | 61.86  | 1.16       | 1.15     |
| Days to 50% silking           | 64.00        | 64.00           | 64.00              | 63.67            | 64.00            | 65.21  | 1.28       | 1.21     |
| Anthesis–Silking interval     | 3.00         | 3.44            | 3.56               | 4.33             | 3.89             | 3.40   | 0.81       | 14.67    |
| Days to maturity              | 100.00       | 100.00          | 99.00              | 100.00           | 100.67           | 101.94 | 1.28       | 0.77     |
| Plant height (cm)             | 178.00       | 208.00          | 195.33             | 173.29           | 176.00           | 191.12 | 11.55      | 3.72     |
| SCMR                          | 53.69        | 53.65           | 53.19              | 53.13            | 53.26            | 51.48  | 1.561      | 1.86     |
| SLA (cm <sup>2</sup> /g)      | 94.29        | 88.58           | 88.25              | 92.13            | 93.00            | 87.70  | 3.95       | 2.28     |
| SLW (mg/ cm <sup>2</sup> )    | 1.06         | 1.13            | 1.13               | 1.09             | 1.10             | 1.14   | 0.05       | 2.77     |
| Cob length (cm)               | 19.12        | 19.43           | 18.03              | 19.10            | 19.24            | 17.80  | 1.03       | 3.57     |
| Cob girth (cm)                | 15.77        | 16.08           | 15.83              | 15.81            | 16.10            | 15.01  | 0.57       | 2.35     |
| Number of kernel rows per cob | 15.33        | 15.67           | 15.67              | 15.00            | 15.94            | 14.59  | 0.81       | 3.44     |
| Number of kernels per row     | 43.00        | 41.67           | 41.67              | 41.67            | 43.00            | 39.17  | 2.96       | 3.92     |
| 100 kernel weight (g)         | 36.27        | 36.25           | 36.30              | 36.51            | 37.90            | 34.71  | 1.15       | 2.04     |
| Harvest index (%)             | 38.99        | 38.63           | 38.37              | 38.86            | 38.68            | 37.87  | 0.71       | 1.16     |
| Kernel yield per plant (g)    | 146.70       | 145.83          | 145.77             | 144.73           | 143.77           | 129.90 | 11.05      | 5.25     |

yielding hybrids with earliness. The other two hybrids viz., BML 7 × DFTY with higher per se performance for kernel yield also recorded high means for 100 kernel weight, harvest index, SCMR while Heypool × PDM 1474 registered higher values for plant height and number of kernel rows per cob in addition to significant kernel yield. These two hybrids may be utilized in population improvement programme in isolating improved inbreds or to capitalize desirable's genes.

Heterosis for yield and yield components : Per cent mean heterosis over mid parent (relative heterosis) and better parent (Heterobeltiosis), range of heterosis among the 45 hybrids for all the characters studied and top five heterotic hybrids identified for each character were summarised and presented in (Table-3). Heterosis was recorded in all the F1 hybrids and for all characters studied over mid and better parent. Per cent heterosis varied from hybrid to hybrid and character to character. The range of variation for per cent heterosis over mid parent and better parent was found high for kernel yield followed by number of kernels per row and 100 kernel weight; moderate for number of kernel rows per cob, cob length, cob girth, SCMR and low for all other characters. Negative heterosis is desirable for days to 50 % tasseling, days to 50% silking, anthesis-silking interval, days to maturity and specific leaf area while positive heterosis is desirable for all other characters.

Heterosis for kernel yield over mid parent varied from 45.43 (BML 15 × PDM 1428) to 100.64 (BML 6 × PDM 1474) with a hybrid mean of 73.24 per cent while it varied from 33.35 (DFTY × PDM 1416) to 95.87 (BML 6 × PDM 1416) over better parent with a mean of 66.64 per cent. Mean per cent heterosis over mid and better parent was found to be higher for kernel yield per plant followed by number of kernels per row, 100 kernel weight, cob

length, cob girth and SCMR while it was moderate for number of kernel rows per cob and harvest index and low for days to 50 % tasseling, days to 50% silking, anthesis-silking interval, plant height, specific leaf area and specific leaf weight. Of the top five heterotic hybrids identified for each character BML 15 × PDM 1452, BML 15 × PDM 1474 and BML 2 × BML 7 recorded positive and significant heterosis for kernel yield over both mid parent and better parent whereas PDM 1416 × PDM 1474, PDM 1452 × PDM 1474 over mid parent and BML 6 × PDM 1474, BML 6 × PDM 1416 better parent only registered positive and significant heterosis. Among the top five hybrids which recorded higher heterosis for kernel yield over mid and better parent, the hybrids viz., BML 15 × PDM 1452 for days to maturity, SCMR, number of kernels per row, 100 kernel weight and harvest index; BML 15 × PDM 1474 for cob length, number of kernel rows per cob, number of kernel per row, 100 kernel weight and harvest index; BML 2 × BML 7 for days to 50 % tasseling, days to 50% silking, cob length, cob girth, number of kernel rows per cob and 100 kernel weight recorded positive and significant heterosis. The other two heterotic hybrids for kernel yield per plant viz., PDM 1416 × PDM 1474 for specific leaf weight and PDM 1452 × PDM 1474 for plant height and number of kernel rows per cob showed positive and significant heterosis. Similar results on heterosis for yield and yield components over mid and better parent were also reported in maize by Uddin et al. (2006), Netravati et al. (2013), Ali et al. (2014), Khan et al. (2014), Ruswandi et al. (2015), Meenakshi Dhoot et al., (2017) and Sandesh et al (2018).

Selection of hybrids only based on heterosis for kernel yield over mid parent or better parent would be often misleading because the hybrids heterotic for kernel yield may not be showing higher mean performance for

Table-3 : Per cent heterosis for kernel yield and yield components over mid-parent (Relative heterosis) and better parent (Heterobeltiosis) in rabi (2016-17).

| S. No. | Character                     | Relative heterosis |                 | Heterobeltiosis |                 | Relative heterosis                                                                                    | Heterobeltiosis                                                                                         | No. of hybrids recorded significant heterosis |                  |
|--------|-------------------------------|--------------------|-----------------|-----------------|-----------------|-------------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------|-----------------------------------------------|------------------|
|        |                               | Mean               | Range           | Mean            | Range           | Top five crosses                                                                                      | Top five crosses                                                                                        | Relative Heterosis                            | Hetero-beltiosis |
| 1.     | Days to 50% tasseling         | -6.55              | -11.27 to -1.01 | -7.70           | -11.82 to -1.51 | BML 2 × BML 7<br>BML 2 × DFTY<br>BML 2 × PDM 1416<br>BML 6 × PDM 1416<br>PDM 1416 × PDM 1452          | BML 2 × BML 7<br>BML 2 × DFTY<br>BML 2 × PDM 1416<br>BML 6 × PDM 1416<br>PDM 1416 × PDM 1452            | 44                                            | 44               |
| 2.     | Days to 50% silking           | -5.88              | -10.53 to -0.24 | -7.16           | -12.15 to -0.48 | BML 2 × BML 7<br>BML 6 × PDM 1416<br>BML 6 × PDM 1452<br>Heypool × PDM 1416<br>PDM 1416 × PDM 1452    | BML 2 × BML 7<br>BML 6 × PDM 1416<br>BML 6 × PDM 1452<br>Heypool × PDM 1416<br>PDM 1416 × PDM 1452      | 43                                            | 43               |
| 3.     | Anthesis –Silking interval    | 11.42              | -64.71 to 87.50 | -1.38           | -72.73 to 6.67  | BML 6 × PDM 1452<br>BML 7 × PDM 1474<br>BML15 × PDM 1416<br>Heypool × PDM 1416<br>Heypool × PDM 1428  | BML 6 × PDM 1452<br>BML 15 × PDM1416<br>Heypool × PDM 1416<br>Heypool × PDM 1428<br>PDM 1428 × PDM 1474 | 2                                             | 3                |
| 4.     | Days to maturity              | -3.46              | -8.28 to 1.07   | -4.08           | -8.84 to 0.57   | BML 2 × PDM 1452<br>BML 6 × Heypool<br>BML 6 × PDM 1452<br>BML 7 × DFTY<br>BML 15 × PDM 1452          | BML 2 × PDM 1452<br>BML 6 × Heypool<br>BML 6 × PDM 1452<br>BML 7 × DFTY<br>BML 15 × PDM1452             | 44                                            | 43               |
| 5.     | Plant height (cm)             | 5.27               | -4.91 to 21.28  | 1.70            | 11.63 to 9.32   | BML 6 × PDM 1428<br>BML 7 × PDM 1416<br>DFTY × PDM 1428<br>PDM 1428 × PDM 1452<br>PDM 1452 × PDM 1474 | BML 7 × PDM 1416<br>BML 15 × PDM 1416<br>DFTY × PDM 1428<br>DFTY × PDM 1452<br>PDM 1428 × PDM 1452      | 21                                            | 13               |
| 6.     | SCMR                          | 21.50              | 10.28 to 38.68  | 15.51           | 6.98 to 27.92   | BML 6 × PDM 1428<br>BML 7 × PDM 1428<br>BML 15 × PDM 1428<br>BML 15 × PDM 1452<br>PDM 1428 × PDM 1452 | BML 6 × PDM 1428<br>BML 7 × PDM 1428<br>BML 15 × PDM 1428<br>BML 15 × PDM 1452<br>PDM 1428 × PDM 1452   | 45                                            | 45               |
| 7.     | SLA (cm <sup>2</sup> /g)      | 8.06               | 31.50 to 15.62  | 6.94            | 0.20 to 14.24   | BML 2 × DFTY<br>BML 6 × BML 7<br>BML 6 × PDM 1452<br>PDM 1416 × PDM 1474<br>PDM 1428 × PDM 1452       | BML 2 × DFTY<br>BML 6 × BML 7<br>BML 6 × PDM 1452<br>PDM 1416 × PDM 1474<br>PDM 1428 × PDM 1452         | -                                             | -                |
| 8.     | SLW (mg/ cm <sup>2</sup> )    | -7.38              | -13.47 to -3.18 | -8.33           | -14.48 to 3.89  | BML 2 × DFTY<br>BML 2 × PDM 1416<br>BML 6 × BML 7<br>PDM 1416 × PDM 1474<br>PDM 1428 × PDM 1452       | BML 2 × DFTY<br>BML 2 × PDM 1416<br>BML 6 × BML 7<br>PDM 1416 × PDM 1474<br>BML 6 × PDM 1452            | -                                             | -                |
| 9.     | Cob length (cm)               | 40.93              | 27.37 to 59.19  | 35.37           | 22.78 to 57.59  | BML 2 × BML 7<br>BML 2 × PDM 1474<br>BML 6 × PDM 1416<br>BML 6 × PDM 1474<br>BML 15 × PDM 1474        | BML 2 × BML 7<br>BML 2 × PDM 1474<br>BML 6 × PDM 1416<br>BML 6 × PDM 1474<br>BML 15 × PDM 1474          | 45                                            | 45               |
| 10.    | Cob girth (cm)                | 39.44              | 28.59 to 60.08  | 34.81           | 24.40 to 55.95  | BML 2 × BML 7<br>BML 2 × Heypool<br>BML 2 × PDM 1474<br>BML 6 × PDM 1416<br>BML 6 × PDM 1474          | BML 2 × BML 7<br>BML 6 × PDM 1416<br>BML 6 × PDM 1474<br>BML15 × PDM 1452<br>BML 15 × PDM 1474          | 45                                            | 45               |
| 11.    | Number of kernel rows per cob | 11.96              | 6.20 to 22.81   | 9.81            | 4.31 to 18.96   | BML 2 × Heypool<br>BML 2 × PDM 1474<br>BML 6 × PDM1474<br>BML 15 × PDM 1474<br>PDM 1452 × PDM 1474    | BML 2 × PDM 1474<br>BML 6 × PDM 1474<br>BML 15 × PDM 1474<br>DFTY × PDM 1452<br>PDM 1452 × PDM 1474     | 45                                            | 37               |
| 12.    | Number of kernels per row     | 70.22              | 51.15 to 92.54  | 63.40           | 42.86 to 84.13  | BML 2 × BML 7<br>BML 2 × PDM 1416<br>BML 2 × PDM 1428<br>BML 15 × PDM 1452<br>BML 15 × PDM 1474       | BML 2 × BML 7<br>BML 2 × PDM 1416<br>BML 2 × PDM 1428<br>BML 15 × PDM 1452<br>BML 15 × PDM 1474         | 45                                            | 45               |

Contd.....

Table-3 : Contd.....

| S. No. | Character                  | Relative heterosis |                 | Heterobeltiosis |                | Relative heterosis                                                                                    | Heterobeltiosis                                                                                 | No. of hybrids recorded significant heterosis |                  |
|--------|----------------------------|--------------------|-----------------|-----------------|----------------|-------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------|-----------------------------------------------|------------------|
|        |                            | Mean               | Range           | Mean            | Range          | Top five crosses                                                                                      | Top five crosses                                                                                | Relative Heterosis                            | Hetero-beltiosis |
| 13.    | 100 kernel weight (g)      | 60.40              | 39.92 to 76.42  | 51.68           | 25.41 to 71.94 | BML 2 × BML 7<br>BML 2 × PDM 1428<br>BML 6 × PDM 1416<br>BML 15 × PDM 1452<br>BML 15 × PDM 1474       | BML 2 × BML 7<br>BML 2 × PDM 1428<br>BML 6 × PDM 1416<br>BML 15 × PDM 1452<br>BML 15 × PDM 1474 | 45                                            | 45               |
| 14     | Harvest index (%)          | 10.14              | 6.27 to 14.85   | 8.90            | 4.11 to 13.00  | BML 6 × BML 15<br>BML 7 × BML 15<br>BML 7 × DFTY<br>BML 15 × PDM 1452<br>BML 15 × PDM 1474            | BML 2 × BML 6<br>BML 6 × BML 15<br>BML 7 × BML 15<br>BML 7 × DFTY<br>BML 15 × PDM 1452          | 45                                            | 45               |
| 15.    | Kernel yield per plant (g) | 73.24              | 45.43 to 100.64 | 66.64           | 33.35 to 95.87 | BML 2 × BML 7<br>BML 15 × PDM 1452<br>BML 15 × PDM 1474<br>PDM 1416 × PDM 1474<br>PDM 1452 × PDM 1474 | BML 2 × BML 7<br>BML 6 × PDM 1416<br>BML 6 × PDM 1474<br>BML 15 × PDM 1452<br>BML 15 × PDM 1474 | 45                                            | 45               |

kernel yield vice versa. In the present study also the two heterotic hybrids among the top five hybrids identified for kernel yield viz., PDM 1416 × PDM 1474 and PDM 1452 × PDM 1474 recorded low mean kernel yields per plant whereas higher kernel yielding hybrids among the top five hybrids viz., BML 7 × DFTY and Heypool × PDM 1474 recorded lower significant and positive heterosis for kernel yield. The three hybrids viz., BML 15 × PDM 1474 (143.77 g), BML 15 × PDM 1452 (144.73 g) and BML 6 × PDM 1474 (145.83 g) registered higher mean kernel yields per plant and higher significant and positive heterosis not only for kernel yield but also for most of the yield components. Hence, these three hybrids viz., BML 15 × PDM 1474, BML 15 × PDM 1452 and BML 6 × PDM 1474 may be better utilised in heterosis breeding in evolving superior hybrids with higher kernel yields. The other two high yielding hybrids viz., BML 7 × DFTY and Heypool × PDM 1474 with higher per se performance for most of the yield components and kernel yield but lower positive and significant heterosis may be handled through pedigree breeding so as to isolate high yielding varieties.

## Conclusions

Magnitude and direction of per cent heterosis estimated over mid and better parent varied from hybrid to hybrid and from character to character. Most of the hybrids studied registered significant heterosis in desirable direction for yield and yield components. Maximum heterosis was recorded for kernel yield followed by 100 kernel weight and number of kernels per row while low for days to 50 % tasseling, days to 50% silking, anthesis to silking interval, days to maturity, plant height, specific leaf weight and harvest index. Heterosis for kernel yield varied from 45.43 to 100.60 per cent over mid-parent and from

33.35 to 95.87 per cent over better parent among the hybrids. Among the top five hybrids identified based on mean performance for kernel yield out of 45 hybrids studied, three hybrids viz., BML 6 × PDM 1474, BML 15 × PDM 1452 and BML 15 × PDM 1474 registered higher and significant positive heterosis for kernel yield and also for most of the yield contributing characters and these hybrids may be utilized in heterosis breeding. The two other high yielding hybrids viz., BML 7 × DFTY and Heypool × PDM 1474 which recorded moderate heterosis may be exploited through pedigree breeding to evolve high yielding varieties.

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## **Study on Extent of Adoption of Recommended Turmeric Production Technology among the Farmers of Raigarh District, Chhattisgarh**

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### **Abstract**

India is referred to as 'The Land of Spices'. This study was conducted during 2019-20. Out of four 9 blocks, 4 blocks were selected of Raigarh district. 40 turmeric growers were selected to the each blocks and totally 160 farmers was selected. The data were collected individually through a pre-tested interview schedule, and with the aid of a semi-structured interview schedule, the data was collected. Agriculture was the main occupation of the respondents (Turmeric cultivation). More than half of the turmeric producers had annual income ranging from Rs.100,000.00 to 200,000.00 lakh and credit was obtained for more than one third of them. Often, 80% of turmeric growers have had interaction with extension agencies. Often, 80% of turmeric growers have had interaction with extension agencies. More than half of the turmeric growers had access to irrigation sources, from which tube wells were used to the full. The total area cultivated for turmeric growers was 320 ha for the total Kharif season crop, 155 ha for the total Rabi season crop and 53.12 ha for the total summer season crop. The cropping rate of the study area has been found to be 142.18%. For the majority of turmeric growers, progressive farmers and Kisan-mitra were the source of knowledge, with a medium level of scientific orientation for most turmeric growers. Around one-third of turmeric growers had a medium level of knowledge of turmeric production, with a high level of knowledge of sowing, harvesting and earthing practices. More than half of turmeric producers had a medium level of adoption for turmeric production technology, with high practices of sowing, harvesting and earthing time being adopted.

### **Introduction**

India, led by China, is the biggest manufacturer, buyer and exporter of spices in the world. India uses 90% of its produce for domestic use (M. Chigadolli *et al.* 2019). In rotting cow manure, technological interference in the soil, wood ash, crop rotation, mulch and plant protection measures, the application of Trichoderma (biological control agent) increased the farmer's rhizome yield by 20 percent to 30 percent at the farm level (Naresh Babu, 2015). In the Raigarh district, the turmeric area is 1080 hectares and production is 9240 metric tons, with an average yield of 855.55 kg per hectare (Directorate of Agriculture, Govt. of Chhattisgarh, 2018-19). It was concluded in this study that with almost 59.37 percent, most of the respondents belonged to the middle age group of 36 to 55 years. The education level was up to middle school level for the majority of turmeric growers. The caste of other backward classes included more than one-third of turmeric growers. The highest number of turmeric growers (84.37 percent) belonged to other backward classes, followed by planned tribes (10.62 percent) and planned castes (5.01 percent). The general group did not contain any respondents. A land holding of farmers between 1.01 and 2.0 ha has a maximum (40.00%) number of respondents.

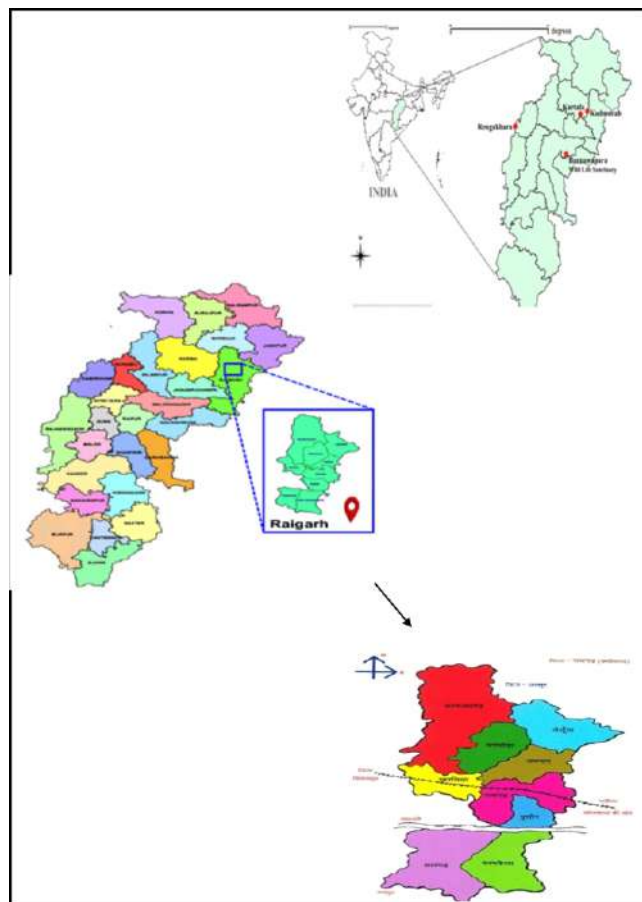
### **Research Methodology**

There was a district of Raigarh in the north-eastern portion of the state of Chhattisgarh. It is located at 21°53'60 N to

83.24 E with a sea level elevation of 214 meters. The Raigarh district's average rainfall was 1531.3 mm per annum. Out of 27 districts in Chhattisgarh, the district of Raigarh consisted of 9 blocks, of which 4 blocks (Raigarh, Pusour, Baramkela, Sarangarh) and 5 villages from each block (Jampali, Hardighariya, Tarkela, Kosmnara, Katahardi, Bijana, Telipali, Kavria, Linzer, Navapara, Tauseer, Navapali, Kenabhata, Kotra, Karrakot, Mauhadhodha, Baltikari, Tangar, Kotmara, Kharwani) were selected purposely because of the turmeric area and maximum output was found. As respondents for each selected village, 8 turmeric growers were selected randomly. Therefore, (8x5=40) turmeric growers were randomly selected from each selected block and a total of 160 turmeric growers were selected. Through using a pre-tested standardized interview schedule, data was collected personally. The data collected was tabulated and analysed using sufficient statistical techniques and methods. Each farmer was asked to mention his problems during the adoption of recommended turmeric production technology to recognise the problems faced by turmeric growers. The farmers were asked to provide useful suggestions in order to resolve the issues that turmeric growers faced during the adoption of turmeric production technology. The suggestions were summed up and ranked in order of number and percentage. As part of the study's objectives, data on selected socio-profile characteristics, adoption extent, and problems perceived in respondent suggestions were collected as primary data. As secondary evidence, the investigator collected official

**Variables and their measurement :****Table-1 : Measurement of variables**

| Sl. No.   | Variables                       | Measurement                                                        |
|-----------|---------------------------------|--------------------------------------------------------------------|
| <b>A.</b> | <b>Independents Variables</b>   |                                                                    |
| 1.        | Age                             | Procedure followed by Usha Rani (1999) with suitable modifications |
| 2.        | Education                       | Procedure followed by Supe (2007)                                  |
| 3.        | Caste                           | Structure schedule                                                 |
| 4.        | Social participation            | Procedure followed by Hardikar (1998)                              |
| 5.        | Farming experience              | Structure schedule                                                 |
| 6.        | Land holding                    | Procedure followed by Marked (1996)                                |
| 7.        | Area under turmeric cultivation | Structure schedule                                                 |
| 8.        | Occupation                      | Procedure followed by Chandramouli (2005)                          |
| 9.        | Annual income                   | Structure schedule                                                 |
| 10.       | Credit acquisition              | Structure schedule                                                 |
| 11.       | Contact with extension agencies | Structure schedule                                                 |
| 12.       | Source of irrigation            | Structured schedule                                                |
| 13.       | Cropping pattern                | Procedure followed by Sinha and kolte (1974)                       |
| 14.       | Cropping intensity              | Procedure followed by Sinha and kolte (1974)                       |
| 15.       | Source of information           | Structured schedule                                                |
| 16.       | Scientific orientation          | Procedure followed by Supe (1975)                                  |
| 17.       | Level of knowledge              | Structured schedule                                                |
| <b>B.</b> | <b>Dependent variable</b>       |                                                                    |

**Location map of the study area :**

documents and records from the appropriate agencies. An interview schedule's reliability is described as "its consistency or stability in obtaining information from respondents." For estimating the reliability of an interview schedule, this study used the test-retest approach. 5-10 respondents from the study region were chosen at random and interviewed again after 2 to 3 weeks, following the same interview schedule as the first interview.

**Results and Discussion**

The results showed that the bulk of the respondents (59.37 percent) were between the ages of 36 and 55. While (21.87 percent) of the respondents were under the age of 35, 18.75 percent of the respondents were over the age of 55. Turmeric growers' educational attainment. It indicates that 1.88 percent of turmeric growers are illiterate, while 21.87 percent have completed primary school, 28.76 percent have completed middle school, 24.37 percent have completed high school, 13.12 percent have completed higher secondary school, and 10% have graduated. The majority of turmeric growers (84.37 percent) were from other backward groups, followed by scheduled tribes (10.62 percent) and scheduled castes (10.62 percent) (5.01 percent). There were no respondents in the general group. The highest percentage of turmeric growers (70.00%) have membership in two or more organisations, followed by (21.25%) who have membership in one organisation, (3.75%) of the respondents who were in the executive/office bearer group, and the lowest majority of (5.00%) who have no

**Table-2 : Distribution, of the respondents according to existing cultivation practices of turmeric production, technology in Raigarh district of C.G.**

| Sl. No.                          | Practices        | Frequency | Percentage |
|----------------------------------|------------------|-----------|------------|
| <b>1. Preparation of land</b>    |                  |           |            |
| (i)                              | Tillage          | 160       | 100        |
| (ii)                             | Sanitation       | 160       | 100        |
| (iii)                            | Soil treatment   | 23        | 14.37      |
| <b>2. Sowing time</b>            |                  |           |            |
| (i)                              | 15 april-15 May  | 26        | 16.25      |
| (ii)                             | 16 may-15 June   | 117       | 110.62     |
| (iii)                            | 16 jun-15 July   | 17        | 10.62      |
| <b>3. Variety</b>                |                  |           |            |
| (i)                              | C.G- 12          | 46        | 28.75      |
| (ii)                             | Roma             | 24        | 15         |
| (iii)                            | Desi             | 90        | 56.25      |
| <b>4. Method of sowing</b>       |                  |           |            |
| (i)                              | Bad method       | 31        | 19.37      |
| (ii)                             | Made method      | 46        | 28.75      |
| (iii)                            | Levelling method | 83        | 51.87      |
| <b>5. Seed, rate/ kg per ha.</b> |                  |           |            |
| (i)                              | Up, to 5 quintal | 16        | 10         |
| (ii)                             | 6-10 quintal     | 68        | 42.50      |
| (iii)                            | 10-15 quintal    | 76        | 47.50      |
| <b>6. Seed treatment</b>         |                  |           |            |
| (i)                              | Not use          | 113       | 70.62      |
| (ii)                             | Mancozeb         | 32        | 20         |
| (iii)                            | Carbendazim      | 15        | 9.37       |
| <b>7. Spacing</b>                |                  |           |            |
| <b>I. Plant to plant</b>         |                  |           |            |
| (i)                              | 15-20 cm         | 91        | 56.87      |
| (ii)                             | 20-25 cm         | 69        | 43.12      |
| <b>I. Row to row</b>             |                  |           |            |
| (i)                              | Up to 20 cm      | 32        | 20         |
| (ii)                             | 25-30 cm         | 92        | 57.50      |
| (iii)                            | 30-35 cm         | 36        | 22.50      |
| <b>8. Use, of manure</b>         |                  |           |            |
| (i)                              | FYM/ ton ha.     |           |            |
| (ii)                             | Not. use         | 76        | 47.50      |
| (iii)                            | Up to 10 ton     | 38        | 23.75      |
| (iv)                             | 10-15 ton        | 32        | 20         |
| (v)                              | Above 15 ton     | 14        | 8.75       |
| <b>9. Use, of fertilizer</b>     |                  |           |            |
| <b>I. Nitrogen kg/per ha.</b>    |                  |           |            |
| (i)                              | Not. use         | 27        | 16.87      |
| (ii)                             | Up to 50 kg      | 24        | 15         |
| (iii)                            | 51-80 kg         | 67        | 41.87      |
| (iv)                             | 80-120 kg        | 42        | 26.25      |
| <b>II. Phosphorus/per ha.</b>    |                  |           |            |
| (i)                              | Not. use         | 28        | 17.50      |
| (ii)                             | 50-80. kg        | 23        | 14.37      |
| (iii)                            | 80-120 kg        | 69        | 43.12      |
| (iv)                             | Above 120 kg     | 40        | 25         |
| <b>III. Potash kg/ per ha.</b>   |                  |           |            |
| (i)                              | Not use          | 26        | 16.25      |
| (ii)                             | Up to 50 kg      | 27        | 16.87      |
| (iii)                            | 51-80 kg         | 68        | 42.50      |
| (iv)                             | 80-120 kg        | 39        | 24.37      |
| <b>10. Irrigation</b>            |                  |           |            |
| (i)                              | Ridge & furrow   | 152       | 95.00      |
| (ii)                             | Drip irrigation  | 08        | 05.00      |
| <b>11. Weed control</b>          |                  |           |            |
| (i)                              | Not use          | 38        | 23.75      |
| (ii)                             | By hand          | 63        | 39.37      |
| (iii)                            | By chemical      | 59        | 36.87      |
| <b>12. Erthing up</b>            |                  |           |            |
| (i)                              | Not use          |           |            |
| (ii)                             | 10-15 day        | 29        | 18.12      |
| (iii)                            | 15-20 day        | 81        | 50.62      |
| (iv)                             | Above 20 day     | 50        | 31.25      |

**Table-2 : Contd....**

| Sl. No.                       | Practices                | Frequency | Percentage |
|-------------------------------|--------------------------|-----------|------------|
| <b>13. Insect control</b>     |                          |           |            |
|                               | Not use                  | 160       | 100        |
| <b>14. Disease management</b> |                          |           |            |
| (i)                           | Not use                  | 48        | 30         |
| (ii)                          | Mankozeb                 | 39        | 24.37      |
| (iii)                         | Carbendazim              | 73        | 45.62      |
| <b>15. Harvesting</b>         |                          |           |            |
| (i)                           | Mid January-Mid February | 56        | 35         |
| (ii)                          | Mid February-Mid March   | 104       | 65         |
| <b>16. Storage</b>            |                          |           |            |
| (i)                           | Pit method               | 23        | 14.37      |
| (ii)                          | Soil & sand              | 94        | 58.75      |
| (iii)                         | Flour                    | 43        | 26.87      |

membership in any organisation. The majority of the respondents (33.75%) had farming experience of up to 10 years, followed by (49.38%) respondents with 11 to 20 years of experience, and (16.87%) respondents with more than 20 years of experience of turmeric farming in the study region. The majority of respondents (40.00 percent) have land holdings between 1.01 and 2.0 ha, followed by (30.00 percent) who have land up to 1.0 ha and (24.37 percent) who have land between 2.01 and 4 ha. Just 5.63 percent of respondents have land greater than 4 hectares. The majority of the respondents grew the turmeric crop on land ranging from 0.32 ha to 0.66 ha. Though 20.62 percent of respondents cultivated the turmeric crop on less than 0.31 hectares, 12.50 percent cultivated it on more than 0.67 hectares. Agriculture (Turmeric cultivation) received the highest percentage of respondents (56.25%), followed by Agriculture (Turmeric cultivation) + Labour (12.50%), Agriculture (Turmeric cultivation) + Industry (9.38%), Agriculture (Turmeric cultivation) + Animal husbandry (15.62%), and Agriculture (Turmeric cultivation) + Service (06.25%). The respondents with the highest annual income (56.25 percent) have annual income between Rs. 1.0 and 2.0 lakh, followed by 25.62 percent with annual income less than Rs. 1.0 lakh. Though (11.25 percent) of respondents have annual incomes ranging from Rs. 2.0 to Rs. 4.0 lakh, only 6.88 percent have annual incomes exceeding Rs. 4.0 lakh. The majority of respondents (81.87 percent) used short-term credit, followed by mid-term (16.25 percent) and long-term (16.25 percent) (06.25 percent). The cooperative society was the source of credit for the majority of the respondents (81.87%), followed by friends/neighbors/relatives/others (47.50%) and nationalised banks (15.00%), respectively. Just 1.87 percent of those surveyed have taken out loans from money lenders. The majority of respondents (80.00%) have a moderate level of contact with extension agencies, followed by (15.00%) and (05.00%) who have a lower and

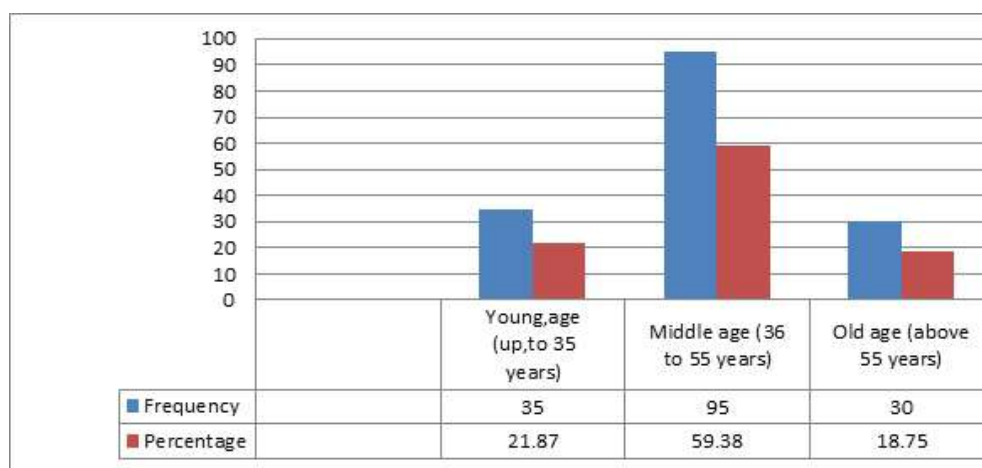


Fig-1 : Distribution of the respondents according to their age.

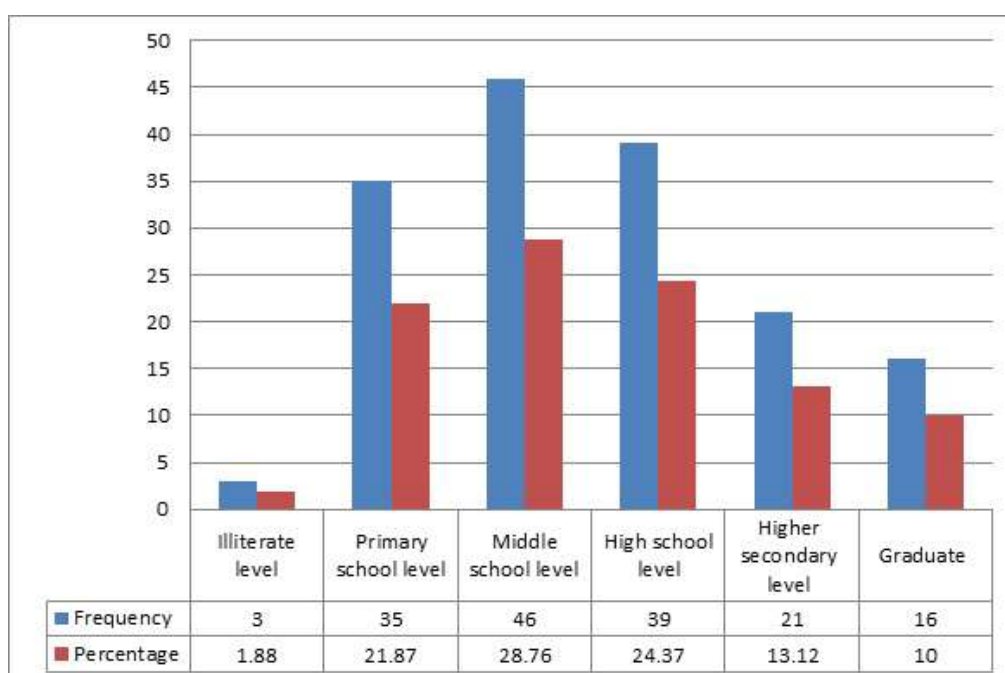


Fig-2 : Distribution of the respondents according to their education

higher level of contact with extension agencies, respectively. In terms of total contact with extension agencies, the majority of respondents (26.87 percent) have regularly contacted the Government Agriculture Department, followed by 27.50 percent, 10.62 percent, and 9.37 percent who have regularly contacted NHM, KVK, and Non-Governmental Agencies, respectively. Just 3.12 percent and 1.87 percent of respondents, respectively, have contacted the Kisan call centre and the Agriculture College on a regular basis. Irrigation is available to the limit of 63.12% of the respondents. Tube well is the most common irrigation source (28.75 percent), followed by pond (12.50 percent), well (11.87 percent), river (4.37 percent), canal (3.75 percent), and Dabri (3.75 percent) (1.87 percent). The total kharif season crop cultivated area by respondent was 320 ha, or 60.60

percent, total rabi season crop cultivated area was 155 ha, or 29.35 percent, and total summer season crop cultivated area was 53.12 ha, or 10.05 percent. Cropping intensity readings indicate that the majority (75%) of respondents have cropping intensity between 101 and 200 percent, with 25% of respondents having cropping intensity greater than 200 percent. Cropping strength was not at 100% in either of the respondents. The source of agricultural information, where the majority of respondents (66.25 percent) have medium level access to the source of information, followed by (23.75 percent) and (10.00 percent) of respondents who have high level and low level access to the source of information, respectively. The majority of respondents (62.50%) have a medium degree of scientific orientation, followed by moderate (20.00%) and low (17.50%) levels of scientific orientation.

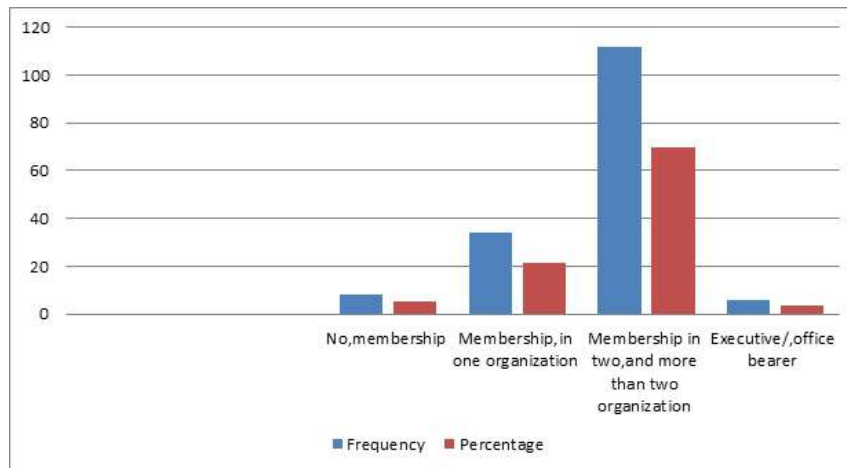


Fig.-3 : Distribution of respondents according to their social participation.

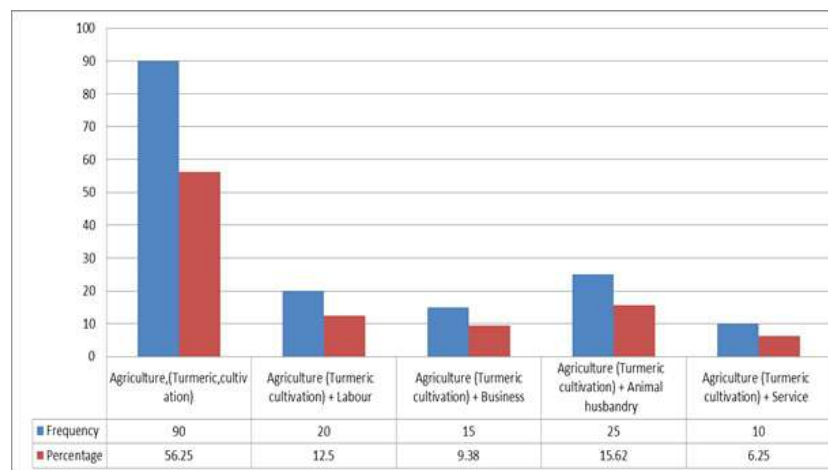


Fig.-4 : Distribution of respondents according to their occupation.

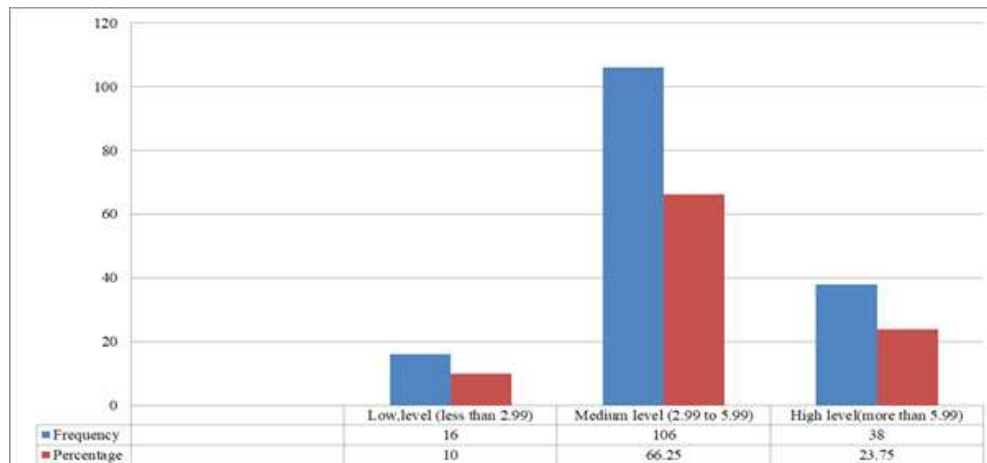


Fig.-5 : Distribution of respondents according to overall use or access with their source of information.

The majority of respondents (76.25 percent) have a medium level of understanding of turmeric development, followed by low (12.50 percent) and high (11.25 percent) levels of understanding. The pace at which turmeric processing technology is being implemented. The majority of respondents (66.88 percent) belong to the medium level of adoption, followed by the high level

(18.75 percent) and low level (14.37 percent) of adoption. The majority of respondents (81.25 percent) lack information about storage facilities, accompanied by a lack of proper price at the local market (75.00 percent), unviability processing unit (74.37 percent), non availability of improved varieties (73.75 percent), weak marketing facilities (68.75 percent), and lack of knowledge about

improved varieties (68.75 present) (67.50 percent), Agriculture labour was inaccessible in 46.87 percent of cases. a shortage The top three reasons were a lack of transportation (40.62 percent), a lack of knowledge of seed care approaches (31.25 present), and a lack of knowledge of credit facilities (25.00 present).

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## Characterization of Diverse Linseed Germplasm as per DUS, UPOV 2011

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### Abstract

Twenty eight varieties of Linseed (*Linum usitatissimum* L.) were sown on 10.11.2019 at Seed Breeding Farm, Department of Plant Breeding and Genetics, JNKVV, Jabalpur during Rabi 2019-20 in 5 rows of 5m length with 30cm row to row distance under recommended package of practices to maintain the reference varieties as per the DUS guidelines of PPV & FR Authority in three replications. The seeds of 32 varieties of linseed (*Linum usitatissimum* L.) were characterized using 15 morphological descriptors adopted from the DUS guidelines of PPV & FR Authority subsequently examined for their Distinctiveness, Uniformity and Stability and are maintained at JNKVV, Jabalpur.

**Key words :** Linseed, distinctiveness, uniformity, stability, characterization, UPOV 2011

### Introduction

Linseed or flax (*Linum usitatissimum*) is a multipurpose crop grown in many environments for food, feed, fibre and industry. The availability of diverse germplasm of characterization data and evaluation data is of greatest importance to realize the potential of flax in agriculture. Dhirhi, *et al.*, (2016)

Linseed (*Linum usitatissimum* L.)  $2n=30$ , is an important oilseed crop that belongs to the genus *Linum* of the family *Linaceae*. It is also called flax or flaxseed. Linseed or flax (*Linum usitatissimum*) is an important crop for seed oil, stem fiber and to a lesser extent, flour. Linseed oil is used for paints, inks, varnish and other wood treatments, soap, linoleum, putty and pharmaceuticals. The fiber from flax is a widely used and valuable raw material for textiles, thread/rope and packaging materials, the straw and short fiber for pulp to produce special papers: for cigarettes, currency notes and artwork; and the wooden part serves as biomass energy or litter in cattle farming (Rowland, 1998). Seeds of different species and varieties within plant species have specific characters, which are suitable for distinguishing of varieties differences. This fact has important place for DUS testing and variety identification and verification (Keefe, 1999).

The requirement of distinctness, uniformity and stability are assessed on the basis of characteristics. Describing the characteristics of a crop species based on standard descriptors is effective for better utilization and conservation of germplasm (Diederichsen and Richards, 2003). Look to the above facts study was undertaken for classification of 150 diverse linseed morphological germplasm based on Linseed descriptors or DUS guidelines or DUS descriptor as per UPOV 2011.

As DUS (distinctness, uniformity and stability),

testing is essential for grant of protection to new plant varieties under the Plant Variety Protection and Farmers Right Act 2001 (PVP & FR Act 2001). The act has provision to compare the candidate variety with the varieties of common knowledge on a set of relevant characteristics and commonly morphological data is also required at the time of filing of application. Therefore, keeping in view the above points, present investigation was undertaken to characterize the reference and farmers varieties of linseeds

### Materials and Methods

The experimental material comprised of thirty two varieties of linseed (*Linum usitatissimum* L.) were evaluated at Seed Breeding Farm, Department of Plant Breeding and Genetics, JNKVV, Jabalpur during Rabi 2017-18.

The experiment was conducted in a randomized block design (RBD) with three replications. Each plot consisted of 5 rows of 5m length with 30cm row to row distance. Varieties were evaluated for 15 traits, viz Time of flowering, Flower: size of corolla (mm), Flower: shape, Flower colour, Flower: aestivation, Flower: venation color, Stamen: colour of distal part of filament, Anther: color, Plant: growth habit, Plant: height (cm), Capsule: Size (mm), Capsule: dehiscence, Seed: color, Seed: size (length mm) and Seed: weight (1000 seed in g). These traits were recorded as per descriptor of DUS guidelines of PPV & FR Authority.

The data were recorded on 5 plants in each replication of each variety for all the characters, at specified stage of crop growth, when the character under study had full expression. All the flowering characteristics were recorded on the 50 days after sowing. Days to flowering was recorded at 50 percent plants with at least one open flower. The entire floral characteristics were

observed at 50 percent flowering. All the seeds characteristics was recorded 95 days after sowing or after harvesting likewise Seed : Colour, Seed : Size (mm) and Seed: Weight of 1000 seeds.

## Results and Discussion

Characterization is the description of plant germplasm. It determines the expression of highly heritable characters ranging from morphological or agronomical features. Morphological characters are considered as marker in the identification of linseed varieties, which are less influenced by environmental fluctuations. In present study to establish distinctiveness among 32 linseed varieties, 15 characteristics have been used (Table-2) as per the DUS guidelines on linseed. Each variety was regularly observed throughout the season at different growth stages, off types are roughed out. All morphological descriptor showed considerable variation for the majority of characters under study

**1. Time of flowering :** For each genotype, number of days taken from the day of sowing to the day on which 50% of the plants showed flowering was recorded as the number of days taken for 50% flowering it is classified into 3 categories early, medium and late. Only one variety of linseed was found to be early (< 50 days), 19 were medium (50-60 day) and 12 varieties were observed as late variety (> 60 days).

**2. Flower; Size of corolla :** It is recorded in beginning of flowering. It is divided into three classes small (15mm), medium (15-20mm) and large (>20mm). Out of 32 varieties of linseed only 2 varieties was observed as small, 8 were medium and remaining 22 varieties are large.

**3. Flower shape :** It must be recorded before afternoon. Flower shape grouped in 4 groups namely, funnel, star, disk and tubular form. 3 varieties are funnel shaped, 5 variety star shaped and 23 varieties was recorded as disk shape. None of them are found to be tubular shape.

**4. Flower color :** It is recorded in fully opened flower by visual observation and it is categorized into white, blue, violet, red-violet and red color. Maximum (21 varieties) contribution of violet color, 8 varieties are white in color. Blue, red and red violet each flower color has one variety.

**5. Flower aestivation:** It is recorded as arrangement of petals. According to this it is classified into 3 classes twisted, semi-twisted and valvet. 22 varieties were observed as twisted pattern 5 were semi-twisted and 5 were valvet.

**6. Flower; venation color :** It is scored in fully developed flower. It has 5 classes-white, Light-violet, violet, blue and red. 8, 2, 20, 1 and 1 varieties were recorded respectively.

**7. Stamen :** color of distal part of filament: it is recorded

after flower opening. On the basis of filament color it is divided into 4 categories viz, white, violet, blue and red color. 25 varieties (mostly) observed as white filament, violet and red has one variety, and remaining 5 varieties was blue in color.

**8. Anther; color :** It is recorded as immediately after flower opening. Anther color showed a continuous range of color variation as, blue, violet, cream and grey. Out of 32 varieties 12 has cream color, 13 has gray in color, and remain 7 has blue color and none was found to be violet in color.

**9.Plant; Growth habit :** It is recorded considering both the angle of the basal branching and the crop canopy. It is classified into three group viz, bushy, semi-erect and erect none varieties are found to be bushy growth habit, seven variety were recorded as semi-erect and 25 were recorded as erect growth habit.

**10.Plant; height :** The height of plant from the base to the tip of the main stem was recorded in centimeters, plant height divided into 3 classes namely dwarf (<50cm), Medium (50-70cm) and Tall (>70cm). Four varieties have dwarf type, 23 has medium and 3 has tall plant height.

**11. Capsule size :** It is recorded of fully develop capsule in millimeter. On the basis of capsule size it is divided in three categories viz, Small (<7mm), Medium (7-8mm) and Bold (>8mm). 5 variety were recorded small size, 25 were in medium categories and only two were bold type capsule found.

**12.Capsule dehiscence :** It is observed at the time of maturity. Grouped into two classes Semi- dehiscence and non-dehiscence. 11 variety were recorded as semi-dehiscence and 21 were non-dehiscence.

**13. Seed color :** It is recorded as visual observation after harvesting. It has five classes fawn, yellow, light brown, brown and dark brown. None of the varieties were found suitable in fawn and yellow color. 8 were in light brown color, 17 were brown in color and 5 were dark brown in color.

**14. Seed size :** Longitudinal dimension measured as the distance from the base to the tip of the seed. It also has three classes Small (<4.5mm), medium (4.5-5.5mm) and bold (>5.5mm). 15 varieties were observed as small seed size, 15 varieties were in medium in size and remaining 2 were bold type seed size.

**15. Seed weight :** Weight of 1000 well developed grain collected from the bulk of plants selected was recorded and expressed in gram. According to weight it is classified into 3 classes low (<6g), medium (6-8g) and bold (>8g). 6 varieties were showed low seed weight 22 were medium and 04 were showed high seed weight.

**Table-1 : Characterization of 32 diverse linseed germplasm based on Distinctness (D), Uniformity (U) and Stability(S) as per DUS, UPOV 2011.**

| S.N. | Trait                                      | Descriptor state                                                                                                     | Class or scale      | Distribution by classes of descriptor (%) |
|------|--------------------------------------------|----------------------------------------------------------------------------------------------------------------------|---------------------|-------------------------------------------|
| 1.   | Time of flowering                          | Number of days taken from the day of sowing to the day on which 50 % of the plants showed flowering was recorded     | Early (< 50 days)   | 1 (3.13%)                                 |
|      |                                            |                                                                                                                      | Medium (50-60 days) | 19 (59.38%)                               |
|      |                                            |                                                                                                                      | Late (>60 days)     | 12 (37.50%)                               |
| 2.   | Flower : size of corolla (mm)              | It is recorded in beginning of flowering.                                                                            | Small (<15 )        | 2 (6.25%)                                 |
|      |                                            |                                                                                                                      | Medium (15-20)      | 8 (25.00%)                                |
|      |                                            |                                                                                                                      | Large (>20)         | 22 (68.75%)                               |
| 3.   | Flower : shape                             | It must be recorded before noon                                                                                      | Funnel              | 4 (12.50%)                                |
|      |                                            |                                                                                                                      | Star                | 5 (15.63%)                                |
|      |                                            |                                                                                                                      | Disk                | 23 (71.88%)                               |
|      |                                            |                                                                                                                      | Tubular             | 00 (0.00%)                                |
| 4.   | Flower colour                              | It scored in fully opened flower by visual observation                                                               | White               | 8 (25.00%)                                |
|      |                                            |                                                                                                                      | Blue                | 1 (3.13%)                                 |
|      |                                            |                                                                                                                      | Violet              | 21 (65.63%)                               |
|      |                                            |                                                                                                                      | Red-violet          | 1 (3.13%)                                 |
|      |                                            |                                                                                                                      | Red                 | 1 (3.13%)                                 |
| 5.   | Flower : aestivation                       | It is recorded as arrangement of petals.                                                                             | Twisted             | 22 (68.75%)                               |
|      |                                            |                                                                                                                      | Semi-twisted        | 5 (15.63%)                                |
|      |                                            |                                                                                                                      | Valvet              | 5 (15.63%)                                |
| 6.   | Flower : venation color                    | It is recorded in fully developed flower.                                                                            | White               | 8 (25.00%)                                |
|      |                                            |                                                                                                                      | Light-violet        | 2 (6.25%)                                 |
|      |                                            |                                                                                                                      | Violet              | 20 (62.50%)                               |
|      |                                            |                                                                                                                      | Blue                | 1(3.13%)                                  |
|      |                                            |                                                                                                                      | Red                 | 1 (3.13%)                                 |
| 7.   | Stamen : colour of distal part of filament | It is recorded after flower opening                                                                                  | White               | 25 (78.13%)                               |
|      |                                            |                                                                                                                      | Violet              | 1 (3.13%)                                 |
|      |                                            |                                                                                                                      | Blue                | 5 (15.63%)                                |
|      |                                            |                                                                                                                      | Red                 | 1 (3.13%)                                 |
| 8.   | Anther : color                             | Immediately after flower opening                                                                                     | Cream               | 12 (37.50%)                               |
|      |                                            |                                                                                                                      | Grey                | 13 (40.63%)                               |
|      |                                            |                                                                                                                      | Violet              | 00 (0.00%)                                |
|      |                                            |                                                                                                                      | Blue                | 07 (21.88 %)                              |
| 9.   | Plant : growth habit                       | Recorded considering both the angle of the basal branching and the crop canopy                                       | Bushy               | 00 (0.00%)                                |
|      |                                            |                                                                                                                      | Semi-erect          | 07 (21.88%)                               |
|      |                                            |                                                                                                                      | Erect               | 25 (78.13%)                               |
| 10.  | Plant : height (cm)                        | The height of plant from the base, to the tip of the main stem was recorded in centimeters.                          | Dwarf (< 50)        | 06 (18.75%)                               |
|      |                                            |                                                                                                                      | Medium (50-70)      | 23 (71.88%)                               |
|      |                                            |                                                                                                                      | Tall ( >70)         | 03 (9.38%)                                |
| 11.  | Capsule : Size (mm)                        | It is recorded of fully developed capsule                                                                            | Small (<7.0)        | 05 (15.63%)                               |
|      |                                            |                                                                                                                      | Medium (7-8)        | 25 (78.13%)                               |
|      |                                            |                                                                                                                      | Bold (> 8)          | 02 (6.25 %)                               |
| 12.  | Capsule : dehiscence                       | It is recorded at the maturity time                                                                                  | Semi-dehiscent      | 11 (34.38%)                               |
|      |                                            |                                                                                                                      | Non-dehiscent       | 21 (65.63%)                               |
| 13.  | Seed : color                               | It is recorded as visual observations                                                                                | Fawn                | 01 (3.13%)                                |
|      |                                            |                                                                                                                      | Yellow              | 01 (3.13%)                                |
|      |                                            |                                                                                                                      | Light brown         | 08 (25.00%)                               |
|      |                                            |                                                                                                                      | Brown               | 17 (53.13%)                               |
|      |                                            |                                                                                                                      | Dark brown          | 05 (15.63%)                               |
| 14.  | Seed : size (length mm)                    | Longitudinal dimension measured as the distance from the base to the tip of the seed.                                | Small ( < 4.5)      | 15 (46.88%)                               |
|      |                                            |                                                                                                                      | Medium(4.5-5.5)     | 15 (46.88%)                               |
|      |                                            |                                                                                                                      | Bold (> 5.5)        | 02 (6.25%)                                |
| 15.  | Seed : weight (1000 seed in g)             | Weight of 1000 well-developed grains collected from the bulk of plants selected was recorded and expressed in grams. | Low (<6)            | 06 (18.75%)                               |
|      |                                            |                                                                                                                      | Medium (6-8)        | 22 (68.75%)                               |
|      |                                            |                                                                                                                      | High (> 8)          | 04 (12.50%)                               |

A range of descriptors was elaborate for 150 diverse linseed accessions maintained at and these have uses for both the characterization of germplasm and its evaluation for use by farmers and breeders. Diversity in the germplasm was essential to meet different purposes of the crop such as increased yield (Joshi and Dhawan, 1986), wider adaptation, desirable quality, pest and disease resistance (Begum *et al.*, 2007). Information on the extent and nature of interrelationship among characters help in formulating efficient scheme of multiple trait selection. Besides this, knowledge of the naturally occurring diversity in a population helps identifying diverse groups of genotypes (Tedesse *et al.*, 2009). These findings are significant for understanding linseed domestication and also are useful in classifying intra specific diversity of cultivated of linseed, establishing a core subset of the linseed collection and exploring new sources of genes for linseed improvement (Fu, 2005). Adugna *et al.* (2006), Savita (2006), Fulkar *et al.* (2007), Sinha and Wagh (2013) reported wide range of genetic diversity in linseed.

In conclusion, there is substantial morphological variation within the linseed germplasm and reflecting both regional and altitude differences. Yield contributing characters like plant height, time of flowering, capsule size, seed size and seed weight showed variation themselves. The highest 78.13% lines comes under white stamen colour of distal part of filament and erect plant growth habit, 71.88% lines showed disk flower shape and medium plant height, 68% lines grouped under large flower size of corolla, twisted flower aestivation and medium seed weight and 65.63% flower colour classified under violet colour. Results from the present study indicate that several genes interact for development of different characters. Measurements of morphological variation will be helpful in the selection of distinguishable, uniform and stable traits, which will be very useful at the time of seed production, monitoring programme of linseed. In addition to that suitable parents for breeding programme may be used by making diallel among diverse parents. They provide good transgressive segregant for oil, linen, dual purpose integrated with value addition along with regional adaptation. In this way the crop diversity can be exploited for reaching the goals as well as

linseed with regarding the area, production and productivity in future with respective challenges.

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## Impact of Covid-19 Pandemic on Post-Harvest Technologies and Value Chain System of Vegetables in Bihar

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### Abstract

The COVID-19 pandemic is beginning to disrupt food value chains, impacting the livelihood of farmers and the diets of rural and urban households. These effects are likely to hit the poorest and most vulnerable farmers and consumers the hardest, but they are not yet well understood. More evidence is needed to guide the government and other organizations in devising responses. To understand these effects, a qualitative and rapid appraisal of the vegetable value chain was conducted. The study is based on a large value chain survey conducted through phone interviews (March 23-April 20) with key stakeholders: Small-scale farmers and large-scale investors. The study divides the whole analysis into short term, or immediate, impacts on the fruit and vegetable supply chain, and then consider long-term impacts that are likely to persist for the entire duration of the pandemic. The findings suggest that urban consumption of fruits and vegetables is declining, and the trade is affected by travel ban, which reduces competition and farmers have to face lower prices and reduced access to inputs. Over the longer term, the potential impacts will be felt through input markets, most notably labor, and structural changes in the industry, which may undergo fundamental and largely irreversible shocks, such as consolidation and a move toward online shopping.

**Key words :** *value chains system, logistics support, nutritionally rich foods, post-harvest technology, and consumption pattern.*

### Introduction

India is the second-largest producer of vegetables in the world (ranked next to China) and accounts for 15 percent of world's production of vegetables. The current production level is over 146.55 million MT and the total area under vegetable cultivation is around 8.49 million hectares which are about 3 percent of the total area under cultivation in the country. It is estimated that around 20-25 percent of the total vegetables are lost due to poor post-harvesting practices. Less than 2 percent of the total vegetables produced in the country are commercially processed as compared to 70 percent in Brazil and 65 percent in the USA.

With respect to post-harvest operations and value addition, there is a considerable gap between the gross production and net availability. Furthermore, only a small fraction of fruits and vegetables are utilized for processing (less than 1%) and exported (Fruits 0.5 percent and Vegetables 1.7 percent) compared to other countries. Post-harvest losses in fruits and vegetables are very high (20-40 percent). About 10-15 percent fresh fruits and vegetables shrivel and decay, lowering their market value and consumer acceptability, also due to current Covid-19 situations it increases day by day.

In light of the Covid-19 case, the government closed schools, banned all public gatherings and sporting activities, and recommended social distancing. Other measures to contain the spread of the virus soon followed. Travellers from abroad were put into a 14-day

mandatory quarantine, bars were closed until further notice, and travel through land borders was prohibited. Several regional governments banned all public transportation and imposed restrictions on other vehicle movements between cities and rural areas. While these actions are expected to slow the spread of the disease, they are likely to have substantial effects on value chains, and thus on the livelihoods of farmers and other workers, and on consumption also. Measures to contain Covid-19 are expected to have significant effects on food value chains the horticultural products are expected to be especially vulnerable because of their seasonal labor requirements and high perish ability. Over 30 percent of the vegetables lie un-harvested, due to the acute shortage of labor. The harvested crops remain stacked in the fields and houses of farmers, as they could not transport the vegetables without logistics support. Anxiety prevails over the village at the sudden turn of their fortune. The possibility of rain has only compounded their problem. Immediate sale of the product is crucial to them for two reasons: to subsist and to grow the next crop. The rising unemployment among domestic workers in the coming months may provide a ready supply of substitute workers, attracting workers to the fields will require higher wages and production costs. The spread of novel corona virus, SARS, CoV2, and the Covid-19 disease has had unprecedented impact on all food markets, including the market for fruits and vegetables. Throughout the value chain, grower-shippers accustomed to just-in-time inventory management systems and retailers able to stock every product with minimal interruption faced

shocks in both supply and demand. In this article, we reviewed the nature of these changes due to the spread of Covid-19.

### Objectives :

Impact of Covid-19 on fruits and vegetable traders

Importance of post-harvest technology in fruits and vegetables

Scope of fruits and vegetable preservation and value addition in India

Economical value addition processes and preservation techniques in fruits and vegetables.

To understand these effects, a qualitative and rapid appraisal of the vegetable value chain was conducted. The study is based on a large value chain survey conducted through phone interviews (March 23-April 20) with key stakeholders: Small-scale farmers, large scale investors. Given that this assessment was done based on a limited and non-representative number of interviews, caution is warranted for extrapolation of our observations. They should be seen more as hypotheses of impacts on these value chains. (Therein need to have intended to substantiate these findings with more representative surveys shortly.) The study divides the whole analysis into short-term, or immediate, impacts on the fruit and vegetable supply chain, and then consider long-term impacts that are likely to persist for the entire duration of the pandemic,

## Results and Discussion

### 1. Impact of covid-19 on fruits and vegetable trade :

The findings suggest that urban consumption of fruits and vegetables is declining, and the trade is affected by travel bans and it reduces competition and farmers have to face lower prices and reduced access to inputs. Again, urban demand for fruits and vegetables—high value, nutritionally rich foods—is declining. It is possible that this is driven by misinformation regarding the risk of contracting COVID-19 from produce. If so, there is a need for widespread and effective information campaigns. Contracting for fresh produce helps buyers ensure a consistent supply of high-quality products from trusted suppliers, with lower transaction costs than purchasing from a spot, or terminal market. In the present circumstance like Covid-19 losses arise on perishable crops, which affect the economy.

Perishability separates the fresh produce industry from most other agricultural sectors, particularly in terms of the most visible impact of COVID-19 on the retail market. To overcome these losses post-harvest technology like preservation and value addition is important to solve the problem. The analysis made in terms of its effect on vegetable trade, on farmer's daily life and in terms of changes made in their daily consumption

pattern. It was found that urban retail prices are not significantly affected so far. Both supply and demand appear to be impacted simultaneously: The lower urban demand that typically leads to a reduction in vegetable prices is balanced by a declining vegetable supply.

A number of farmers indicated that they had to leave some vegetables in the field to rot due to the lack of buyers. The study also reflects consumers' fears of being in proximity to others, online food sales surged as the pandemic spread. Before the spread of COVID-19, only 1.5 percent of groceries were sold online in Patna, a number that had grown to over 9.0 percent by the third week of March. In fact, grocery chains were reporting surges in online orders of up to 300 percent and some were limiting physical access to stores. Although much of this online ordering activity was surely for nonperishable and household items, the fact that many supermarkets charge fixed online delivery fees means that shoppers have an incentive to order their entire shopping list online and avoid the risk of shopping in physical stores

### (a) Vegetable trade and consumption are reduced :

Since the start of the Covid-19 crisis, despite this period being the fasting season when vegetable consumption is usually higher. Based on our interviewees, this seems to be linked to four factors :

There is a presumption among some urban residents that consuming raw vegetables increases the likelihood of contracting and spreading the virus, reducing demand for certain vegetables.

Some—especially larger and wealthier—traders are taking precautionary measures to avoid exposing themselves to the virus. These measures appear to have reduced their vegetable trading activity.

The travel bans have reduced the volume and frequency of trucks coming to market

Urban retail prices are not significantly affected so far. Both supply and demand appear to be impacted simultaneously : The lower urban demand that typically leads to a reduction in vegetable prices is balanced by a declining vegetable supply

### (b) Producer prices for vegetables are on the decline :

Fewer traders are traveling to rural areas because of the travel ban, the social distancing policy, and fear of infection. Combined with reduced urban demand and oversupply, producer prices are rapidly declining.

**(c) Farm losses seem to be increasing :** A number of farmers we contacted indicated that they had to leave some vegetables in the field to rot due to the lack of buyers.

**(d) There is shortage of farm inputs and their prices are increasing :** Prices of important inputs crucial to

vegetable production—including fungicides, insecticides, herbicides, fertilizers, and improved seeds—are increasing due to shortages. These seem to be linked to land border closings, which have blocked (sometimes illegal) imports from neighboring countries, and to reduced imports from China.

**(e) Labor is becoming scarce :** Vegetable production is labor intensive and the Central Rift Valley, where most.

**(f) Commercial production :** Occurs, usually attracts a large number of daily laborers . They often gather in set locations in rural towns to be picked up by vegetable producers. However, in response to restrictions on travel and gatherings (informally imposed by the regional police), these workers are increasingly returning to their home areas.

**2. Importance of post-harvest technology in fruits and vegetables :** Post harvest loss reduction technology encompasses the usage of optimum harvest factors, reduction of losses in handling, packaging, transportation and storage with modern infrastructure machinery, processing into a wide variety of products, home scale preservation with low cost technology. Use of thermal processing, low temperature, drying, chemical and biological reactions coupled with other preservation techniques are applied to enhance the storability. Containers and packaging materials confer portability as well as extend the shelf-life. Adoption of these techniques could make available a large quantity of food by avoiding losses and provide better quality food and nutrition, more raw materials for processing, thus ensuring better returns to the farmers.

**3. More scope of fruits and vegetable preservation and value addition in India :** The techniques like preservation and value addition in fruits and vegetables reduces farmers losses when market is not available. Research stations found economical techniques for preservation. Importance of Post-harvest technology lies in the fact that it has the capability to meet food requirement of growing population by eliminating losses making more nutritive food items from raw commodities by proper processing and fortification. Post-harvest technology has potential to create rural industries. India, where 80 percent people live in the villages and 70 percent of them depend on agriculture has experienced that the process of industrialization has shifted the food, feed and fibre industries to urban areas. This process has resulted in capital drain from rural to urban areas, decreased employment opportunities in the rural areas balance trade in favour of urban sector and mismatched growth in economy and standard of living between rural and urban people. It is possible to evolve appropriate technologies which can establish agricultural based rural

industries. The farmer whose role has been reduced to producer can be transformed into producer cum processor and thus getting more dividends for hard labour, input, kind of risk taken and generating resource for socio-economic advancement keeping pace with the modern times.

**4. Increased economical value addition processes and preservation techniques in fruits and vegetables :**

These days, a lot of attention is being given on health and nutrition of individuals. Today, consumers demand food products, which are nutritious as well as convenient to use. Lot of focus has been given to the food products having some additional health benefits rather than the conventional products. Food powders contain the natural flavor and health benefits rather than artificial food flavoring substances, and they can be used as natural food additives. The uses of food powders are unlimited, and they can be used to prepare processed products as well as for culinary purposes. The processing of the food in the forms which are preferred by the consumer, have long shelf life and involve low cost of production. Appropriate processing at the time of gluts, can be profitable to the farmers, besides making available the nutrients to the Indian dietaries, thus meeting nutritional security of the population. Different preservation techniques [Preservation through Canning, Bottling, Freezing, Dehydration, Drying, Ultraviolet and Ionizing Radiations] and value addition processes [Value added products like, jam, syrup etc. and canned fruits/vegetables] in important fruits [Grapes, Pomegranate, Watermelon, Citrus, Banana] and vegetables [Leafy vegetables and fruit vegetables] will cumulate the outcome.

## Conclusions

Implementation of efficient postharvest processing technologies were able to minimize the losses of fruits and vegetables and enhance the food availability which can reduce the scarcity of the agriculture produces among the consumers due to pandemic Covid-19. Maintenance of the physical appearance, flavour, market value and other characteristics of consumable commodities are required for proper and scientific processing. More and more emphasis is required for minimizing the fruits and vegetables losses throughout the world for overcoming their scarcity in any corner of the world. This would help to enhance the per capita availability of fruits and vegetables by applying intensive and modern technologies because of reduction in losses automatically increased the availability of products without applying extra resources for enhancing the production and productivity. The multinationals now entering the food industry have an international marketing network and have their brand

loyalties all over the world. This will enable the Indian products reaching all over the world in the form and packing required. With the rise in the per capita income particularly of the middle class a drastic change in the food habits has been noticed. This will lead to an increased domestic consumption of processed foodstuffs. A strong and dynamic food processing sector could play a vital role in diversifying agricultural activities, improving value addition opportunities and creating surplus for exports of agro food products. The desired growth of horticulture sector in general and economic prosperity of rural farmer in particular is achievable only with the effective integration and synergy between horticulture and agro based industries. Value addition ensures better market and remunerative price of the horticultural produce by

making it more marketable, creating better entrepreneurship for the unemployed youth.

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Book: Post Harvest Management & Value Addition of Fruits & vegetable: Author-TNAU



## The Study about Socio-Economical Profile of the Respondents of Bund and Sole Cultivation Practices of Pigeonpea of Chhattisgarh State

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### Abstract

The purpose of this study was to study about socio-economical profile of the respondents of bund and sole cultivation practices of pigeonpea of chhattisgarh state. To serve this purpose, a sample size of 120 respondents were selected from 2 blocks of Kabirdham district during the year 2019-20. The findings of the study shows that the majority of farmers who practiced bund cultivation of pigeonpea falls under age group of "36 to 55 years", educated up to primary school residing with family size up to 5 members, having 11 to 20 years farming experience with membership of one social organization, whereas farmers of sole cultivation majority were belonged middle age group, educated up to higher secondary school, had 6 to 8 members in family, having farming experience up to 10 years with membership in one organization. The result reveals that all the respondents of both bund and sole crop were practiced agriculture as their main occupation and Agriculture accounts for the majority of household income, which was typically in the range of Rs. 1.0 to 2.5 lakh. Farmers with modest to medium sized land holdings dominated the study area (1.01 to 2 ha).

**Key word :** Socio-economical profile, bund and sole farmers, cultivation practices of pigeonpea.

### Introduction

Pigeonpea (Arhar) commonly known as red gram or tur is the second most important pulse crop in the country which accounts for about 15.9% of the total pulse area and 17.06% of total pulse production of the country (Directorate of pulses department, Bhopal, 2017-18). It is mainly eaten in the form of split pulse as 'dal' and supplies a major share of the protein requirement of the vegetarian population of the country. It is an integral part of the subsistence and rainfed farming systems in many parts of India because it can be grown successfully under rainfed or low input condition and provide nutritive food, feed, fodder and fuel wood. Being a legume crop it possesses valuable properties as restorer of nitrogen to the soil. Availability of pulses for human consumption during 1951 to 1961 per capita availability of pulses varied from 59-72 gms, but in general remained above 60 gms reaching a peak availability of 75 gms in 1959. Later however, there has been a steady decline in per capita availability, the lowest figures, 39 gms being reached in 1977 due to low production. The requirement of protein is 84 g/individual/day as per World Health Organization standards.

Pigeonpea is sown in India during the first two weeks of June, typically in line sowing using a seed drill or desi plough. India is the world's largest pulse producer, with about 29 million hectares under cultivation. It takes top place in both area and production, with 34% and 26%, respectively. The area of pigeonpea during 2018-19 was 4.549 million ha with the production of 33.154 lakh tonne

and productivity was 7.29 q/ha. (Source: Directorate of Pulses Development, India)

In Chhattisgarh, pigeonpea is cultivated as either as a flat sown crop or in the bunds; latter being the predominant due to lower availability of land and poor drainage and water logging systems. In comparison to a flat-sown crop, raised beds or ridges promote improved aeration and nodulation. The area of pigeonpea in Chhattisgarh during 2018-19 was 0.131 million ha with the production of 0.98 lakh tonne and productivity was 7.48 q/ha. (Source: Directorate of Pulses Development, India)

The Kabirdham or Kawardha district of Chhattisgarh is one of the most important pigeonpea-growing district and the increase area under pigeonpea crops in Kawardha district has brought a change in the social as well as economic condition of the farmers." The area of pigeonpea in Kabirdham during 2018-19 was 6439 ha with the production of 849.95 metric tonne and productivity was 13.20 q/ha. (Source: Directorate of Economics and Statistics, Govt. of C.G.)

### Research Methodology

The present study was carried out during 2019-2020 at the Kabirdham district of Chhattisgarh due to its maximum area coverage and productivity under pigeonpea. The pigeonpea is also grown in both conditions as sole crop and bund cultivation. Out of total 4 Blocks of the District, 2 Blocks namely Kawardha and Pandariya were selected purposively because of maximum number of farmers were practiced pigeonpea cultivation by both the methods. 5 pigeonpea growing villages from each block were

Table-1 : Distribution of the respondents according to their socio-personal characteristics.

| S. No.    | Particular                                  | Bund farmers (n=60) |       | Sole farmers (n=60) |       | Overall (n=120) |       |
|-----------|---------------------------------------------|---------------------|-------|---------------------|-------|-----------------|-------|
|           |                                             | F                   | %     | F                   | %     | F               | %     |
| <b>1.</b> | <b>Age</b>                                  |                     |       |                     |       |                 |       |
| i.        | Up to 35 years                              | 14                  | 23.33 | 13                  | 21.67 | 27              | 22.50 |
| ii.       | 36-55 years                                 | 44                  | 73.34 | 42                  | 70.00 | 86              | 71.67 |
| iii.      | More than 55 years                          | 02                  | 03.33 | 05                  | 08.33 | 07              | 05.83 |
| <b>2.</b> | <b>Education</b>                            |                     |       |                     |       |                 |       |
| i         | Illiterate                                  | 07                  | 11.67 | 03                  | 05.00 | 10              | 08.33 |
| ii        | Primary school                              | 20                  | 33.34 | 12                  | 20.00 | 32              | 26.67 |
| iii       | Middle school                               | 06                  | 10.00 | 06                  | 10.00 | 12              | 10.00 |
| iv        | High school                                 | 08                  | 13.33 | 09                  | 15.00 | 17              | 14.17 |
| v         | Higher Secondary school                     | 14                  | 23.33 | 27                  | 45.00 | 41              | 34.16 |
| vi        | Graduation and above                        | 05                  | 08.33 | 03                  | 05.00 | 08              | 06.67 |
| <b>3.</b> | <b>Size of family</b>                       |                     |       |                     |       |                 |       |
| i         | Small family<br>(Up to 5 members)           | 36                  | 60.00 | 22                  | 36.67 | 58              | 48.33 |
| ii        | Medium family<br>(6 to 8 members)           | 21                  | 35.00 | 29                  | 48.33 | 50              | 41.67 |
| iii       | Large family (more than 8 members)          | 03                  | 05.00 | 09                  | 15.00 | 12              | 10    |
| <b>4.</b> | <b>Farming experience</b>                   |                     |       |                     |       |                 |       |
| i         | Up to 10 years                              | 26                  | 43.33 | 28                  | 46.67 | 54              | 45    |
| ii        | 11 to 20 years                              | 29                  | 48.34 | 17                  | 28.33 | 46              | 38.33 |
| iii       | More than 20 years                          | 05                  | 08.33 | 15                  | 25.00 | 20              | 16.67 |
| <b>5.</b> | <b>Social participation</b>                 |                     |       |                     |       |                 |       |
| i         | No membership                               | 05                  | 08.33 | 07                  | 11.67 | 12              | 10    |
| ii        | Membership of one organization              | 28                  | 46.67 | 33                  | 55.00 | 61              | 50.84 |
| iii       | Membership of two organization              | 24                  | 40.00 | 19                  | 31.67 | 43              | 35.83 |
| iv        | Executive office bearer in any organization | 03                  | 05.00 | 01                  | 01.67 | 04              | 03.33 |

selected purposively. 12 respondents from each selected village were considered as respondents, out of which 6 (50.00%) farmers practiced pigeonpea cultivation as sole crop and remaining 50 per cent were practiced pigeonpea cultivation in bunds. The data was collected by personal interview with the help of well prepared, structured and pretested interview schedule. The data collected were tabulated and analyzed using appropriate statistical tools and methods.

## Results and Discussion

The data presented in Table-1 has Socio-personal characteristics of respondent indicated that as regard to involvement in age shows that (73.34 per cent) of the bund cultivation of pigeonpea farmers reside to middle age group "36 to 55 years" whereas, the majority (70.00 per cent) of sole farmers were involve middle age group "36 to 55 years" and (33.34%) were found to be studied up to primary school of bund farmers. Whereas, 45.00 per cent of the higher secondary school of sole farmers. The data regarding size of family majority (60.00%) of the bund farmers had small family "up to 5 members", whereas 48.33 per cent of the sole farmers had medium farmers (6 to 8 members). The data regard of farming experience majority of 48.34 per cent of the bund farmers had 11 to 20 years, whereas 46.67 per cent of the sole farmers had up to 10 years. As social participation maximum of the respondent (46.67 per cent) had membership of one

organization of bund farmers, whereas 55.00 per cent of respondent had same of sole farmers.

The data given in table-2 Socio-economic characteristics of respondent, regarding the occupation, reveals that all the respondent both bund and sole crop were practiced agriculture as their main occupation. In case of respondent practicing pigeonpea cultivation as bund crop, about 21.67 percent respondent were practicing labour as their secondary occupation which can followed by the respondents were having services and animal husbandry as secondary occupation with agriculture i.e. 10.00 and 6.67 percent respectively. While 5.0 per cent were having business as secondary occupation with agriculture. In case of the farmers practiced the pigeonpea cultivation as sole crop, about 25.00 percent respondent were having labour as secondary occupation along with agriculture who were followed by 15.00 and 8.33 percent respondent who were practiced animal husbandry and services as their secondary occupation respectively. Only 5.00 percent respondents were having business as their secondary occupation along with agriculture. In case of overall respondent, 23.33 percent were work as labour as secondary occupation followed by 9.16 and 10.83 percent respondents having service and animal husbandry respectively as their secondary occupation similarity, only 5.0 respondent were having business as their secondary occupation along with agriculture.

**Table-2 : Distribution of the respondents according to their occupation.**

| S.No. | Category                       | Bund farmers |       | Sole farmers |       | Overall |       |
|-------|--------------------------------|--------------|-------|--------------|-------|---------|-------|
|       |                                | F            | %     | F            | %     | F       | %     |
| 1.    | Agriculture                    | 60           | 100   | 60           | 100   | 120     | 100   |
| 2.    | Agriculture + Labor            | 13           | 21.67 | 15           | 25.00 | 28      | 23.33 |
| 3.    | Agriculture + Service          | 06           | 10.00 | 05           | 08.33 | 11      | 9.16  |
| 4.    | Agriculture + Animal husbandry | 04           | 06.67 | 09           | 15.00 | 13      | 10.83 |
| 5.    | Agriculture + Business         | 03           | 05.00 | 03           | 05.00 | 06      | 5.00  |

F = Frequency    % = Percentage    \*Data are based on multiple responses.

**Table-3 : Distribution of the respondents according to their annual income.**

| S.No. | Category                 | Bund farmers (n=60) |       | Sole farmers (n=60) |       | Overall (n=120) |       |
|-------|--------------------------|---------------------|-------|---------------------|-------|-----------------|-------|
|       |                          | F                   | %     | F                   | %     | F               | %     |
| 1.    | Up to Rs.1.0 lakh        | 10                  | 16.67 | 08                  | 13.33 | 18              | 15    |
| 2.    | Rs. 1.0 lakh to 2.5 lakh | 34                  | 56.66 | 31                  | 51.67 | 65              | 54.17 |
| 3.    | Rs.2.51 lakh to 5 lakh   | 13                  | 21.67 | 16                  | 26.67 | 29              | 29.16 |
| 4.    | Above Rs. 5.0 lakh       | 03                  | 05.00 | 05                  | 08.33 | 08              | 6.67  |

(F = Frequency    % = Percentage)

**Table-4 : Distribution of the respondents according to their land holding.**

| S. No. | Category              | Bund farmers (n=60) |       | Sole farmers (n=60) |       | Overall (n=120) |       |
|--------|-----------------------|---------------------|-------|---------------------|-------|-----------------|-------|
|        |                       | F                   | %     | F                   | %     | F               | %     |
| 1.     | Marginal (up to 1 ha) | 10                  | 16.67 | 04                  | 06.67 | 14              | 11.67 |
| 2.     | Small (1.01 to 2 ha)  | 40                  | 66.67 | 39                  | 65.00 | 79              | 65.83 |
| 3.     | Medium (2.01 to 4 ha) | 08                  | 13.33 | 12                  | 20.00 | 20              | 16.67 |
| 4.     | Large (above 4.0 ha)  | 02                  | 03.33 | 05                  | 08.33 | 07              | 05.83 |

(F = Frequency    % = Percentage)

The data compiled in Table-3 shows that the distribution of respondents related to their Annual income ranged from Rs.1.1 to 2.5 lakh for 54.17 percent of the respondents, followed by Rs. 2.51 to 5 lakh for 29.16 percent of the respondents, and Rs.1.0 lakh for 15.00 percent of the respondents. Just 6.67 per cent had an annual income of above Rs.5 lakh. In case of farmers in bund cultivation of pigeonpea majority, 56.66 per cent annual income was from “Rs. 1.1 to 2.5 lakh” followed by 21.67 per cent with annual income of Rs. 2.51 to 5.0 lakh while 16.67 per cent had annual income of Up to Rs.1 lakh. Just 5.00 per cent had an annual income of above Rs. 5.0 lakh. Overall 54.17 percent annual income was from Rs.1.1 to 2.5 lakh followed by 29.16 percent with annual income of Rs. 2.51 to 5.0 lakh while 15.00 percent had annual income of up to more than 1.0 lakh. Just 6.67 per cent had an annual income of above Rs.5.0 lakh.

The data compiled in Table-4 of The majority of bund pigeonpea farmers (66.67%) had 1.01 to 2 ha of “small land holdings”, after that 13.33 percent who had (2.01 to 4 ha) of “medium land holdings”, 16.67% had up to 1 ha of “marginal land holdings”, and 3.33 percent had more than 4.0 ha of “large land holdings”. In the case of farmers sole cultivated of pigeonpea, the majority (55.00%) had a small land holding of 1.01 to 2 ha, followed by 20.00%

with a medium (2.01 to 4.0 ha) land holding, 8.33 percent with a large (above 4.0 ha) land holding, and 6.67 percent with a marginal (up to 1 ha) land holding.

Overall, 65.83 percent of pigeonpea farmers had a small land holding of 1.01 to 2 ha, 16.67 percent had a medium land holding of 2.01 to 4 ha, 11.67 percent had up to 1 ha marginal land holding, and 5.83 percent had more than 4.0 ha of large land holding.

## Conclusion

The study about age, majority of the farmers belonged to middle aged group between 36 to 55 years both in case of bund and sole cultivation of pigeonpea. Followed by bund cultivation farmer were less educated while of farmers belonged to sole cultivation of pigeonpea, majority of the respondent were educated up to higher secondary level. As regard to family size, it may be concluded that if look the overall population is small family size is dominated. In case of farmers practicing bund cultivation the majority of the regards resided in medium size of family, while in case of the respondent practicing sole cultivation of the pigeonpea the majority of the respondent were resided in large family size. It may be reason behind the cultivation practicing adopted by the respondent as per the man power availability for different cultivation practice.

In farming experience, majority of the farmers practicing bund cultivation of pigeonpea had farming experience about 11-20 years as cultivating while, the farmer who are cultivation the pigeonpea as sole crop had the farming experience up to 10 years. It reveals that the young farmers are practicing the sole cultivation for commercial purpose while old farmers are just growing the pigeonpea for their hold consumption. As in social participation, in both category of pigeonpea cultivating farmers had free membership of only one organization while the sole cultivation had many less responsibility of the organization as office bearer or executive. It may be due to more time devotion in their farm practicing than the social organization. The result reveals that all the respondents in both bund and sole crop were practiced agriculture as their main occupation. The data regarding annual income, majority of farmers in bund cultivation of pigeonpea had annual income in the range of Rs. 1.1 to 2.5 lakh, majority of farmers in sole cultivation were having annual income in the range of Rs. 1.1 to 2.51 lakh. The data regarding land holding, farmers in bund cultivation of pigeonpea, majority had 1.01 to 2 ha of small holding and also in case of farmers in sole cultivation of pigeonpea, majority had 1.01 to 2 ha of small land holding.

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## Climate Resilient Technological Interventions to Ensure Food Security in Flood Affected Area – An Experience from NICRA Village, Sirusuwada, Srikakulam District, Andhra Pradesh

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### Abstract

The study conducted on “performance of flood tolerant rice varieties in flood affected areas of Sirusuwada village” of Srikakulam District, Andhra Pradesh under National Innovation on Climate Resilient Agriculture (NICRA) project implemented by Krishi Vigyan Kendra, Amadalavalasa for two consecutive years (2018-19 & 2019-20) on clay loam soils. The demonstrations were organized 20 each in high, medium and low inundation areas. The village was situated under Kothuru sub-division in the district Srikakulam of AP, India N 180 48.037' E 083 53.729' & 203 Ft from mean sea level. Recurrent floods has been the principal constraints in rice production in this villages affecting mainly Kharif rice during the growing season at the time of tillering and panicle initiation and maturity. The prevailing weather patterns of the area were observed to have a strong bearing on the occurrence, intensity and magnitude of floods. About 61 per cent of total rainfall occurs during monsoon period (June to September) and the overflow of river Vamsadhara. Generally, the flooding in the field can be either water logging due to over flow of river Vamsadhara coupled with heavy rainfall. To ensure rice production to climatic variability leading to flood, site specific climate resilient technologies such as tolerant rice variety 'MTU-1061, RGL-2537 and MTU-1064 were tested and demonstrated in the project village of Sirusuwada in 60 locations. The results revealed that the flood tolerant variety MTU-1061 recorded an increased yield of 23% in 2018-19 and 20.02% in 2019-20 compared to check variety MTU-7029 . The flood tolerant variety RGL-2537 recorded increased yield of 20.05% in 2018-19 and 11.4% in 2019-20. The performance of these varieties during both the years resulted in more number of panicles/m<sup>2</sup> (403,415) more grains per panicle (196, 200), lodging resistant and pest and disease resistant to the climatic vulnerability as well as farmer's acceptability under medium and low inundation areas, but these varieties were completely failed under high inundation areas. The average yield of the rice variety 'MTU-1061 and RGL-2537' 56.8 and 56.4 q per hectare respectively. As a result of the study and demonstration to endure recurrent flood and climatic variability, flood tolerant varieties has spread over the highest area in the project village.

### Introduction

The study on “performance of flood tolerant rice varieties in flood affected areas of Sirusuwada village” was conducted in Sirusuwada village of Srikakulam District, Andhra Pradesh under National Innovation on Climate Resilient Agriculture (NICRA) project implemented by Krishi Vigyan Kendra, Amadalavalasa during from 2013 to 2019. The village was situated under Kothuru sub-division in the district Srikakulam of AP, India N 180 48.037' E 083 53.729' & 203 Ft from mean sea level. Recurrent floods has been the principal constraints in rice production in this villages affecting mainly Kharif rice during the growing season at the time of tillering and panicle initiation and maturity. The prevailing weather patterns of the area were observed to have a strong bearing on the occurrence, intensity and magnitude of floods. About 61 per cent of total rainfall occurs during monsoon period (June to September) and the overflow of river Vamsadhara.

Flooding or Submergence, Water logging, also called as flood/submergence, anoxia, hypoxia etc., is one of the major harmful abiotic stresses limiting crop yields. Generally, flooding in the field can be either water logging in which root and some portion of the shoot under water

are complete submergence or where the whole plant is under water Kumar *et al.*, (2001). Lack of oxygen supply is the main cause of damage in water logging conditions, because of which plant shifts its metabolism from aerobic to anaerobic mode (Gangavar and Ram, 2005). Aerenchyma formation, greater activity of glycolate pathway, involvement of anti-oxidative metabolism is some of the adaptive mechanisms to cope with flooding tolerance. Ethylene is associated with induction of genes related to the adaptive mechanism of tolerance (Alamgir and Uddin, 2011).

ICAR has launched a major Project entitled, National Initiative on Climate Resilient Agriculture (NICRA) during 2010-11 with an outlay of Rs. 350 crores for the XI Plan with the following objectives.

To enhance the resilience of Indian agriculture covering crops, livestock and fisheries to climatic variability and climate change through development and application of improved production and risk management technologies

To demonstrate site specific technology packages on farmers' fields for adapting to current climate risks

To enhance the capacity building of scientists and

Table-1 : Frequency of Floods experienced during the year 2018-19.

| Month     | No of flood incidences | No of days flood experienced | Stage of the crop  | Type of damage                                     |
|-----------|------------------------|------------------------------|--------------------|----------------------------------------------------|
| June      | -                      | -                            | -                  | -                                                  |
| July      | -                      | -                            | -                  | -                                                  |
| August    | 1                      | 3-4                          | Tillering          | High inundation areas paddy crop severely effected |
| September | 2                      | 5-6                          | Panicle initiation | Crop partially lodged.                             |
| October   | -                      | -                            | -                  | -                                                  |

Table-2 : Frequency of Floods experienced during the year 2019-20.

| Month     | No of flood incidences | No of days flood experienced | Stage of the crop  | Type of damage                                            |
|-----------|------------------------|------------------------------|--------------------|-----------------------------------------------------------|
| June      | -                      | -                            | -                  | -                                                         |
| July      | -                      | -                            | -                  | -                                                         |
| August    | 1                      | 3-5                          | Tillering          | High inundation areas paddy crop severely effected        |
| September | -                      | -                            | -                  | -                                                         |
| October   | 1                      | 3-7                          | Panicle initiation | Crop partially lodged and silting of leaves were observed |
| November  | -                      | -                            | -                  | -                                                         |

Table-3 : Stage wise floods and inundation incidences during last ten years.

| S. No. | Name of the crop | Stage of the rice mostly affected during last 10 years |                    |                                           |                              |
|--------|------------------|--------------------------------------------------------|--------------------|-------------------------------------------|------------------------------|
|        |                  | Very frequently                                        | frequently         | Rare                                      | Very rare                    |
| 1.     | Paddy            | Tillering stage                                        | Panicle initiation | Seedling stage & Flowering to pollination | Grain hardening & Harvesting |

other stakeholders in climate resilient agricultural research and its application.

Flooding is a major challenge for rice production in the country. Heavy and intense rainfall events cause flash floods due to overflow of rivers and canals or sometimes tidal movements in coastal areas. Continuous high rainfall in a short span leading to water logging and heavy rainfall with high speed winds in a short span due to cyclonic storms cause inundation of paddy fields and lodging of the crop at grain filling and maturity stages causing huge losses to the farmer. Flood is a recurrent phenomenon in coastal Andhra Pradesh. The problem is accentuated due to poor or non-existent drainage and in some cases due to the topography of the land which impedes fast drainage from crop lands. Apart from improving drainage and other preventive measures, farmers can adopt flood tolerant varieties that can withstand inundation for an extended period and reduce the risk from flood damage. In the light of above facts the study was conducted on "performance of flood tolerant rice varieties in flood affected areas of Sirusuwada village" conducted during two successive kharif seasons of 2018-19 and 2019-20.

## Materials and Methods

Scientists in KVK, Amadalavalasa, Srikakulam District of ANGRAU in collaboration with ICAR, ATARI, Hyderabad

has introduced climate resilient technologies such as flood tolerant rice variety 'MTU-1061, RGL-2537' and MTU-1064, were tested and demonstrated in the project village of Sirusuwada, compared to check variety MTU-7029 during Kharif 2018-19 and 2019-20 in 60 locations.

**Influence of rain fall (Seasonal conditions) on crop performance :** Severe flash flood occurred due to heavy rain on 15<sup>th</sup>, August (2018) and 17<sup>th</sup>, August (2019) coupled with over flow Vamsadhara canal which affected the paddy crop at tillering stage severely. Complete crop lost in the high inundation areas due to flash floods during the month of august and October. Whereas 255.3 and 157.4 mm (2018&2019) rainfall was received in July which facilitated paddy nurseries and good growth in broadcasted paddy fields. An excess rainfall of 35.8 (2018) and 79 mm (2019) was received during the month of September (157.4) during both the years against normal of 106.2 mm which was found congenial for the incidence of blast and sheath blight in paddy. In paddy, Flash Floods occurred during 12<sup>th</sup> October 2018 and 24<sup>th</sup> October 2019, paddy crop was at panicle initiation stage, silt deposition on leaves and crop lodging was observed. Application of tricyclozole @ 120gm/ac and hexaconazole @ 400ml/ac were taken up to manage Blast and Sheath blight diseases. Real time contingency measures were

**Table-4 : Yield attributes and yield of flood tolerant varieties in medium and low inundated Areas (Two years average).**

| Plant characters                 | Demonstrated varieties |                              |                 | Check variety     |
|----------------------------------|------------------------|------------------------------|-----------------|-------------------|
|                                  | MTU 1061 (Indra)       | RGL 2537 Srikakulam sannalu) | MTU1064 (Amara) | MTU-7029 (Swarna) |
| Root volume (cm <sup>3</sup> )   | 498                    | 454                          | 397             | 376               |
| Root length (cm)                 | 25.2                   | 22.7                         | 19.4            | 17.9              |
| Plant height (cm)                | 126                    | 119                          | 117             | 115               |
| No. of Tillers per Hill          | 26                     | 24                           | 22              | 21                |
| No. of panicles m-2              | 409                    | 401                          | 378             | 363               |
| No. of panicles per hill         | 22                     | 20                           | 19              | 17                |
| Panicle length (cm)              | 30                     | 27                           | 26              | 24                |
| No. of Spikelets per panicle     | 14                     | 13                           | 12              | 12                |
| No. of grains per panicle        | 198                    | 186                          | 183             | 170               |
| No. of filled grains per panicle | 159                    | 150                          | 133             | 121               |
| Test weight                      | 24.52                  | 24.24                        | 24.15           | 23.48             |
| Grain Yield (q/ha)               | 50.3                   | 47.7                         | 43.29           | 39.43             |
| Straw yield (q/ha)               | 56.8                   | 56.4                         | 47.7            | 45.2              |
| Cost of Cultivation (Rs/ha)      | 40500                  | 40500                        | 40500           | 40500             |
| Gross returns (Rs/ha)            | 76394                  | 72532                        | 65670           | 59891             |
| Net returns (Rs/ha)              | 37440                  | 33580                        | 26820           | 22440             |
| B:C ratio                        | 1.96:1                 | 1.86:1                       | 1.68:1          | 1.60:1            |

demonstrated in flood affected paddy like nutrition management and plant protection measures.

**Resilient practice / technology demonstrated :** Rice varieties MTU-1061(Indra): This is also flood tolerant non-lodging, fine grain variety with crop duration of 150 days. It has got dormancy of 2-3 weeks. It can tolerate inundation up to 10 days only at later stages of crop growth but not during early stage. RGL 2537 (Srikakulam Sannalu): Suitable for late planting situation with over aged seedlings, also able to tolerate short period of inundation (4-5 days), but not for prolonged inundation. Fine grain variety with crop duration of 165 days. Rice varieties MTU-1064(Amara)

These varieties are high yielding with good grain quality apart from possessing submergence tolerance and perform better under flood situation. Demonstration of these varieties in flood-prone areas could tolerate submergence up to two weeks and could perform significantly better compared to other improved and local cultivars. Yield attribute of lodging resistance saves from not only loss in grain but also straw yield which is the main source of dry fodder.

**Impact of flood tolerant varieties :** In Sirsuwada, a village of Kothuru mandal in Srikakulam district of Andhra Pradesh, farmers prefer to grow improved varieties of paddy such as BPT-5204, Swarna due to high yield potential and market demand in the district but are susceptible to flooding. However, in recent years due to heavy and intense rainfall and cyclonic storms, paddy crop is experiencing damage due to flooding. KVK, Srikakulam encouraged farmers to adopt flood tolerant varieties to

minimize crop damage due to submergence. Rice varieties Indra-MTU-1061 having the characters of seed dormancy of 2-3 weeks, non-lodging and tolerated inundation up to 10 days at later stages of crop growth and RGL 2537 having the characters of suitable for late planting situation with over aged seedlings, also able to tolerate short period of inundation (4-5 days), but not for prolonged inundation. Fine grain variety with crop duration of 165 days were demonstrated in 60 locations for two successive kharif seasons of 2018-19 and 2019-20. Twenty demonstrations were conducted each under high, medium and low inundation areas. Among the varieties tested, both the varieties Indra-MTU-1061 and RGL 2537 performance was good both in medium and low inundation areas compared to check variety MTU-7029. Where as in high inundation areas all the varieties both check and flood tolerant varieties were completely failed.

## Results and Discussion

The results revealed that the flood tolerant variety MTU-1061 recorded highest grain yield (50.3) straw yield (56.8) and yield attribute parameters like panicles / m<sup>2</sup> (409), No of grains/panicle (198), No of filled grains/panicle (158) test weight (24.52) compared to other flood tolerant varieties RGL - 2537 (47.7), MTU - 1064 (43.29) and check variety MTU - 7029 (39.43) during both the years (Table-3).

MTU-1061 recorded, increased yield and risk minimization reduced by 21.50 % in 2018-19 and 2019-20 compared to check variety MTU-7029. The flood tolerant variety RGL-2537 recorded increased yield and risk minimization reduced by 15.72% in 2018-19 and 2019-20.

The performance of these varieties resulted in lodging resistant and pest and disease resistant to the climatic vulnerability as well as farmer's acceptability under medium and low inundation areas, but these varieties were completely failed under high inundation areas.

The maximum gross returns was recorded with MTU-1061 (76394) followed by RGL-2537 (72532) maximum net returns was recorded with MTU-1061 (37440) followed by RGL-2537 (33580) in two consecutive years (Table-4). Where as the B:C ratio of MTU-1061(1.96), RGL-2537(1.86), MTU- 1064 (1.68) and MTU-7029 (1.60) during the two consecutive years.

### Conclusion

Overall, the project has generated high enthusiasm among farmers and raised hopes that by combining technology solutions with community mobilization, by flood tolerant rice varieties MTU-1061, RGL-2537 and MTU-1064 were high yielding with good grain quality apart from possessing submergence tolerance and perform better under flood situation. KVK, Srikakulam encouraged farmers to adopt flood tolerant varieties to minimize crop damage due to submergence and can help small and

marginal farmers to cope with current climate variability to some extent.

### Acknowledgement

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## Attitude of Farmers Towards Kisan Call Centre

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### Abstract

Kisan Call Centre plays crucial role in transfer of technology for the development of agriculture. The current pandemic situation highlights the importance of Kisan Call Centers (KCC) as the services are provided on phone calls i.e. without physical proximity. The present study was undertaken in Baramati and Rajgurunagar tehsils of Pune district with a sample size of 120 respondent farmers. The study revealed that 65.00 percent of the respondent farmers had moderately favourable attitude towards KCC.

**Key words :** Kisan call centre, attitude, farmers.

### Introduction

The country today has an impressive Telecom network both in the Private and Government sectors. Over five lakh villages have a public telephone in a country. India has the second largest number of telephone connections in the world. The tele-density has reached 86.37% in urban areas, while the rural tele-density is at 58.85%. It has been felt for long that this impressive telecom network could be put to effective use for delivering knowledge and information to the farming community. With the decrease in the number of extension workers, there is a need to use the latest technologies for delivering extension services. Towards this, the Department of Agriculture and Cooperation has been working on schemes to use both Mass-Media and telecom network for the delivery of extension services. The KCC scheme is functioning since 21st January 2004. The Call Centers can be accessed by the farmers all over the country on common Toll-Free Number 1551 from land line telephone and 1800-180-1551 from any mobile phone. Since 10th June, 2004 the Call Centre Service has been made available right from 6 a.m. to 10 p.m. except on Sundays and gazetted holidays, beyond these hours the calls are attended in the Interactive Voice Response System (IVRS) mode. The Call Centre for the state of Maharashtra and Goa has been started functioning effectively since 21st January 2004 at Pune. The KCC is functioning at three levels of experts. Each Call Centre covers some specific states and is controlled by a nodal organization/center. The call centers are armed with the basic technological know-hows meant for providing the basic information about the package of practices, Crop production, Horticulture, Nutrient Management, Animal husbandry,

Plant protection, Storage aspects, and other allied activities.

Farmers need guidance of expert agriculturists with the increase in choices of farm inputs, pesticides, herbicides, high yielding varieties of seeds. KCC is a new dimension in agriculture extension management, which takes account of, and makes full use of on-going information and communication revolution.

For the making call at KCC there must be positive attitude of the farmers towards Kisan Call Centre. Considering the vital role played by KCC in dissemination of agricultural technology it was felt necessary to study the farmers' attitude towards it with the objectives to study the profile of farmers and to study the attitude of farmers towards KCC.

### Materials and Methods

Two tehsils viz. Baramati and Rajgurunagar of Pune district were selected for the present study. Six villages from each tehsil and ten respondent farmers from each village were selected randomly comprising the total sample of 120 respondents. Respondents were selected on the basis of the prerequisite that they had contacted or attempted to contact Kisan Call Centre. Ex-post facto research design was used for the present study.

It could be stated from the above findings that majority of the respondent farmers were found in middle and old aged group. Thirty-five per cent of the respondent farmers had completed secondary school level of education, followed by 28.34 per cent of them educated up to primary education school level. Higher secondary school level was availed by 17.50 per cent of the respondent followed by graduation level (10.00 per cent); 8.83 per cent respondent farmers were found literate and

**Table-1 : Distribution of respondent farmers according to their personal, socio-economical characteristics.**

| Sr. No.  | Particulars                                  | Respondents (n=120) |          |
|----------|----------------------------------------------|---------------------|----------|
|          |                                              | Frequency           | Per Cent |
| <b>A</b> | <b>Age</b>                                   |                     |          |
| 1        | Young (up to 35 years)                       | 23                  | 19.17    |
| 2        | Middle (36 to 55 years)                      | 64                  | 53.33    |
| 3        | Old (56 & above years)                       | 33                  | 27.50    |
| <b>B</b> | <b>Education</b>                             |                     |          |
| 1        | Illiterate(no formal schooling)              | 10                  | 8.33     |
| 2        | Primary school (1st to 7th std.)             | 34                  | 28.34    |
| 3        | Secondary school (8th to 10th std.)          | 42                  | 35.00    |
| 4        | Higher secondary school (11th and 12th std.) | 21                  | 17.50    |
| 5        | Graduation ( 13th std. to 15th std.)         | 12                  | 10.00    |
| 6        | Post-graduation (above 15th std.)            | 1                   | 0.83     |
| <b>C</b> | <b>Farming Experience</b>                    |                     |          |
| 1        | Low (up to 9 years)                          | 26                  | 21.67    |
| 2        | Medium (10 to 29 years)                      | 67                  | 55.83    |
| 3        | High (30 years and above)                    | 27                  | 22.50    |
| <b>D</b> | <b>Land Holding</b>                          |                     |          |
| 1        | Marginal (up to 1.00 ha)                     | 28                  | 23.33    |
| 2        | Small (1.01 to 2.00 ha)                      | 61                  | 50.83    |
| 3        | Semi-medium (2.01 to 4.00 ha)                | 23                  | 19.17    |
| 4        | Medium (4.01 to 10.00 ha)                    | 8                   | 6.67     |
| <b>E</b> | <b>Annual Income (Rs.)</b>                   |                     |          |
| 1        | Up to Rs. 50,000/-                           | 40                  | 33.33    |
| 2        | Rs.50,000/- to 1,00,000/-                    | 57                  | 47.50    |
| 3        | Rs.1,00,001/- to 1,50,000/-                  | 09                  | 7.50     |
| 4        | Rs.1,50,001/- to 2,00,000/-                  | 06                  | 5.00     |
| 5        | Above Rs. 2,00,001/-                         | 08                  | 6.67     |
| <b>F</b> | <b>Extension contact</b>                     |                     |          |
| 1        | Low (up to 2 score)                          | 31                  | 25.83    |
| 2        | Medium (between 3 to 6 score)                | 80                  | 66.67    |
| 3        | High (7 score and above)                     | 9                   | 7.50     |
| <b>G</b> | <b>Sources of Information</b>                |                     |          |
| 1        | Low (up to 7 score)                          | 32                  | 26.67    |
| 2        | Medium (between 8 to 14 score)               | 73                  | 60.83    |
| 3        | High (15 score and above)                    | 15                  | 12.50    |
| <b>H</b> | <b>Social Participation</b>                  |                     |          |
| 1        | Low (up to 1 score)                          | 43                  | 35.83    |
| 2        | Medium (2 to 4 score)                        | 46                  | 38.33    |
| 3        | High (5 score and above)                     | 31                  | 25.84    |

only one (0.83 per cent) respondent farmer was post graduate. The data indicated that, more than half (55.83 per cent) of respondents had medium farming experience followed by 22.50 per cent of respondents had high farming experience and while only 21.67 per cent of respondents had low farming experience. It was also revealed that half of the respondent farmers (50.83 per cent) possessed small size land holding, followed by 23.33 per cent of the respondent farmers having marginal size category of land holding, the respondent farmers found in semi-medium and medium category of land

holding were 19.17 per cent and 6.67 per cent respectively. It is observed from table that, almost half (47.50 per cent) of the respondent farmers had their annual income in between Rs. 50,001/- to 1,00,000/- followed by 33.33 per cent respondent farmers had total annual income less than 50,000 whereas, 7.50 per cent of respondent farmers had an annual income between Rs. 1,00,001/- to 1,50,000/- followed by 6.67 per cent and 5.00 per cent respondent farmers possessed annual income above 2,00,001/- and between Rs. 1,50,001/- to 2,00,000/- respectively. Therefore, it was concluded that majority of the respondent farmers earned total annual income in between Rs. 50,001/- to 1,00,000/-. Results presented in the table indicated that, the 66.67 per cent of the respondent farmers kept medium extension contact with extension agencies for seeking information, followed by one fourth (25.83 per cent) and 7.50 per cent of the respondent farmers having low and high extension contact with the extension agencies respectively. It can be seen from table that, more than half (60.83 per cent) of the respondent farmers had medium sources of information with different extension agencies for seeking information, followed by 26.67 per cent and 12.50 per cent of the respondent farmers having low and high sources of information respectively. It is indicated from table that 8.33 per cent respondent farmers had medium level of social participation followed by low (35.83 per cent) and high (25.84 per cent) level of social participation.

It is evident from the distribution in Table-2 that, 95.83 per cent of the respondent farmers had highly favourable attitude regarding KCC they thought that other farmers should avail the benefits of the KCC. Majority (93.33 per cent) of the respondent farmers had highly favourable attitude with regards to Kisan Call Centre saves farmers labor, time, money, etc. of farmers, 90.00 per cent respondent farmers thought through KCC farmers receive immediate information, 87.50 per cent of the respondent farmers had highly favourable attitude with KCC helps farmers to accept updated technology for production, 85.00 per cent of the respondent farmers had highly favourable attitude for the development of small farmers the concept of the KCC is a good thing and worthwhile, 70.83 per cent of the respondent farmers had highly favourable attitude towards KCC for farmers get in-depth knowledge of various schemes through KCC. About 65.00 per cent of the respondent farmers had highly favourable attitude with farmers get help in sudden agriculture problems through Kisan Call Centre. About 55.83 per cent of the respondent farmers had highly favourable attitude with this scheme for farmers makes them helps to strengthen for farming. About 46.67 per cent of the respondent farmers had moderately favourable attitude that this scheme minimizes the problems of farmers. About 45.00 per cent of the

**Table-2 : Distribution of respondent farmers according to their statement wise attitude towards kisan call centre.**

| Sr. No. | Attitude                                                                                                  | Frequency (n=120) |                       |                 |
|---------|-----------------------------------------------------------------------------------------------------------|-------------------|-----------------------|-----------------|
|         |                                                                                                           | Highly favourable | Moderately favourable | Less favourable |
| 1.      | Through Kisan Call Centre farmers receive immediate information.                                          | 108<br>(90.00)    | 7<br>(5.83)           | 5<br>(4.17)     |
| 2.      | Kisan Call Centre toll free number is not connecting timely.                                              | 38<br>(31.67)     | 12<br>(10.00)         | 70<br>(58.33)   |
| 3.      | This scheme for farmers makes them helps to strengthen for farming.                                       | 67<br>(55.83)     | 38<br>(31.67)         | 15<br>(12.50)   |
| 4.      | Farmers get help in sudden agriculture problems through Kisan Call Centre.                                | 78<br>(65.00)     | 09<br>(7.50)          | 33<br>(27.50)   |
| 5.      | Scientific information of KCC operators is not updated.                                                   | 34<br>(28.33)     | 29<br>(24.17)         | 57<br>(47.50)   |
| 6.      | This scheme is specially for small farmers.                                                               | 17<br>(14.17)     | 06<br>(5.00)          | 97<br>(80.83)   |
| 7.      | For the development of small farmers the concept of the Kisan Call Centre is a good thing and worthwhile. | 102<br>(85.00)    | 18<br>(15.00)         | 0<br>(0.00)     |
| 8.      | KCC operators are not willing to solve the problems of farmers.                                           | 23<br>(19.17)     | 7<br>(5.83)           | 90<br>(75.00)   |
| 9.      | This scheme minimizes the problems of farmers.                                                            | 38<br>(31.67)     | 56<br>(46.67)         | 26<br>(21.66)   |
| 10.     | Kisan Call Centre encourages farmers to accept updated technology for production.                         | 105<br>(87.50)    | 12<br>(10.00)         | 3<br>(2.50)     |
| 11.     | Kisan Call Center does not help in improving all technological aspects of the farmers.                    | 12<br>(10.00)     | 18<br>(15.00)         | 90<br>(75.00)   |
| 12.     | Kisan Call Centre saves labour, time, money etc. of farmers.                                              | 112<br>(93.33)    | 2<br>(1.67)           | 6<br>(5.00)     |
| 13.     | KCC helped to reduce the unemployment.                                                                    | 43<br>(35.83)     | 54<br>(45.00)         | 23<br>(19.17)   |
| 14.     | Farmers get in-depth knowledge of various schemes through KCC.                                            | 85<br>(70.83)     | 17<br>(14.17)         | 18<br>(15.00)   |
| 15.     | KCC is not encouraging the use of improved, scientific and new technology.                                | 11<br>(9.17)      | 6<br>(5.00)           | 103<br>(85.83)  |
| 16.     | Other farmers should avail the benefits of KCC.                                                           | 115<br>(95.83)    | 3<br>(2.50)           | 2<br>(1.67)     |

(Figures in parenthesis indicates per cent)

**Table-3 : Distribution of respondent farmers according to their attitude.**

| Sr. No. | Attitude (Score)                 | Respondents (n=120) |          |
|---------|----------------------------------|---------------------|----------|
|         |                                  | Frequency           | Per Cent |
| 1.      | Less favourable (up to 54)       | 31                  | 25.83    |
| 2.      | Moderately favourable (55 to 65) | 78                  | 65.00    |
| 3.      | Highly favourable (above 65)     | 11                  | 9.17     |

respondent farmers had moderately favourable attitude that KCC helped to reduce the unemployment. Most (85.83 per cent) of the respondent farmers have less favourable attitude towards KCC is not encouraging the use of improved, scientific and new technology followed by 80.83 per cent of respondent farmers had less favourable attitude towards this scheme is specially for small farmers. About three fourth (75.00 per cent) of the respondent farmers had less favourable attitude towards KCC does not help in improving all technological aspects of the farmers and KCC does not help in improving the knowledge of the farmers. About 58.33 per cent of the

respondent farmers had less favourable attitude towards KCC toll free number is not connecting timely and 47.50 per cent has less favourable attitude towards scientific information of KCC operators is not updated. Hence, it is concluded that, majority of the respondent farmers had highly favourable attitude towards Kisan Call Centre, due to the KCC, the daily agricultural problems is going to be solved and it is well thought out and benefiting approach for the small farmers development. Majority of the respondent farmers had moderately favourable attitude towards KCC.

It can be seen from Table-3 that, majority (65.00 per cent) of the respondent farmers had moderately favourable attitude towards KCC, followed by 25.83 per cent of the respondent farmers had less favourable attitude towards KCC. Only 9.17 per cent showed that respondent farmers had highly favourable attitude towards Kisan Call Centre.

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## Biofortification : A Nutritional Security and Approach to Fight against Malnutrition

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### Abstract

So far, our agricultural system has not been designed to promote human health; instead, it only focuses on increasing grain yield and crop productivity. Biofortification is the idea of breeding crops to increase their nutritional value. This can be done either through conventional selective breeding, or through genetic engineering. It is an upcoming, promising, cost-effective, and sustainable technique of delivering micronutrients to a population that has limited access to diverse diets and other micronutrient interventions. Unfortunately, major food crops are poor sources of micronutrients required for normal human growth. The manuscript deals in all aspects of crop biofortification which includes—breeding, agronomy, and genetic modification. It tries to summarize all the biofortification research that has been conducted on different crops. Success stories of biofortification include lysine and tryptophan rich quality protein maize, Vitamin A, rich orange sweet potato, generated by crop breeding, oleic acid, and stearidonic acid soybean enrichment, through genetic transformation and selenium, iodine, and zinc supplementation. The biofortified food crops, especially cereals, legumes, vegetables, and fruits, are providing sufficient levels of micronutrients to targeted populations. Although a greater emphasis is being laid on transgenic research, the success rate and acceptability of breeding is much higher. Besides the challenges biofortified crops hold a bright future to address the malnutrition challenge.

**Key words :** Biofortification, transgenic, malnutrition.

### Introduction

“Biofortification” or “biological fortification” refers to nutritionally enhanced food crops with increased bioavailability to the human population that are developed and grown using modern biotechnology techniques, conventional plant breeding, and agronomic practices. Despite increased food crop production, around two billion people across the world suffer from another type of hunger known as “hidden hunger,” which is caused by an inadequate intake of essential micronutrients in the daily diet. Besides this overnutrition is growing matter of concern. Now agriculture is undergoing a shift from producing more quantity of food crops to producing nutrient-rich food crops in sufficient quantities. This will help in fighting “hidden hunger” or “micronutrient malnutrition” especially in poor and developing countries, where diets are dominated by micronutrient-poor staple food crops.

Traditionally, vitamins and minerals have been provided to the masses through nutrient supplementation programs, but it falls short of the goals set by the international health organizations as the supplementation programs rely on external funding that is not guaranteed to be available from year to year. Other limitations are purchasing power of poor people, their access to markets and health-care systems, and lack of awareness regarding the long-term health benefits of these nutrient

supplements. Hence, biofortification of different crop varieties offers a sustainable and long-term solution in providing micronutrients-rich crops to people. Furthermore, biofortified crops with increased bioavailable concentrations of essential micronutrients are deployed to consumers through traditional practices used by agriculture and food trade which therefore provides a feasible way of reaching undernourished and low income group families with limited access to diverse diets, supplements, and fortified foods. From an economic point, biofortification is a one-time investment and offers a cost-effective, long-term, and sustainable approach in fighting hidden hunger because once the biofortified crops are developed; there are no costs of buying the fortificants and adding them to the food supply during processing.

Plant-based foods offer an array of nutrients that are essential for human nutrition and promote good health. However, the major staple crops of the world are often deficient in some of these nutrients. Traditional agricultural approaches can marginally enhance the nutritional value of some foods, but the advances in molecular biology are rapidly being exploited to crops with enhanced key nutrients. Nutritional targets include elevated mineral content, improved fatty acid composition, increased amino acid levels, and heightened antioxidant levels.

Hidden hunger is insidious. It strikes people who, on the outside, may appear to be consuming an adequate

amount of food—mainly staple crops grown on small family farms. Yet, the calories of many staple crops disguise an invisible hunger that affects the health and wellbeing of people living on the margins. Hidden hunger describes a condition of undernutrition where the body lacks essential vitamins and minerals that keep people healthy. Deficiencies in micronutrients such as zinc, iron and vitamin A can cause profound and irreparable damage to the body—blindness, growth stunting, mental retardation, learning disabilities, low work capacity, and even premature death. The effects of hidden hunger are acute during the first 1,000 days of a child's life—from conception to the age of two years. Micronutrient deficiencies are especially damaging to women. This condition reduces their productivity, decreases their economic potential, and affects their reproductive health outcomes. Biofortification, the process of breeding nutrients into food crops, provides a comparatively cost-effective, sustainable, and long-term means of delivering more micronutrients. The biofortification strategy seeks to put the micronutrient-dense trait in those varieties that already have preferred agronomic and consumption traits, such as high yield and disease resistance. Marketed surpluses of these crops may make their way into retail outlets, reaching consumers first in rural and then urban areas.

**Breeding approaches of biofortification :** Conventional plant breeding is not new, it began hundreds of years ago. Farmers have been altering the genetic makeup of the crops they grow for the past eight to ten thousand years, since the dawn of agriculture. Early farmers chose the best looking plants and seeds and saved them for next year's planting. As the science of genetics became better understood, plant breeders were able to select certain desirable traits in a plant to create improved varieties of plants through genetic engineering. Biofortification was principally developed as a food-based strategy to address widespread deficiencies of vitamin A, iron, and zinc that remain prevalent to the greatest extent in low-income countries. Strategies most widely implemented for the prevention of micronutrient deficiencies are the distribution of micronutrient supplements in pharmacological preparations, and food fortification, with far less investment thus far in dietary diversification strategies. In this context, there are several potential advantages and limitations to biofortification as a micronutrient intervention. Biofortification is targeted primarily to the rural poor who rely heavily on locally produced staple foods as their primary source of nutrition, and who often have restricted financial or market access to commercially processed fortified foods.. The biofortification strategy has potential for sustainability as, once planting material is obtained, it can often be saved, recycled, and further disseminated to other farmers. Once

initial development and dissemination are completed, recurring costs of maintaining production of biofortified crops are estimated to be low. However, the additional amount of micronutrient achievable through biofortification will be modest compared to amounts supplied in supplements, and in some cases fortified food. The time required to develop a viable crop with a stable, minimum level of additional nutrient content can extend up to 6–8 years or more. As such, there is less flexibility to adjust the content and combination of nutrients according to specific needs.

### Advantages of biofortification

Biofortification is built on what poor households grow and eat (staple crops)

The one time investment to develop seeds that fortify themselves keep recurrent cost low, it can be shared globally and making it highly cost effective.

Bio fortification is sustainable

It reaches country most vulnerable people, living in remote rural area with no access or money for commercially fortified foods.

It produces higher yields in environmentally friendly way.

### Conclusion

Humans require more than 22 mineral elements, which can all be supplied by an appropriate diet. However, the diets of populations subsisting on cereals, or inhabiting regions where soil mineral imbalances occur, often lack Fe, Zn, Ca, Mg, Cu, I or Se. Traditional strategies to deliver these minerals to susceptible populations have relied on supplementation or food fortification programs. Unfortunately, these interventions have not always been successful. An alternative solution is to increase mineral concentrations in edible crops. This is termed 'biofortification'. It can be achieved by mineral fertilization or plant breeding. There is considerable genetic variation in crop species that can be harnessed for sustainable biofortification strategies. Furthermore, in the next few decades, a major population increase might take place in the developing world and with the changing climatic conditions; achieving food security will pose a greater challenge.

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## Effects of Ultra-Violet Lights on Keeping Quality and Shelf-Life of Perishable Vegetables

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### Abstract

The production and consumption of fresh fruits and vegetables are fast increasing day to day. In the agricultural industry, the main growing issue is the post-harvest spoilage due to its perishable nature. A large percentage of fruits and vegetables are highly susceptible to microbial spoilage. This lost can be prevented by the application of new methods and technologies such as-surface treatments, Minimal processing techniques that is ultraviolet (UV) light treatment. The smart UV exposure system are proved to be effective and well- known germicidal properties widely used for water disinfection, destroy pathogens on the surface of fruits and vegetables and significantly increase their shelf life. The surface treatment on fruits and vegetables has to be possible for maintaining the moisture level and freshness of fruits and vegetables. This procedure avoided the microbial growth and preserve the colour and texture, preventing diseased as well as enhancing their shelf life and quality of crop vegetables and fruits. By this application reducing the post-harvest losses, reduce the level of refrigeration needed, eliminate environmental hazards, reducing the green-house gas emission and improve the energy consumption during storage facilities.

**Key words :** Ultraviolet light, surface treatment, fruits, vegetables, shelf life, decontamination, microbial growth.

### Introduction

Food irradiation is a unique process in exposing food and food packaging materials without direct contact to the food product such as with UV light or ionizing radiation as-gamma rays or X-rays. In this process some energy is absorbed by chemical bonds. UV light is electromagnetic radiation and kills 99.99% of bacteria and viruses, with a wavelength from 10-400 nm that can be further subdivided into UV-A (315-400 nm), UV-B (280-315 nm), and vacuum UV (100-200 nm) (Barbosa-Canovas, 2004).

The role of fruits and vegetables as essential component of a healthy and balanced diet as they not only add flavour, colour, and variety but also supply essential nutrients. Due to awareness among the consumers related to diet and health, their increasing interest as purchasing power of fruits and vegetables (Baka *et al*, 2007). Fruits and vegetables has high nutritional value and are also major source of antioxidants, anticarcinogenic phytochemicals, and complex carbohydrates which are essential for human well-being. Fruits and vegetables are highly perishable nature, so that its more chances of fungal infection, tissue senescence and transpiration (Kinay *et al*, 2005).

As a result, the food industry is continuously seeking safer and more effective preservation techniques for control in UV-treated commodities. According to World Health Organization (WHO/FAO, 2004) reported that a minimum of 400 g of fruits and vegetables are recommended per day except potatoes and other starchy

vegetables for the prevention of several micronutrient deficiencies. When eaten fresh and cooked fruits and vegetables the important point should be considered as vegetables should be sound, clean and free of pesticides and microorganisms such to be associated as foodborne pathogens viz-*Salmonella*, *Shigella*, *spp.*, *Campylobacter*, *Escherichia coli*, *Staphylococcus aureus*, *Clostridium spp.*, *cereus* (Yaun *et al*, 2004). Simple washing of raw fruits and vegetables in hot water all external microorganism and contamination can be eliminated (Khademi *et al*, 2013). UV-C ultraviolet light treatment can be effective in reducing the number of pathogens on the surface of fresh fruits and vegetables as such a better option to extend the shelf life and high quality fruits and vegetables (Shama, 2005). Moreover, UV technology as an alternative has a huge source of pasteurization of liquids, or disinfecting process of solids foods instead of thermal treatment or application of microbial compounds (Erkan *et al*, 2008). Current methods of sterilization and toxic decontamination included process with lengthy treatments, high temperatures, or harsh chemicals, in this treatment affected generally the color, texture, flavor, and nutritional content of the food (Misra *et al*, 2015).

### Advantages of processing fruits and vegetables by UV-lights :

The UV-radiation as non-thermal technology is applied in food industry (Chun *et al.*, 2010). Food wastage is a major problem these days due to their short shelf life. The prevention of these spoilage LSU Ag Centre food scientist are working to prolong the shelf life of fruits

and vegetables which will help reducing the waste. Ultraviolet light (UV) considerable traditional thermal processing techniques which has a great role in many food industries for treatment of fruits, vegetables, meat and poultry products. UV treatment also positively impact the evolution of several quality parameters in treated commodities. UV treated horticultural crops can improved resistance to disease development by inducing synthesis and accumulation of phytoalexins as well as other defence mechanism (Stevens *et al.*, 1990).

In food processing and vegetable sectors, UV-C is becoming a unconventional and most pertinent to sanitizing both fruit and vegetables. Research shows that by using UV light to sanitize our fruit and veg you can delay microbial growth without altering the quality of the produce. UV light can be more effective in reducing microbial growth than the commonly used chlorine, hydrogen peroxide or ozone, which can leave remnant and ultimately reduce quality.

In the area of UV-C post-harvest, benefits has been shown an effective sanitizing solution proven to extend the shelf life of fresh produce. This is as UV-C light blocks microorganisms development by altering their DNA and can trigger the defense response against pathogens attacks.

UV radiation has a potential impact in the area of postharvest technology for preserving fresh fruit and vegetables during storage which is given below-

**Tomatoes** : In busy lifestyles, consumer demand for processed tomato products mostly increasing time-to-time. Using UV-C improves the nutritional value and increases the Lycopene level and delayed ripening, longer shelf-life. (Severo et al, 2015). UV-C can also perform the main function as delaying the tissue softening, preserving the nutritional and sensory attributes.

**Mushrooms** : Mushroom contain a pro-vitamin called ergosterol that is another form of vitamin D. Mushroom is a meat alternatives and 90% vitamin retain after the cooking and storage. UV-C radiation creates an antimicrobial effect which is perfect for sanitizing mushrooms.

**Baby Spinach** : UV-C reduces microbial growth and extends shelf life without compromising the fresh-cut or quality. UV radiation can also limit the growth of listeria monocytogenes, salmonella enterica, pseudomonas marginalis, psychrotrophic and enterobacteriacease.

**Broccoli** : UV-C can disable the chlorophyll degradation and increase the antioxidant activity in the vegetable. This significantly helps reduce floret yellowing which is a critical issue with Broccoli reducing it shelf-life and quality.

**Pepper** : UV-C light will reduce the incident and severity of chilling injuries which are common in peppers. They do this by maintaining the firmness of the tissue.

**Strawberries** : UV-C light can ignite the defense response genes this will delay tissue softening which can defend the fruit against infection such as grey mold.

**Blueberry** : UV-C radiation will reduce over ripeness, which causes the berries to decay. It will also increase the antioxidant compounds level. UV-C is proven to improve the berries phytochemical properties from 2.15 to 4.30 KJ/m<sup>2</sup>.

**Apple** : UV-C radiation can prevent the tissue browning and off-odors development by sanitizing the apple surface and stopping the oxidative enzymes. UV light also creates a dried protective film over the surface which limits microbial growth this prevents juice leakage.

**Watermelon** : UV-C applied at the right dose can reduce microbial growth and catalase enzyme activity on a fresh cut watermelon.

In brief the advantage of UV-C treatment can effectively sanitize and extend the shelf life of fresh fruit and vegetables without affecting the structure or taste of the fruit – proving that it's a valued alternative to the chemical alternatives. No residues are left on the food, it does not need energy as a treatment medium, and it is therefore considered as safe for humans.

**Measuring the effects of UV treatment** : Effects of UV light on a food quality can be measured by organoleptic properties (appearance, colour, fragrance, smell, texture and flavour). Vitamin content are most sensitive and also determining by UV treatment. (Heiss and Radtke, 1968). Sour cream, whipped cream, dried vegetable soup powder, butter, margarine and mayonnaise given unpleasant smell after a short period of UV treatment. Irradiation was applied for one to three days of bakery products such as sugar, chocolate, chips, cheese, bacon, raw sausage, green beans, and salty peanuts etc and undergo visible changes. After four to seven days significant changes showed in rice and potato chips where as 10-30 days were necessary for pastries, almond, and split peas. These changes generally affected by the wavelength of UV light to which the given food shows sensitivity, the transparency of packaging, and treatment temperature (Koutchma et al, 2002).

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## Conclusions

Fresh produce are highly susceptible to microbial spoilage and this can be avoided with the application of surface treatments. Treatment can be apply as gentle as possible for keeping quality and freshness of fruits and vegetables. Minimal processing techniques proved to be effective at reducing microbial loads of pathogens on fresh fruits and vegetables. There is no specific legislation regarding the usage of UV light in food production, radiation is absolutely useful for the consumer. UV treatment had no harmful effect on human organism. UV treatment completely destroy the microorganisms when the initial total microbial count was extremely high. Some effect can be seen on food composition or vitamin content and quality of milk and dairy products. Food wastage is a big problem these days, fruits and veggies are spoiled quickly. So LSU AgCenter food scientists successfully working to extend the shelf- life of fresh produce. UV light is a most prominent part for the treatment of food contact surfaces and to extend the shelf-life of fresh produce.

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## Effect of Micronutrients and Plant Bioregulators on Yield of Okra and Potato with Final Cost of Cultivation

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### Abstract

A field experiment was conducted at Research farm of I.F.T.M University, Lodhipur Rajput, Moradabad (U.P.) India to evaluate Effect of micronutrients and plant bio-regulators on growth of okra and potato crop. The experiment consists of 16 treatment combination with some foliar application macro and micro nutrients which were laid out in Factorial Randomized Design with three replication. Maximum fruit yield q/ha of okra was 154.88 and 159.50 was noted with application of RDF which was statistically on par with application of M2 and M4 during first year however during second year it was at par with M2 only. Minimum fruit yield q/ha of okra was 140.00 and 145.20 was noted under treatment M3 during first and second year of experimentation respectively. Maximum tuber yield (q/ha) of potato was 329.85 and 339.68 was noted with application of RDF which was statistically on par with application of M2 and M4 during first year however during second year it was at par with M2 only. Minimum tuber yield (q/ha) of was 268.25 and 276.13 was noted under treatment M3 during first and second year of experimentation respectively. The maximum cost of cultivation of potato and okra (Rs. 115751/ha in both I and II year) was incurred in the treatment T<sub>2</sub> - RDF + PGR-1, while the lowest cost of cultivation of both potato and okra (Rs. 97625/ha) was associated with T<sub>3</sub> - ZN+PGR-3. The benefit cost ratio was found maximum (3.14 and 4.02 in both I and II year respectively).

**Key words :** Experimentation, tuber, okra, on par.

### Introduction

Okra (*Abelmoschus esculentus* L.) belongs to the Malvaceae. Okra is a warm-season as well as rainy season of both tropical and subtropical regions of the world. India ranks first in the world with a total area under okra crop is 509.0 thousand hectare which produces 6094.9 thousand MT with average productivity 12 MT ha<sup>-1</sup>. In Madhya Pradesh okra is grown in 43.76-thousand-hectare area with a production of 638.34 thousand MT and 14.59 MT ha<sup>-1</sup> productivity. In Tikamgarh district okra is grown in 1.24-thousand-hectare area with a production of 15.44 thousand MT (Horticulture statistics, 2017-18).

Okra pod contains many nutritional contents which important for human health. It contains good amount of potassium, calcium, magnesium, phosphorus, vitamin 'A' and 'C'. The edible fruit of okra one hundred gram of fresh pod has around; 1.9 g of protein, 0.2 g fat, 6.4 g carbohydrate, 0.7 g minerals and 1.2 g fiber (Tiwari *et al*, 1998). Okra (*Abelmoschus esculentus*) and Potato (*Solanum tuberosum*) are important vegetable crops. Deficiency of micronutrients is common problem in vegetable crops. Foliar fertilization with multi-nutrients to achieve balanced plant nutrition is considered to play a significant role in modern sustainable vegetable production. A number of studies have highlighted the benefits of foliar fertilization in improving plant growth, crop yield, nutrient uptake and product quality (El-Aal *et*

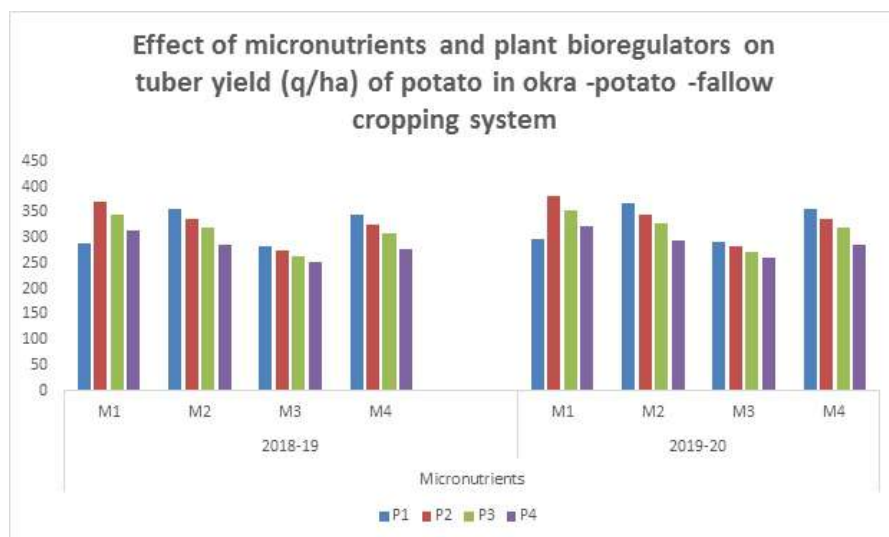
*al.*, 2010; Zodape *et al.*, 2011). In India, Okra is cultivated in an area of 509 thousand ha with the production of 6094.0 million tones and average productivity of 12 Metric Tons/hectare in 2017-18 (Agricultural Statistics at a Glance 2018). In India, Potato is cultivated in an area of 2141.7 thousand ha with the production of 51310 metric tons and average productivity of 24 Metric Tons/hectare in 2017-18 (Agricultural Statistics At A Glance 2018), It has since spread around the world and become a staple crop in many countries. Raw potato is 79% water, 17% carbohydrates, 2% protein, contains negligible fat. In a 100 grams amount, raw potato provides 322 kilojoules and is a rich source of vitamin B6 and vitamin C. In literature, varying level of heterosis, combining ability and gene action in Okra have been registered. Singh (1979).

### Materials and Methods

A field experiment was conducted at Agronomy Research farm of IFTM University, Lodhipur Rajput, Moradabad (U.P.) India to evaluate Effect of micronutrients and plant bio-regulators on growth of okra and potato crop. The experiment consist of 16 treatment combination with some foliar application macro and micro nutrients which were laid out in Factorial Randomized Design with three replication. There are 16 treatments viz. T<sub>1</sub>- RDF Control, T<sub>2</sub> RDF+PGR-1, T<sub>3</sub> RDF+PGR-2, T<sub>4</sub> RDF+PGR-3, T<sub>5</sub> RDF+ZN, T<sub>6</sub> RDF+BO, T<sub>7</sub> RDF+SI, T<sub>8</sub> ZN+PGR-1, T<sub>9</sub> ZN+PGR-2, T<sub>10</sub> ZN+PGR-3, T<sub>11</sub> BO+PGR-1, T<sub>12</sub> BO+PGR-2, T<sub>13</sub> BO+PGR-3, T<sub>14</sub> SI+PGR-1, T<sub>15</sub> SI+PGR-2 and T<sub>16</sub> SI+PGR-3.

Table-1 : Effect of micronutrients and plant bioregulators on tuber yield (q/ha) of potato in okra-potato-fallow cropping system.

| Bioregulators                               | Micronutrients |        |             |        |             |
|---------------------------------------------|----------------|--------|-------------|--------|-------------|
|                                             | 2019-20        |        |             |        |             |
|                                             | M1             | M2     | M3          | M4     | Av          |
| P1                                          | 289.40         | 356.20 | 283.00      | 345.70 | 318.58      |
| P2                                          | 371.20         | 335.80 | 273.80      | 326.00 | 326.70      |
| P3                                          | 344.40         | 319.10 | 263.30      | 309.70 | 309.13      |
| P4                                          | 314.40         | 287.10 | 252.90      | 278.40 | 283.20      |
|                                             | 329.85         | 324.55 | 268.25      | 314.95 | 309.40      |
| 2020-21                                     |                |        |             |        |             |
| P1                                          | 298.00         | 366.90 | 291.00      | 356.00 | 327.98      |
| P2                                          | 382.00         | 345.90 | 282.00      | 335.40 | 336.33      |
| P3                                          | 354.80         | 328.70 | 271.20      | 318.70 | 318.35      |
| P4                                          | 323.90         | 295.80 | 260.30      | 286.40 | 291.60      |
|                                             | 339.68         | 334.33 | 276.13      | 324.13 | 318.56      |
| 2019-20                                     |                |        | 2020-21     |        |             |
|                                             |                | SE(m)  | CD (p=0.05) | SE(m)  | CD (p=0.05) |
| Between levels of micronutrients (M)        |                | 4.861  | 14.040      | 4.789  | 13.832      |
| Between levels of bioregulators (P)         |                | 6.276  | 18.126      | 6.183  | 17.858      |
| Between interaction of micronutrients (MxP) |                | 10.870 | 31.395      | 10.709 | 30.930      |



## Results and Discussion

**Tuber yield (q/ha) :** The data clearly indicates that different micronutrients have their significant influence on tuber yield (q/ha) of potato. Maximum tuber yield (q/ha) of potato was 329.85 and 339.68 was noted with application of RDF which was statistically on par with application of M2 and M4 during first year however during second year it was at par with M2 only. Minimum tuber yield (q/ha) of potato was 268.25 and 276.13 was noted under treatment M3 during first and second year of experimentation respectively.

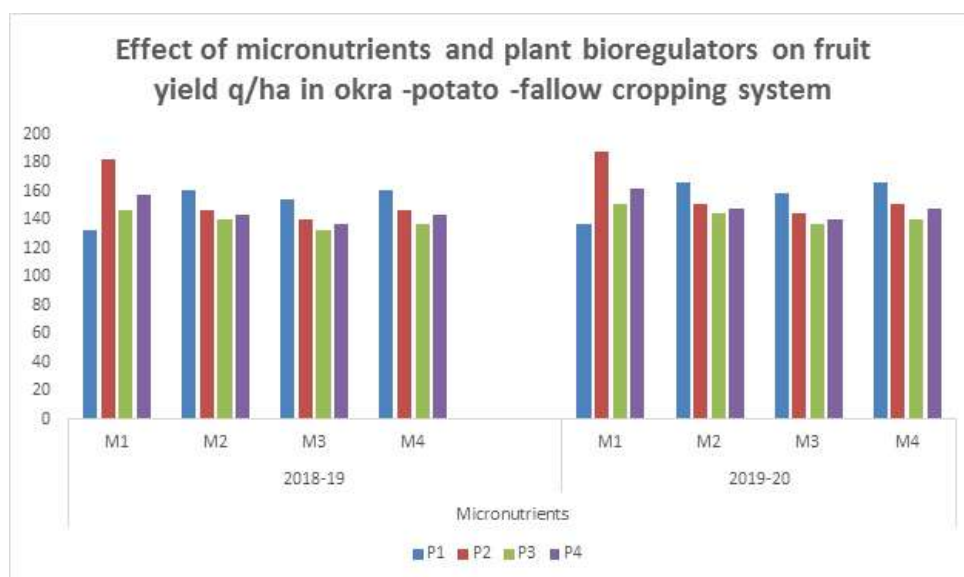
The application of bioregulators expressed their effect significantly on tuber yield (q/ha) of potato (326.70

and 336.33) was noted under application of P2 non significantly followed by P1 and P4 and Significantly followed by P3 during both respective years of study. Minimum tuber yield (q/ha) i.e., 283.20 and 291.60 was noted when P3 bioregulator was applied during 2019-20 and 2020-21. Combined effect of micronutrients and bioregulators was also significant scrutinizing of data indicates that max tuber yield (q/ha) of potato was 371.20 and 382.00 was recorded under combination of M1 x P2 followed by rest combinations. Minimum tuber yield (q/ha) of potato was noted when M3 was combined with P3 the trend of data was similar during both the years of study.

**Fruit yield q/ha :** The data presented in study clearly indicates that different micronutrients have their significant

Table-2 : Effect of micronutrients and plant bioregulators on fruit yield q/ha in okra-potato-fallow cropping system.

| Bioregulators                               | Micronutrients |         |             |         |             |
|---------------------------------------------|----------------|---------|-------------|---------|-------------|
|                                             | 2019-20        |         |             |         |             |
|                                             | M1             | M2      | M3          | M4      | Av          |
| P1                                          | 133.00         | 161.00  | 154.00      | 161.00  | 152.25      |
| P2                                          | 182.00         | 147.00  | 140.00      | 147.00  | 154.00      |
| P3                                          | 147.00         | 140.00  | 133.00      | 136.50  | 139.13      |
| P4                                          | 157.50         | 143.50  | 136.50      | 143.50  | 145.25      |
| AV                                          | 154.88         | 147.88  | 140.88      | 147.00  | 147.66      |
| 2020-21                                     |                |         |             |         |             |
| P1                                          | 137.00         | 165.90  | 158.60      | 165.90  | 156.85      |
| P2                                          | 187.60         | 151.40  | 144.30      | 151.40  | 158.68      |
| P3                                          | 151.40         | 144.30  | 137.30      | 140.60  | 143.40      |
| P4                                          | 162.00         | 147.80  | 140.60      | 147.90  | 149.58      |
| Av                                          | 159.50         | 152.35  | 145.20      | 151.45  | 152.13      |
|                                             |                | 2019-20 |             | 2020-21 |             |
|                                             |                | SE(m)   | CD (p=0.05) | SE(m)   | CD (p=0.05) |
| Between levels of micronutrients (M)        |                | 2.434   | 7.031       | 2.209   | 6.379       |
| Between levels of bioregulators (P)         |                | 3.143   | 9.076       | 2.851   | 8.235       |
| Between interaction of micronutrients (MxP) |                | 5.443   | 15.721      | 4.939   | 14.264      |



influence on fruit yield q/ha of okra. Maximum fruit yield q/ha of okra was 154.88 and 159.50 was noted with application of RDF which was statistically on par with application of M2 and M4 during first year however during second year it was at par with M2 only. Minimum fruit yield q/ha of okra was 140.00 and 145.20 was noted under treatment M3 during first and second year of experimentation respectively.

It is evident that application of bioregulators expressed their effect significantly on fruit yield q/ha of okra maximum fruit yield q/ha of okra was (154.00 and 158.68) was noted under application of P2 non significantly followed by P1 and P4 and Significantly followed by P3 during both respective years of study. Minimum fruit yield q/ha of okra i.e., 139.13 and 143.40

was noted when P3 bioregulator was applied during 2019-20 and 2020-21.

Combined effect of micronutrients and bioregulators was also significant scrutiny of data indicates that max fruit yield q/ha of okra was 182.00 and 187.60 was recorded under combination of M1 x P2 followed by rest combinations. Minimum fruit yield q/ha of okra was noted when M3 was combined with P3 the trend of data was similar during both the years of study.

**Economics :** The maximum cost of cultivation of potato and okra (Rs. 115751/ha in both I and II year) was incurred in the treatment T<sub>2</sub> - RDF + PGR-1, while the lowest cost of cultivation of both potato and okra (Rs. 97625/ha) was associated with T<sub>3</sub> – ZN+PGR-3. The maximum gross

**Table-3 : Effect of micronutrients and plant bioregulators on economics in soil in okra-potato-fallow cropping system.**

| Treatment Details | Cost of cul sequence | Gross Return I | Gross Return II | Net Return I | Benefit :Cost I | Net Return II | Benefit : Cost II |
|-------------------|----------------------|----------------|-----------------|--------------|-----------------|---------------|-------------------|
| RDF (Control)     | 109501               | 364520         | 404000          | 255019       | 2.33            | 294499        | 2.69              |
| RDF+PGR-1         | 115751               | 478960         | 531060          | 363209       | 3.14            | 415309        | 3.59              |
| RDF+PGR-2         | 113251               | 422520         | 468120          | 309269       | 2.73            | 354869        | 3.13              |
| RDF+PGR-3         | 110501               | 409020         | 453515          | 298519       | 2.70            | 343014        | 3.10              |
| RDF+ZN            | 111126               | 445960         | 494355          | 334834       | 3.01            | 383229        | 3.45              |
| RDF+BO            | 110126               | 415640         | 460555          | 305514       | 2.77            | 350429        | 3.18              |
| RDF+SI            | 113251               | 395280         | 438125          | 282029       | 2.49            | 324874        | 2.87              |
| ZN+PGR-1          | 102875               | 373180         | 414010          | 270305       | 2.63            | 311135        | 3.02              |
| ZN+PGR-2          | 100375               | 380400         | 421810          | 280025       | 2.79            | 321435        | 3.20              |
| ZN+PGR-3          | 97625                | 359040         | 398430          | 261415       | 2.68            | 300805        | 3.08              |
| BO+PGR-1          | 101875               | 343640         | 381550          | 241765       | 2.37            | 279675        | 2.75              |
| BO+PGR-2          | 99375                | 338820         | 375915          | 239445       | 2.41            | 276540        | 2.78              |
| BO+PGR-3          | 96625                | 437560         | 485090          | 340935       | 3.53            | 388465        | 4.02              |
| SI+PGR-1          | 105000               | 407800         | 451630          | 302800       | 2.88            | 346630        | 3.30              |
| SI+PGR-2          | 102500               | 384260         | 425555          | 281760       | 2.75            | 323055        | 3.15              |

return was calculated in both I and II year (Rs. 478960/ha and 531060/ ha during I and II year, respectively)

The benefit cost ratio was found maximum (3.14 and 4.02 in both I and II year respectively). It is clear from the above result that the maximum profit was found in II year.

## Conclusion

Maximum fruit yield q/ha of okra was 154.88 and 159.50 was noted with application of RDF which was statistically on par with application of M2 and M4 during first year however during second year it was at par with M2 only. Minimum fruit yield q/ha of okra was 140.00 and 145.20 was noted under treatment M3 during study. Minimum fruit yield q/ha of okra was noted when M3 was combined with P3 the trend of data was similar during both the years of study.

However it may be concluded from the following results that the variety arka anamika of okra can be used under different programmes as its yield and its contributing characters express in different agro-climatic conditions. Grewal *et al.* (1972), carried out a seed production of okra sown on three dates 20th June, 10th and 30th July in three row spacing (30,45 and 60 cm) and subjected to one to four pickings of green fruits. They found that seed yield, seed weight and weight of dry (mature) pods per plant were adversely affected by late sowing, wider row spacing and a greater number of picking. However, two picking of green fruits affected the seed yield and contributed towards maximum profit.

Maximum tuber yield (q/ha) of potato was 329.85 and 339.68 was noted with application of RDF which was statistically on par with application of M2 and M4 during first year however during second year it was at par with M2 only. Minimum tuber yield (q/ha) of potato was noted

when M3 was combined with P3. It is evident from the current study of potato cropping system be concluded from the following results that the variety Kufri Chipsona-1 of potato can be used under different programmes as its yield and its contributing characters express in different agro-climatic conditions.. Kamalnathan *et al.* (1970), recommended a spacing of 16 to 20 cm with two plants per hill for maximum economic return from summer crop. In another experiment they obtained the maximum fruit yield per plant and per hectare under 60x40 cm and 60x20 cm respectively. Bid *et al.* (1971), studied the effect of N, P and K at 60, 30 and 30 Kg ha<sup>-1</sup> respectively in various combination and reported that the two nutrient combinations gave better crop growth and yield. Out of these combinations N, K was found to be the most effective followed by N, P and P, K. Chiotan (1971), reported that the highest yield of Okra was obtained with an application at 96 Kg/ha each N and P, followed by 48 Kg N and 48 Kg P/ha. However, the maximum economic return was associated with the application of 48 Kg ha<sup>-1</sup> each of N and P. Krishnappa (1990) stated that the application of potassium had a marked effect on the yield of large medium and small sized tubers, but had no effect on very small sized tubers, The yield was large and medium sized tubers was increased progressively with the increasing levels of potassium. The difference between 50, 1. and 150 Kg K<sub>2</sub>O /ha in the production of large (More than 75 gm medium and small sized less than 25 gm) tubers befit non-significant. I-E further concluded that the increase yield due to potassium application was mainly the function of the size of % tubers.

The maximum cost of cultivation of potato and okra (Rs. 115751/ha in both I and II year) was incurred in the treatment T<sub>2</sub>- RDF + PGR-1, while the lowest cost of cultivation of both potato and okra (Rs. 97625/ha) was

associated with T<sub>3</sub> – ZN+PGR-3. The benefit cost ratio was found maximum (3.14 and 4.02 in both I and II year respectively).

### Conclusion

It can be concluded from the study that maximum yield of potato and okra was achieved using the following treatment combinations also the maximum economic benefit was achieved in the second year of study.

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## Polygenic Variability and Genetic Advance in Chickpea (*Cicer arietinum* L.) for Yield in M<sub>2</sub> and M<sub>3</sub> Generation

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### Abstract

In general, all the mutagenic treatments generated substantial amount of variability for all the seven polygenic characters studied (days to 50% flowering, days to maturity, plant height, pods per plant, seeds per pod, 100-seed weight and seed yield per plant) in both M<sub>2</sub> and M<sub>3</sub> generations. The polygenic variability recorded in M<sub>3</sub> coefficient of variation was more than in M<sub>2</sub> coefficient of variation for different characters exception few cases. However, the magnitude of variability expressed in M<sub>2</sub> itself is high enough to exercise effectiveness selection. Among the characters studied, yield and pods per plant showed maximum induced variability followed by seeds per pod and plant height, whereas, days to maturity and days to 50 per cent flowering showed minimum variability. The increase in variance due to generation advancement was negligible for seed yield, pods per plant and seeds per pod, whereas it was significantly higher for the remaining four polygenic characters. This leads to the conclusion that selection for seed yield, pods per plant and seeds per pod could be confined to M<sub>2</sub> alone, as much advantage is not expected by advancing the mutagenized population to M<sub>3</sub>. Among the mutagens tested gamma rays induced the highest magnitude of polygenic variability followed by chemical and combined (gamma rays + EMS%). Another important feature of this analysis was detection of a great deal of heterogeneity among different M<sub>2</sub> families in each mutagenized population in respect of mean values for all the characters. Coefficient of variation than the highest observed in the control to identify the promising M<sub>2</sub> families. Intrafamily selection was also practiced among promising families. As a result, a large number of promising families were isolated from the M<sub>2</sub> population itself most of which were confirmed in M<sub>3</sub> generation. The frequency of such families with different mutagens was in the order of gamma rays > chemical > combined.

**Key words :** Chickpea, variability, mutagenesis, coefficient variation, heritability.

### Introduction

Mutation was first observed by English Farmer Seth Wright in 1791 in male lamb which had about short legs, we were used the term of mutation to describe phenotypic changes which were heritable. He is first differentiated between heritable and environmental variation. The term of mutation is now used in a rather strict sense to cover only those change which after the chemical structure of gene at the molecular level. These are commonly called point mutations or gene mutations. But changes in chromosome number and structure were also produce heritable changes in phenotype, these are termed as chromosomal aberration or chromosomal mutation. Hugo de Vries in 1900 observed the mutation in *Oenothera* and give this term. Systematic studies on mutations began in 1910 by T.H Morgan in *Drosophila* for white eye mutation. The first X-rays mutagen used for creation of mutation in *Drosophila* in 1927 for this work he was awarded Nobel Prize for physiology and Medicine in 1946. And in 1928 by L.J Stadler described mutagenic effect of X-rays in barley. Subsequently mutagenic effect of mustard gas and other chemical were observed by C. Auerbach in 1946.

Grain legumes occupy a unique position in world agriculture by virtue of their high protein content and capacity to fix atmospheric nitrogen. For developing countries like India, pulses constitute the major source of dietary proteins. In developed countries, grain legumes are also an important indirect source of protein, being animal feed of high biological value. They contain 20-30 per cent protein in their seeds, which is 2 to 3 times more than in the cereals. The proteins from pulses are also nutritionally valuable because of higher lysine content than the cereal proteins. These two groups of crops have a complementary relationship in their amino acid composition and their combined intake can compensate, to a great extent, for their mutual amino acid deficiency. The major chickpea growing countries in order of their significance are India, Turkey, Pakistan, Iran, Australia, Mexico, Ethiopia, Myanmar, Spain and Bangladesh. India has the distinction of being the largest chickpea producer and accounts for over 64 and 68 per cent of the total area and production in the world. It grows chickpea on about 7.5 million hectares producing 6.1 million tons of grains, which represents 33 and 47 per cent of the national pulse area and production, respectively. DE

Candolle (1883) traced the origin of chickpea to an area south of the Caucasus and northern Persia. Vavilov (1926) designated south west Asia and the Mediterranean as primary and Ethiopia as secondary centers of diversity. However, the most probable centre of origin seems to be southeastern Turkey and Adjuring, Syria (Ladizinsky, 1975) since the most closely related wild species of *C. arietinum* namely, *C. bijugum*, *C. echinospermum* and *C. reticulatum* have been widely distributed in this fertile crescent. It is generally considered that the *Kabuli* type owes its origin to selection from the most primitive *desi*.

## Materials and Methods

Mutation has been a dominant force in the evolutionary process though mutation breeding is not an exclusive breeding procedure. It is a tool to produce new additional heritable variation which may be utilized in traditional recombination breeding programmes. The following investigation was carried out at the Department of Agricultural Botany (Genetics and Plant Breeding), Janta Vedic College, Baraut, and IIMT University, Meerut. The material used and method applied during the course of present study are being described as given below:

**Experimental material :** The experimental materials for this study consisted of 3 varieties of chickpea having good agronomic base and belonging to diverse group viz., *desi* (BGM-524) *Kabuli* (BG-1053) and green seed (KSB-220) were treated with different doses of gamma rays, ethyl methane, sulphonate (EMS) and their combination (EMS+ Gamma rays)

**Mutagens :** The physical, chemical and combined mutagens were employed to induce mutations. The brief description about the source, mode of action and method of application is given below :

Details of mutagens and their doses for each three varieties used in present investigation.

| Mutagen            | Dose         | No. of seeds treated | Treatment condition                        |
|--------------------|--------------|----------------------|--------------------------------------------|
| Gamma-rays         | 20 kR        | 100x3                | Dry Dry Dry<br>Dry Dry                     |
|                    | 30 kR        | 100x3                |                                            |
|                    | 40 kR        | 100x3                |                                            |
|                    | 50 kR        | 100x3                |                                            |
|                    | 60 kR        | 100x3                |                                            |
| EMS                | 0.10%        | 100x3                | Soaking (400 ml)<br>“<br>“<br>“<br>“       |
|                    | 0.15%        | 100x3                |                                            |
|                    | 0.20%        | 100x3                |                                            |
|                    | 0.25%        | 100x3                |                                            |
|                    | 0.30%        | 100x3                |                                            |
| Combined treatment | 20 kR + 0.10 | 100x3                | Dry + Soaking<br>(400 ml) “<br>“<br>“<br>“ |
|                    | 30 kR + 0.15 | 100x3                |                                            |
|                    | 40 kR + 0.15 | 100x3                |                                            |
|                    | 50 kR + 0.15 | 100x3                |                                            |
|                    | 60 kR + 0.15 | 100x3                |                                            |

Total treatment = 16x3 = 48

Total experimental seeds = 48x100 = 4800

**Physical mutagen :** The gamma-rays obtained from a 2000 curie CO<sup>60</sup> Gamma cell installed in the Division of NRL, IARI, New Delhi, with a dose rate of 2500 rads per min. Was used as physical mutagen. Gamma rays are electromagnetic type of Adiations, induce mutations through ionization. When a biological material is irradiated, a gamma-rays photon hits an Orbital electron of the atom. The electron gets excited and in turn ejected out leaving behind a positively charged atom. The ejected electron has tremendous energy and is capable of causing further ionizations along its path. Well dried uniform seeds of each variety size about 10 per cent moisture content were filled in a seed envelope and exposed to gamma rays irradiations in the gamma cell. Different doses of gamma-rays were used for irradiation of seeds i.e., 10, 20, 30, 40, 50 and 60 kr. Depending upon the dose of irradiation, time of exposure was adjusted accordingly.

**Chemical mutagen :** Ethyl methane sulphonate (EMS), a potent alkylating agent obtained from Eastman Kodak Chemicals, USA was used as chemical mutagen. It is a most widely used chemical mutagen and is also a powerful carcinogen. It induces through alkylation of DNA. well dried selected seeds of uniform size were presoaked in water for 6 hours and then treated with freshly prepared aqueous solutions of EMS at 25±2°C. To have maximum absorption of solution, the seeds contained in the conical flask were repeatedly subjected to shaking. Treatments with five different concentrations i.e., 0.10, 0.15, 0.20, 0.25 and 0.30 per cent for 4 to 6 hrs each were given with intermittent shaking. As soon as treatment is over, seeds were washed in running tap water for 5-10 minutes to remove traces of chemical from the seed surface. Thereafter, by spreading the seeds on blotting paper excessive water was removed. The seeds were sown in the field immediately after treatment, whereas, seeds soaked in tops water for 6 hours were used as control.

**Combined Mutagens :** Seeds irradiated at different doses viz. 20, 30, 40, 50 and 60 kR were treated with 0.10, 0.15, 0.20, 0.25 and 0.30 per cent EMS aqueous solution of ethyl methane sulphonate for 6 hr. by the method described above.

## Results and Discussion

The estimates of mean, range, coefficient of variance, heritability and genetic advance for days to 50% flowering in M<sub>2</sub> generation for BGM 524, BG-1053 and KSB-220 are presented in Table 4.14. The estimates of CV (coefficients of variance) showed wide range with the values ranging from 2.73 to 7.05 (50 kR) for varieties KSB-220 and BGM-524, respectively. On the other hand, treatments of ethyl methane sulphonate, the estimates of

Table-2 : Components of variation, heritability and genetic advance for seed yield per plant (g) in M<sub>2</sub> generation of BGM-524, BG-1053 and KSB-220.

| Statistical parameter | Gamma rays (kR) |        |        |        |       |       | Ethyl methane sulphonate (EMS, %) |       |       |        | Combination (Gama rays kR+EMS, %) |        |         |        |         |         |
|-----------------------|-----------------|--------|--------|--------|-------|-------|-----------------------------------|-------|-------|--------|-----------------------------------|--------|---------|--------|---------|---------|
|                       | Control         | 20     | 30     | 40     | 50    | 60    | 0.1                               | 0.15  | 0.2   | 0.25   | 0.3                               | 20+0.1 | 30+0.15 | 40+0.2 | 50+0.25 | 60+0.30 |
| Variance              |                 |        |        |        |       |       |                                   |       |       |        |                                   |        |         |        |         |         |
| V <sub>1</sub>        | 21.75           | 102.62 | 109.20 | 121.14 | 9.03  | 30.36 | 49.76                             | 40.19 | 27.51 | 38.59  | 33.57                             | 27.42  | 34.39   | 50.49  | 102.30  | 26.49   |
| V <sub>2</sub>        | 55.52           | 99.48  | 47.06  | 99.0   | 15.22 | 23.72 | 25.84                             | 90.02 | 97.12 | 16.60  | 67.94                             | 101.34 | 23.03   | 21.47  | 19.19   | 13.21   |
| V <sub>3</sub>        | 42.40           | 82.62  | 73.12  | 33.45  | 6.18  | 21.25 | 58.89                             | 32.94 | 45.30 | 108.33 | 42.43                             | 147.43 | 271.30  | 48.36  | 30.15   | 45.71   |
| GCV                   |                 |        |        |        |       |       |                                   |       |       |        |                                   |        |         |        |         |         |
| V <sub>1</sub>        | 0.03            | 0.08   | 0.11   | 27.32  | 0.25  | 23.62 | 10.40                             | 9.67  | 2.72  | 15.72  | 25.11                             | 5.41   | 2.60    | 6.55   | 8.39    | 7.39    |
| V <sub>2</sub>        | 9.54            | 13.46  | 14.29  | 41.89  | 34.52 | 26.39 | 0.10                              | 10.36 | 32.26 | 24.93  | 8.83                              | 17.47  | 11.17   | 3.55   | 35.82   | 17.30   |
| V <sub>3</sub>        | 13.96           | 24.64  | 16.73  | 41.60  | 0.13  | 22.41 | 13.28                             | 12.99 | 10.01 | 40.84  | 16.14                             | 19.55  | 33.07   | 15.58  | 11.29   | 38.64   |
| PCV                   |                 |        |        |        |       |       |                                   |       |       |        |                                   |        |         |        |         |         |
| V <sub>1</sub>        | 16.16           | 30.48  | 41.46  | 42.40  | 25.89 | 33.44 | 26.67                             | 26.82 | 10.82 | 25.14  | 45.96                             | 25.44  | 22.78   | 11.16  | 8.90    | 16.35   |
| V <sub>2</sub>        | 11.87           | 19.07  | 16.62  | 4.89   | 38.12 | 27.22 | 19.61                             | 11.30 | 13.17 | 28.88  | 10.25                             | 19.27  | 17.53   | 5.87   | 42.64   | 14.70   |
| V <sub>3</sub>        | 17.97           | 29.55  | 23.25  | 52.37  | 14.41 | 27.43 | 15.50                             | 14.76 | 11.71 | 44.45  | 20.57                             | 20.39  | 36.19   | 20.29  | 16.26   | 47.85   |
| Heritability          |                 |        |        |        |       |       |                                   |       |       |        |                                   |        |         |        |         |         |
| V <sub>1</sub>        | 32.00           | 42.15  | 52.36  | 62.30  | 71.45 | 49.65 | 25.12                             | 23.25 | 63.46 | 23.56  | 29.32                             | 25.30  | 23.25   | 34.54  | 88.20   | 22.23   |
| V <sub>2</sub>        | 64.25           | 89.12  | 74.23  | 87.16  | 82.65 | 94.32 | 37.45                             | 84.20 | 84.36 | 69.58  | 74.41                             | 82.45  | 40.26   | 36.10  | 71.56   | 73.26   |
| V <sub>3</sub>        | 60.20           | 71.26  | 79.71  | 63.45  | 68.12 | 66.20 | 73.14                             | 79.13 | 75.10 | 84.24  | 61.10                             | 81.32  | 83.56   | 59.41  | 48.65   | 81.48   |
| Genetic advance       |                 |        |        |        |       |       |                                   |       |       |        |                                   |        |         |        |         |         |
| V <sub>1</sub>        | 3.12            | 4.13   | 5.11   | 6.92   | 8.00  | 4.01  | 1.90                              | 1.51  | 0.65  | 2.70   | 2.82                              | 0.47   | 1.26    | 3.89   | 21.35   | 14.82   |
| V <sub>2</sub>        | 6.50            | 4.25   | 6.64   | 10.78  | 4.06  | 17.59 | 1.20                              | 10.04 | 10.45 | 5.68   | 7.99                              | 10.50  | 2.99    | 3.19   | 3.39    | 8.23    |
| V <sub>3</sub>        | 5.47            | 8.55   | 5.11   | 5.00   | 6.13  | 4.15  | 7.39                              | 5.75  | 6.45  | 11.06  | 5.52                              | 13.65  | 17.29   | 5.72   | 3.89    | 6.99    |

CV showed wide range with the values ranging from 2.24 (0.10% EMS) to 5.60 (0.20% EMS) for varieties BGM- 524 and BG-1053, respectively. Whereas, in combination (gamma-rays + EMS%). The coefficient of variance showed also wide range with the values ranging from 2.32 (30 kR + 0.15% EMS) to 6.10 (60 kR + 0.30% EMS) for varieties BGM-524 and BG-1053, respectively. This indicates the presence of considerable amount of variability among all the treatments studied. The estimates of heritability in broad sense were maximum values 84.52 (0.10% EMS) followed by 78.62% (20 kR + 0.1 EMS) and 77.02% (20 kR) for variety KSB-220. The estimates of genetic advance were highest 14.00 (60 kR + 0.30% EMS) for variety BG-1053, followed by 12.45 (50 kR + 30% EMS) and 10.80 (20 kR) for variety BGM-524.

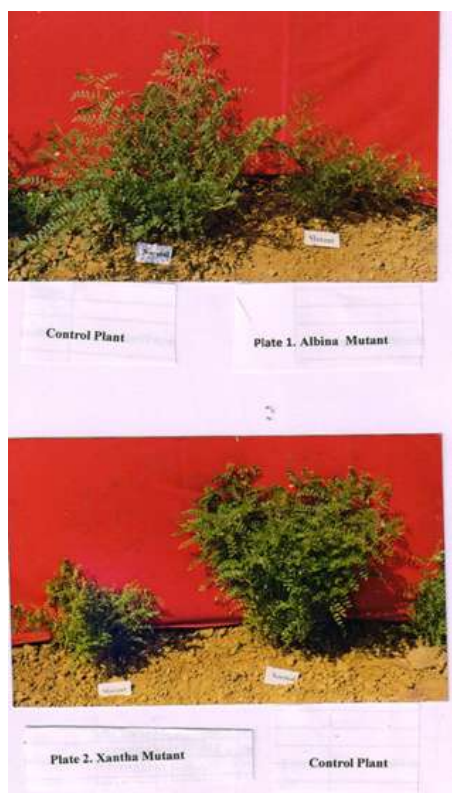
**Plant height :** The estimates of mean, range, coefficient of variance, heritability and genetic advance for plant height in M<sub>2</sub> generation on three varieties are presented in Table 4.15. The coefficient of variance (CV) showed wide range with the values ranging from 3.12% (60 kR + 0.30% EMS) to 29.00 (50 kR + 0.25% EMS) of BGM-524 (*desi*) and KSB-220, respectively. On the other hand, treatments of ethyl methane sulphonate (EMS%), the coefficient of variance (CV) showed wide range with the values ranging from 4.83 (0.20% EMS) to 24.59 (0.25% EMS) for varieties of BGM-524 and KSB-220, respectively. Whereas, in combination of (gamma-rays + EMS%) treatments, the coefficient of variance also showed also wide range with the values ranging from 3.12% (60 kR + 0.30% EMS) to 29.00% (50 kR + 0.25% EMS) for varieties of BGM-524 and KSB-220, respectively. The

Table-3 : Range, population mean, variance, SD and CV for days to 50% flowering in M3 generation for BGM-524, BG-1053 and KSB-220.

| Statistical parameter | Control        | Gamma rays (kR) |        |        |        |        |        | Ethyl methane sulphonate (EMS, %) |        |        |        |        |         | Combination (Gamma rays kR+EMS, %) |         |         |  |  |  |
|-----------------------|----------------|-----------------|--------|--------|--------|--------|--------|-----------------------------------|--------|--------|--------|--------|---------|------------------------------------|---------|---------|--|--|--|
|                       |                | 20              | 30     | 40     | 50     | 60     | 0.1    | 0.15                              | 0.2    | 0.25   | 0.3    | 20+0.1 | 30+0.15 | 40+0.2                             | 50+0.25 | 60+0.30 |  |  |  |
| Range                 | V <sub>1</sub> | 73.5-           | 100.4- | 110.0- | 83.0-  | 83.3-  | 79.0-  | 89.0-                             | 89.3-  | 85.5-  | 79.1-  | 89.3-  | 84.4-   | 85.3-                              | 91.4-   | 97.0-   |  |  |  |
|                       |                | 130.7           | 119.4  | 117.0  | 113.4  | 109.1  | 116.6  | 112.0                             | 119.2  | 113.0  | 108.9  | 109.9  | 109.3   | 117.3                              | 113.1   | 117.0   |  |  |  |
|                       | V <sub>2</sub> | 90.5-           | 89.3-  | 83.3-  | 81.5   | 83.0-  | 85.5-  | 87.0-                             | 89.0-  | 101.0- | 83.0-  | 76.1-  | 75.5-   | 79.1-                              | 83.0-   | 87.9-   |  |  |  |
|                       |                | 113.5           | 107.3  | 119.5  | 117.4  | 97.2   | 99.5   | 117.3                             | 114.2  | 119.4  | 99.8   | 99.9   | 99.3    | 109.2                              | 104.3   | 109.2   |  |  |  |
|                       | V <sub>3</sub> | 73.5-           | 100.4- | 101.1- | 83.3-  | 85.0-  | 84.4-  | 83.4-                             | 79.7-  | 88.8-  | 87.4-  | 79.3-  | 84.5-   | 87.3-                              | 97.7-   | 101.2-  |  |  |  |
| Mean                  |                | 130.7           | 119.4  | 113.1  | 117.3  | 112.0  | 113.4  | 112.3                             | 107.3  | 117.0  | 119.2  | 109.9  | 109.3   | 117.2                              | 117.9   | 125.5   |  |  |  |
|                       | V <sub>1</sub> | 97.78           | 108.81 | 113.50 | 102.76 | 101.43 | 96.53  | 101.93                            | 105.77 | 99.40  | 98.66  | 101.73 | 100.01  | 99.18                              | 99.44   | 105.66  |  |  |  |
|                       | V <sub>2</sub> | 100.13          | 96.37  | 94.11  | 104.25 | 106.74 | 88.65  | 94.77                             | 100.12 | 108.74 | 92.02  | 87.70  | 88.82   | 97.10                              | 93.30   | 98.42   |  |  |  |
|                       | V <sub>3</sub> | 102.86          | 109.77 | 106.44 | 100.30 | 97.35  | 101.40 | 103.10                            | 97.14  | 104.19 | 104.07 | 99.97  | 99.77   | 98.07                              | 106.36  | 110.66  |  |  |  |
|                       | Variance       |                 |        |        |        |        |        |                                   |        |        |        |        |         |                                    |         |         |  |  |  |
| SD                    | V <sub>1</sub> | 11.62           | 25.77  | 86.72  | 43.50  | 45.60  | 53.26  | 48.68                             | 48.94  | 64.69  | 58.09  | 20.80  | 50.40   | 49.20                              | 35.73   | 13.66   |  |  |  |
|                       | V <sub>2</sub> | 9.79            | 18.60  | 47.31  | 72.62  | 78.44  | 14.12  | 38.69                             | 127.33 | 31.77  | 24.64  | 40.38  | 26.30   | 39.70                              | 37.02   | 29.85   |  |  |  |
|                       | V <sub>3</sub> | 197.05          | 28.54  | 13.92  | 69.85  | 130.93 | 41.40  | 28.66                             | 47.18  | 37.21  | 60.84  | 47.00  | 48.43   | 31.56                              | 22.96   | 36.85   |  |  |  |
|                       | V <sub>1</sub> | 18.41           | 5.08   | 9.31   | 6.50   | 6.75   | 7.25   | 6.90                              | 6.99   | 8.04   | 7.60   | 4.56   | 7.14    | 7.00                               | 5.97    | 3.72    |  |  |  |
|                       | V <sub>2</sub> | 3.13            | 4.13   | 6.87   | 8.52   | 8.83   | 3.70   | 3.66                              | 11.28  | 5.63   | 4.96   | 6.35   | 5.12    | 6.30                               | 6.08    | 5.44    |  |  |  |
| CV                    | V <sub>3</sub> | 14.03           | 5.34   | 3.72   | 8.35   | 11.44  | 6.43   | 5.35                              | 7.22   | 6.10   | 7.80   | 6.74   | 6.93    | 5.61                               | 4.79    | 6.04    |  |  |  |
|                       | V <sub>1</sub> | 3.34            | 4.66   | 8.20   | 6.32   | 6.65   | 7.51   | 6.79                              | 6.60   | 8.08   | 7.70   | 4.48   | 7.10    | 7.05                               | 6.00    | 3.52    |  |  |  |
|                       | V <sub>2</sub> | 3.12            | 4.32   | 7.29   | 8.19   | 8.27   | 4.20   | 3.86                              | 11.26  | 5.21   | 5.39   | 7.22   | 5.76    | 6.48                               | 6.51    | 5.52    |  |  |  |
|                       | V <sub>3</sub> | 13.63           | 4.87   | 3.49   | 8.38   | 11.75  | 6.34   | 5.19                              | 7.06   | 5.85   | 7.48   | 6.74   | 6.94    | 5.72                               | 4.50    | 5.45    |  |  |  |
|                       |                |                 |        |        |        |        |        |                                   |        |        |        |        |         |                                    |         |         |  |  |  |

estimates of heritability in broad sense were maximum values 94.47% (30 kR) followed by 94.18% (50 kR) and 93.33% (0.15% EMS) for varieties BG-1053 and KSB-220, respectively. Genetic advance were also highest 13.57 (30 kR) in BG-1053 followed by 12.78 (50 kR) in KSB-220. Days to maturity The mean, range, coefficient of variance, heritability and genetic advance are presented in Table 02. The coefficient of variance (CV) had widest range from 1.98 to 10.59 (20 kR) in varieties of BGM-524 and BG-1053, respectively, and other side in ethyl methane sulphonate had wide range 2.20 (0.20% EMS) to 4.87 (0.25% EMS) in BGM-524 and BG-1053, respectively. Whereas in combined treatment also had wide range from 2.23 (20 kR + 0.10% EMS) to 3.85 (50 kR + 0.25% EMS) in KSB-220 and BG-1053, respectively. Table indicates that the presence of variance had different variability under different mutagens in all mutagenized population. The estimate of heritability was highest 91.36 under 30 kR treatment followed by 85.45 and 83.10 with 0.25% EMS for varieties of BG-1053, KSB-220 and BGM-520, respectively. Genetic advance (GA) was also found highest 11.91 (30 kR) in BG-1053 followed by 9.40 (50 kR + 0.25% EMS) and 8.97 (0.25% EMS) in variety of BGM-524 and KSB-220, respectively.

**Number of pods plant :** The data on number of pods per plant for M<sub>2</sub> generation are presented in Table 2-3. The



estimates of coefficient of variance (CV) showed widest range with the values ranging from 8.66 (30 kR) to 88.35 (50 kR) for varieties KSB-220 and BG-1053, respectively. On the other hand, treatment of ethyl methane sulphonates showed wide range with 2.24 (0.15% EMS) to 89.77 (0.30% EMS) found in mutinied populations, only one variety of chickpea in BG-1053. Whereas the widest ranges were also found 6.93 (40 kR + 0.20% EMS) to 44.93 (60 kR + 0.30% EMS) for varieties BGM-524 and KSB-220, respectively. Considerable amount of variability among all the treatments are studied in the presence of statistical analysis. The estimates of heritability in broad sense were maximum values 93.32 (50 kR) for BG-1053 followed by 94.36 (0.30% EMS) and 63.45 (40 kR) for variety KSB-220. The estimates of GA were highest 81.36 under 30 kR + 0.15% EMS for variety BG-1053, followed by 61.90 (0.25% EMS) and 59.18 (50 kR) for KSB-220 (green).

**Number of seeds per pod :** Table 2-3 showed the number of seeds per pod in  $M_2$  generation for BGM-524, BG-1053 and KSB-220 in different statistical parameters i.e. range, mean, coefficient of variance, heritability and genetic advance. The coefficient of variance was observed widest range from 3.07% (20 kR) to 56.21% (30 kR) on various doses of gamma-rays, in BGM-524 for the character number of seeds per pod. While the coefficient of variance was found in widest range with 4.36% (0.25% EMS) to 82.35% (0.10% EMS) in

BG-1053. Whereas, in combined treatment showed the wide range with the values ranging showed the wide range with the values ranging from 11.42% (40 kR + 0.20% EMS) to 43.36% (20 kR + 0.10% EMS) for KSB-220 and BG-1053, respectively. The estimates of heritability were maximum for 91.45% (0.15% EMS) followed by 91.03% (0.25% EMS) and 90.12% (40 kR) for KSB-220 and BG-1053, respectively. The estimates of genetic advance (GA) were highest 12.00 (60 kR + 0.30% EMS) followed by 9.62 (50 kR + 0.25% EMS) for BGM-524. 100-seed weight (g) The estimates of mean, range, coefficient of variation, heritability and genetic advance for 100-seed weight in  $M_2$  generation for BGM-524, BG-1053 and KSB-220 are presented in Table 4.19. The estimates of coefficient of variance showed wide range with the values ranging from 11.79 (20 kR) to 36.26 (50 kR) for varieties BG-1053 and BGM-524, respectively. On the other hand, treatments of ethyl methane sulphonate, the estimate of coefficient of variance showed wide range with the values ranging from 8.47 (0.15% EMS) to 30.48 (0.20% EMS) for BG-1053 and KSB-220, respectively. Whereas, in combined treatments (gamma-rays + EMS%), the coefficient of variance also showed wide range with the values ranging from 4.36 (20 kR + 0.10% EMS) and 85.14 (30 kR + 0.15% EMS) for varieties BGM-524 and BG-1053, respectively. The estimates of heritability in broad sense were maximum (86.47%) for the treatment (30 kR + 0.15% EMS) followed by 85.41% (0.25% EMS) and

82.45% (60 kR) for variety KSB-220. This variety had more drastic heritability in overall mutagenic population than their control. The genetic advance (GA) was also highest 10.54 (30 kR + 0.15% EMS) and 8.89 (30 kR + 0.15 EMS) for variety KSB-220 and BG-1053 (Table-3).

**Grain yield per plant :** The data on grain yield per plant in M<sub>2</sub> generation for three varieties are presented in Table 2-3. From the table, it is evident that coefficient variance showed widest range from 6.98 (50 kR) to 42.26 (40 kR) for varieties BG-1053 and BGM-524, while the estimates of CV for ethyl methane sulphonate (EMS%) had wide range from 10.00 (0.30 EMS) to 43.54 (0.20% EMS) for variety BG-1053 and KSB-220, respectively. Whereas, for combined treatment also showed widest range from 11.40 (40 kR + 0.20% EMS) to 42.00 (60 kR + 30% EMS) for varieties BGM-524 and BG-1053, respectively. The heritability was observed highest 94.32 (60 kR) followed by 84.36% (0.20% EMS) in variety BG-1053. However, 88.20 (50 kR + 0.25% EMS) and 84.24 (0.25% EMS) in varieties BG-1053, BGM-524 and KSB-220, respectively. Whereas, the estimate of genetic advance was highest value 21.35 (50 kR + 0.25% EMS) for BGM-524 followed by 17.59 (60 kR) and 17.29 (30 kR + 0.15 EMS) in BG-1053 and KSB-220, respectively.

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## DUS Characterization of Mungbean (*Vigna radiata* L.) Genotypes

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### Abstract

The study was conducted to characterize thirty six improved genotypes of Greengram using DUS descriptors. The 36 genotypes were evaluated and characterized for 15 DUS descriptors i.e., anthocyanin colouration during cotyledonary stage, plant, stem, leaf, flower, pod and seed characters. All 15 characters of DUS descriptors differed significantly indicating a large and exploitable amount of genetic variability for the individual improved genotypes development for identification and protection. The genotypes varied for the important plant traits like plant growth habit and determinate types indicates the incorporation of new germplasm for the improvement by using these traits. The DUS descriptor data generated with unique profiles of the improved genotypes can be used for the registration with PPV & FRA and seed purity testing.

**Key words :** characterization, DUS, mungbean.

### Introduction

Mung bean is an important crop grown in 4.26 million hectare with 2.01 million tonne production (IVth Advance Estimate 2017-18). This crop provides protein-rich diet, restores and maintains the soil fertility by fixing atmospheric nitrogen. This short duration crop is amenable to diverse environmental situation including multiple cropping systems to expand its area and production and making India a nutritionally secure place for its growing population. However, the national productivity of mung bean is only around 472 kg per ha. The low productivity of this crop can be attributed to narrow genetic base (resulting in low yield potential and susceptibility to biotic and abiotic stresses) and lack of suitable plant types for different cropping situations. The desirable ideotype of mungbean should have maturity duration for spring/summer season is 58–62 days, with determinate growth habit, high harvest index, photo-insensitivity and thermo-insensitivity, high pod set in first reproductive flush along with concentration at the top of the plant of pods that remain nonshattering, fast initial growth, long pod with above 10 seeds per pod and 1000-seed weight of 35–40 g. Short duration mung bean varieties require determinate growth habit. The present study was conducted with the specific objective of identifying suitable parents for hybridization. Further, it also emphasize the significance of development of new lines for yield to meet up the rising needs of the nation (Pratap *et al.*, 2018).

Characterization of germplasm is the basic step in forming groups of lines having similar characteristics to get an idea of variability present in the lines and their utilization in breeding programmes (Piyada *et al.*, 2010).

Characterization and identification of new cultivars is essential for their efficient utilization and conservation. Normal morphological descriptions of lines by the plant breeders are inadequate to get the complete picture of the lines and highlight the need of standard procedures described by a competent authority like PPV & FRA (Protection of Plant Varieties and Farmers' Rights Authority) to characterize the genotypes. Thus, characterization using Distinctness, Uniformity and Stability (DUS) is of great significance in the era intellectual property rights for the protection of lines as well as quality seed production and certification (Janghel *et al.*, 2020).

Katiyar *et al.*, (2007) explained the genetic relationships among the breeding lines of greengram present in India using morphological characters. Keeping these points in view, this work is planned to study the DUS characteristics of the thirty six improved lines of greengram.

### Materials and Methods

The study on characterization of 36 mung bean genotypes based on plant characters was taken up at the BSP Unit, Department of Plant Breeding and Genetics, College of Agriculture, Jawaharlal Nehru Krishi Vishwavidhyalaya, Jabalpur during Kharif 2019. These thirty six accessions were evaluated in the field using R.B.D. with three replications. The observations were recorded at specified stages of crop growth period when the traits under study had full expression i.e., different growth stages. The morphological traits observation was done as per the DUS guidelines suggested by the Protection of Plant Varieties and Farmers' Rights Authority (2)

## Results and Discussion

Thirty six improved genotypes of greengram were characterized using DUS descriptors. The characters of anthocyanin colouration during cotyledonary stage, plant characteristics, stem, leaf, flower, pod and seed characteristics during different growth stages of crop growth differed significantly for 14 characters out of 15 characters of DUS descriptors indicating a large and exploitable amount of genetic variability for the improved genotypes development for identification and protection. Katiyar *et al.*, (2008) also exploited DUS characterization in greengram for the identification and protection.

Anthocyanin colouration is generally measured as a key morphological indicator in greengram to categorize the genotypes into two groups based on their presence or absence and was recorded at cotyledonary stage (Mukherjee and Pradhan, 2002). In the present investigation, eight genotypes or 22.22% were without pigmentation and twenty eight genotypes or 77.78% showed anthocyanin colour signifying the presence of variation among the lines and to employ it as selection criteria for identification of the lines (Table-1).

**Plant characters :** Plant morphological characters like plant growth habit and plant type were observed at days to 50 per cent flowering, while plant height observed at fully developed green pod stage and can be used as criteria in varietal purity maintenance and identification. Out of thirty six genotypes, ten or 27.78% showed erect growth habit, twenty two or 61.11% were semi erect types whereas four or 11.11% were recorded to be spreading type. And sixteen or 44.44% were determinate type and twenty or 55.56% showed indeterminate growth. Twenty three were short genotypes while thirteen genotypes of medium height were observed. Normally, erect plant types are favoured as they acquire ample sun shine and are more efficient in synthesizing food for the growth and development of plant. Also, the plants with determinate growth habit are more preferable over indeterminate types as it promote synchronous maturity in plants. Thus, there is a need to incorporate these traits in new improved genotypes for future development.

**Stem characters :** Stem morphological characters, colour and pubescence, were recorded at days to 50% flowering stage of plant. All the genotypes showed pubescence with 75% or twenty seven genotypes having green stem, while nine or 25% showed green stem with purple splashes indicating all the genotypes are similar for pubescence and not useful in identification and purity maintenance, however selection could be effectively done for stem color.

**Leaf characters :** Leaf morphological characters like leaf shape, colour and vein colour were observed at days to 50

per cent flowering stage of the plant. These characters play a significant role in the yielding ability of the genotypes, as the leaves are the source of food synthesis and transpiration site of the plants. All these characters showed variability and the genotypes were categorized into distinct groups (Table-1).

Leaf shape was deltoid in seven genotypes; ovate in twenty seven genotypes and cuneate in two genotypes. Leaf colour was green in fifteen genotypes and dark green in remaining twenty one genotypes. Leaf vein colour was greenish purple in twenty four genotypes, green in seven genotypes and purple for five genotypes. The leaf traits (foliage colour, leaf shape and leaf vein color) showed very good variation and are useful in the characterization but the effect of environmental factors is very high on these traits as they are polygenically controlled.

**Flower characters :** Flower characters *viz.*, colour and time of flower, were observed at days to 50% flowering stage of plant. Flower colour is reliable morphological marker and distinguishing the greengram genotypes. Out of all the thirty six genotypes, twenty seven or 75% genotypes showed the similar flower petal colour *i.e.*, yellow whereas 25% or nine genotypes were observed for light yellow color (Table-1). Hence, this trait can be used in discriminating the genotypes in the present material. Jain *et al.*, (2002) reported the usefulness of flower characteristics in characterization of greengram germplasm.

**Pod characters :** Greengram pod characteristics are highly useful in identification of the genotypes. The pod characters like pod pubescence were observed at fully developed green pod stage while pod color were noted during plant maturity stage before harvest (Table-1). These characteristics influence the yielding ability of the plant and are considered as the main yield attributing traits. All these characters showed variation and were categorized into distinct groups.

Pod pubescence was present in all genotypes except one. Kaur *et al.*, (2017) also reported similar trend for this trait in their study. Pod colour is a quite useful morphological marker and may be used in quality seed production programmes at maturity stage to monitor the mixture of other varieties but most of the lines showed black pods at the time of maturity except three genotypes indicating this trait is of little use for identification of lines in the present material.

Thus, these pod characteristics can be exploited for identification and characterization but are found to be variable due to more number of genes and environmental influence on the expression.

**Seed characters :** The price of premium genotypes of greengram or consumer acceptance of a variety is

Table-1 : Morphological characterization of 36 mungbean genotype.

| S. No. | Trait                               | Classes                    | No. of Genotypes | Frequency |
|--------|-------------------------------------|----------------------------|------------------|-----------|
| 1.     | Hypocotyl : anthocyanin coloration  | Absent                     | 8                | 22.22     |
|        |                                     | Present                    | 28               | 77.78     |
| 2.     | Plant : growth habit                | Erect                      | 10               | 27.78     |
|        |                                     | Semi-erect                 | 22               | 61.11     |
|        |                                     | Spreading                  | 4                | 11.11     |
| 3.     | Plant : growth type                 | Determinate                | 16               | 44.44     |
|        |                                     | Indeterminate              | 20               | 55.56     |
| 4.     | Stem : pubescence                   | Absent                     | 0                | 0.00      |
|        |                                     | Present                    | 36               | 100.00    |
| 5.     | Stem : color                        | Green                      | 27               | 75.00     |
|        |                                     | Green with purple splashes | 9                | 25.00     |
|        |                                     | Purple                     | 0                | 0.00      |
| 6.     | Leaf shape (terminal)               | Deltoid                    | 7                | 19.44     |
|        |                                     | Ovate                      | 27               | 75.00     |
|        |                                     | Lanceolate                 | 0                | 0.00      |
|        |                                     | Cuneate                    | 2                | 5.56      |
| 7.     | Leaf : color                        | Green                      | 15               | 41.67     |
|        |                                     | Dark green                 | 21               | 58.33     |
| 8.     | Leaf : vein color                   | Green                      | 7                | 19.44     |
|        |                                     | Greenish purple            | 24               | 66.67     |
|        |                                     | Purple                     | 5                | 13.89     |
| 9.     | Flower : colour of petal (standard) | Yellow                     | 27               | 75.00     |
|        |                                     | Light yellow               | 9                | 25.00     |
| 10.    | Pod : pubescence                    | Absent                     | 1                | 2.78      |
|        |                                     | Present                    | 35               | 97.22     |
| 11.    | Plant : height                      | Short                      | 23               | 63.89     |
|        |                                     | Medium                     | 13               | 36.11     |
|        |                                     | Long                       | 0                | 0.00      |
| 12.    | Pod : color                         | Brown                      | 3                | 8.33      |
|        |                                     | Black                      | 33               | 91.67     |
| 13.    | Seed : color                        | Yellow                     | 2                | 5.56      |
|        |                                     | Green                      | 28               | 77.78     |
|        |                                     | Mottled                    | 6                | 16.67     |
|        |                                     | Black                      | 0                | 0.00      |
| 14.    | Seed : luster                       | Shiny                      | 25               | 69.44     |
|        |                                     | Dull                       | 11               | 30.56     |
| 15.    | Seed : shape                        | Oval                       | 28               | 77.78     |
|        |                                     | Drum                       | 8                | 22.22     |

decided by the seed characteristics like colour, luster and shape (Pratap *et al.*, 2018). Varieties with oval shining green grains with medium size are preferred over dull/ brown/ black and drum shaped grains. Seed morphological characters like colour, luster and shape were observed at mature seed stage of plant in the present experiment (Table-1).

All these characters were grouped into distinct groups. Seed colour was yellow in two genotypes, green in twenty eight genotypes and mottled in six genotypes respectively. Seed color determines phytic acid levels in the seed and there are reports that yellow seeded genotypes had low phytic acid content which can be used

as a donor for quality improvement of greengram seeds (Tajoddin *et al.*, 2011).

Seed luster was shiny in 25 genotypes and dull in 11 genotypes. Seed shape was oval in 28 genotypes and drum shaped in 08 genotypes. Thus, seed morphological traits form very good markers for the purity testing and identification. Some of the lines are having consumer accepted seed traits for fetching premium price in the market. Venkateswarlu (2001) and Khajudparn and Tantasawat (2011) also discussed the usefulness of seed characters in the characterization of lines in greengram.

Among the 15 morphological DUS traits observed four characters (plant growth habit, leaf shape, leaf vein

color and seed color) recorded trimorphic variation; ten characters (anthocyanin colouration of cotyledons, plant growth type, stem color, leaf color, flower petal color, pod pubescence, plant height, pod color, seed luster and seed shape) indicated the dimorphic grouping and stem pubescence showed no variation *i.e.*, monomorphic grouping signifying the presence of remarkable amount of genetic variability in these genotypes which have huge potential to assign distinctive morphological profiles from combination of morphological DUS traits which could be used for improved lines identification and characterization as well as selection of diverse parents in hybridization programme for more heterotic response and generation of better segregants in mungbean breeding.

In the present investigation, stem pubescence are same in all the lines and are not useful for discrimination but anthocyanin colouration at cotyledonary stage, plant, leaf, pod and seed characteristics are having lot of variability which can be exploited for the genotypes identification and utilization as reported by Patel *et al.*, (2019) and smoothen the process of the easy registration with these distinct characters present in the genotypes with PPVFRA.

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## Studies on Processing and Storage Stability of Bael (*Aegle marmelos* Correa) Nectar for Nutritional Security

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### Abstract

A trial was conducted on Bael fruits to study the physical properties and chemical composition to find out the suitable recipes for preparation of ideal Nectar, also storage stability of Nectar prepared from suitable recipes. Physical and chemical properties revealed that average weight (g)-510.25, Juice content(%)-75.28, TSS(%)-38.42, Total titratable acidity (%)-0.42, Ascorbic acid (mg/100g)-14.32 indicated the proper maturity stage of Bael for Nectar preparation. In this study different recipes of Bael Nectar was standardized to explore the processing potential of Bael, a minor fruit. There were five different possibilities of recipes. The Nectar prepared from the recipes 20% pulp, 13% TSS and 0.30% Acidity gave highest organoleptic quality score, greater consumer acceptabilities and retain good nutritional qualities followed by Nectar prepared from 20% pulp, 18% TSS and 0.25% Acidity and the quality of the prepared Nectar was maintained up to fifth months at ambient temperature.

**Key words :** Bael, nectar, beverage, processing, storage stability.

### Introduction

**Bael** (*Aegle marmelos* Correa) belongs to family Rutaceae is indigenous to India. The importance of Bael fruit lies in its curative properties. Bael is a deciduous and hardy tree grown wild all over India. The Bael fruit is a hard shelled berry and the pulp contains tunnels which are filled with a mucilage. The fruit is very nutritive and contains fair amount of vitamin-A, vitamin-B, vitamin-C, minerals and high carbohydrates content. The fruit is very rich in Riboflavin (Vitamin B<sub>2</sub>). Bael fruit is not popular as a desert fruit due to its hardshell, mucilagenous texture and numerous seed. It has good processing attributes such as excellent flavour, nutritive and therapeutic values. But the excellent nutritive and therapeutic values of fruits has great potentiality for processing in to various quality products. Which can get position in national and international market. Keeping the above points in view this research problem was designed to find out a nutritious soft drink of consumer acceptability.

### Materials and Methods

Fruits free from bruises, cracks and white spot were harvested randomly from different plants of orchard. five fruits replicated four times were used for assessing the physical characteristic (Table-2). The flesh of five fruits (100g each) replicated three times was subjected to chemical analysis Table-3).The pulp from Bael was extracted according to the flow diagram (fig.-1).

Fresh and matured bael fruits → Cleaned it thoroughly → Sliced with the help of slicer → The slices were kept in the

cold water in such a manner that all slices were under the water (for half an hour) → The seed, mucilaginous matter and rind was removed from the slices using knife and fork → Slices were made into pieces and boiled with a little quantity of water for five minutes → The above material are put into a pulping machine (Addition of water in the ratio of 1:0.25) → Pulp was obtained in semi solid form → Pulp was filtered by strainer → Collected the clear pulp.

**Fig.-1: Flow sheet for extraction of Pulp from ripen Bael fruits**

Nectar was prepared according to the flow diagram (fig.2):

Fruit pulp → Straining → Mixing with syrup according to recipe → Straining and cooling it → Addition of preservative according to recipe → Bottling → Crown Corking → Pasteurization for 20 minutes → Cooling → Labeling → Storage at ambient temperature.

**Fig.- 2 : Flow sheet for extraction of Pulp from ripen Bael fruits**

After that it was subjected to organoleptic evaluation, the results obtained was given in the table-4. Nectar prepared from ideal treatments was analyzed for chemical parameters initially and at an interval of one month upto sixth month of storage period and the results obtained was given in the table-4.

**Table-1 : Following five recipes each with three replications were tried.**

| Treatments     | Pulp (%) | TSS (%) | Acidity (%) |
|----------------|----------|---------|-------------|
| T <sub>1</sub> | 20       | 15      | 0.30        |
| T <sub>2</sub> | 20       | 13      | 0.30        |
| T <sub>3</sub> | 20       | 16      | 0.25        |
| T <sub>4</sub> | 20       | 18      | 0.25        |
| T <sub>5</sub> | 20       | 14      | 0.30        |

**Table-2 : Physical Characters of Bael fruits.**

| No. | Characters                        | Average Value |
|-----|-----------------------------------|---------------|
| 1.  | Average weight (g)                | 510.25        |
| 2.  | Volume (ml)                       | 575           |
| 3.  | Specific gravity (g/cc)           | 0.887         |
| 4.  | Overall length (cm)               | 10.2          |
| 5.  | Maximum width (cm)                | 8.3           |
| 6.  | Juice content (%)                 | 75.28         |
| 7.  | Sphericity (%)                    | 250           |
| 8.  | Bulk density (kg/m <sup>3</sup> ) | 450           |
| 9.  | True density (kg/m <sup>3</sup> ) | 852           |
| 10. | Moisture content (%)              | 64.22         |

**Table-3 : Chemical composition of Bael fruits.**

| Sl. No. | Characters                 | Average Value |
|---------|----------------------------|---------------|
| 1.      | Total Soluble Solids (%)   | 38.42         |
| 2.      | Total Titrable acidity (%) | 0.42          |
| 3.      | Ascorbic acid (mg/100g)    | 14.32         |
| 4.      | Reducing Sugar (%)         | 4.82          |
| 5.      | Total carbohydrates (g%)   | 12.84         |

**Table-4 : Organoleptic quality of different recipes of Bael Nectar.**

| Recipe No       | Pulp (%) | TSS (%) | Acidity (%) | Organoleptic quality |                  |
|-----------------|----------|---------|-------------|----------------------|------------------|
|                 |          |         |             | Score                | Rating           |
| 1               | 20       | 15      | 0.30        | 7.24                 | Liked moderately |
| 2               | 20       | 13      | 0.30        | 8.43                 | Liked verymuch   |
| 3               | 20       | 16      | 0.25        | 7.20                 | Liked moderately |
| 4               | 20       | 18      | 0.25        | 7.28                 | Liked moderately |
| 5               | 20       | 14      | 0.30        | 6.23                 | Liked slightly   |
| C.D at 5% level |          |         |             | 0.22                 |                  |
| S.E.M $\pm$     |          |         |             | 0.07                 |                  |

**Table-5 : Changes in chemical characters during storage of ideal recipis of Bael Nectar.**

| S.N. | Characters              | Storage period in months |       |       |       |       |       |       |
|------|-------------------------|--------------------------|-------|-------|-------|-------|-------|-------|
|      |                         | 0                        | 1     | 2     | 3     | 4     | 5     | 6     |
| 1.   | TSS %                   | 13.00                    | 13.00 | 13.00 | 13.25 | 13.45 | 13.65 | 13.88 |
| 2.   | Acidity %               | 0.30                     | 0.30  | 0.30  | 0.31  | 0.32  | 0.34  | 0.35  |
| 3.   | Ascorbic Acid (mg/100g) | 13.64                    | 13.60 | 12.89 | 12.64 | 12.46 | 12.00 | 11.89 |
| 4.   | Browning (O.D)          | 0.08                     | 0.08  | 0.10  | 0.13  | 0.14  | 0.17  | 0.20  |
| 5.   | Reducing Sugar %        | 18.22                    | 18.38 | 18.46 | 18.54 | 18.59 | 18.78 | 18.92 |
| 6.   | Total carbohydrate (g%) | 22.20                    | 22.15 | 22.12 | 22.08 | 22.00 | 20.92 | 20.87 |
| 7.   | Organoleptic quality    | 8.43                     | 8.28  | 8.09  | 7.89  | 7.64  | 7.32  | 6.89  |

The TSS was estimated by hand refractometer. The acidity was determined by method of simple acid base titration method using phenolphthalein as indicator. The ascorbic acid content in the samples were measured by reduction of 2,6 dichlorophenol indophenol dye as given by Ranganna (1986). The reducing and non-reducing and total sugars were estimated by Lane and Eynon (1923). Non-enzymatic browning was estimated by the method of Ranganna (1986). The organoleptic evaluation of RTS prepared under different treatment was carried out by a panel of six judges using hedonic rating scale given by Amerine *et. al.*, 1965). The analysis of variance of the

date was carried out by the technique as described by Raghuramula *et.al.*, (1983).

The data on organoleptic quality of various recipes of nectar is presented in Table-4. Results indicated that the recipe containing 20 percent juice 13 percent TSS and 0.3 percent acidity was found to be ideal followed by recipe containing 20 percent pulp, 18 percent TSS and 0.25 percent acidity. There was significant difference in the organoleptic scores of these two recipes. The differences among the organoleptic scores of recipes No. 1, 3 and 4 were however, statistically in significant.

Studies on changes during storage of Bael Nectar indicated that TSS increased slightly after three month of storage. It is due to the conversion of polysaccharides in to sugars. Similar observation was recorded by Khurdiya (1979) in phalsa beverages. Total acidity of Nectar did not change up to three months of storage, then gradually increases the acidity of fruit products. (Conn and Stumf, 1976), the present findings are also in agreement with the

observation of several workers (Ashraf, 1987 : Singh, 2000). Results indicated that ascorbic acid content of the Nectar beverage decreased continuously during the entire period of storage. The reduction may be due to oxidation of ascorbic acid in to dehydro ascorbic acid by oxygen. Several authors (Roy and Singh, 1979; Singh, 2000) have also reported losses of ascorbic acid in fruit beverages during ambient storage. In the present study browning of Nectar increased continuously throughout the entire period of storage. It may be due to non-enzymatic reactions, which occurs between nitrogenous compounds

with sugar or organic acids with sugars. Increase in browning was observed by several workers (Siddappa *et.al.*, 1959). Reducing sugars increased continuously and total carbohydrate decreased continuously. The organoleptic scores of Nectar decreased gradually during storage at room temperature. The acceptability of Nectar was maintained up to fifth months. Similar findings were observed in different beverages by several workers.

Thus it may be concluded that Nectar prepared from the recipe containing 20% pulp, 13% TSS and 0.30% acidity contain best eye appeal, flavours, consistency, taste and nutritious as compared to the other recipes, and it may play an important role in food and nutritional security.

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## Slow Release Multi Nutrient Tablets for Improving Soil Fertility, Nutrient Use Efficiency and Yield of Tomato

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### Abstract

Slow release fertilizers have been in common use for decades. They are effective compared to conventional fertilizers due to their gradual pattern of nutrient release which better meets plant needs, minimizes losses and therefore increases nutrient availability. Multinutrient tablets containing major, secondary and micronutrients were prepared using compatible fertilizer materials, binding agents and filler materials. A pot culture experiment carried out to evaluate the effect of these multinutrient tablets in tomato revealed that multinutrient tablets containing fertilizer materials like neem coated urea, factamphos, muriate of potash, magnesium oxide, phosphogypsum, zinc sulphate, borax and binding agent methyl cellulose and clay (filler) applied at 75 per cent of recommended dose of fertilizers increased the nutrient availability in soil, nutrient use efficiency and yield of tomato. The fruit yield of tomato was increased by 46.22 % over control. The highest NUE of nitrogen ( $58.77 \text{ g g}^{-1}$ ), phosphorus ( $55.10 \text{ g g}^{-1}$ ) and potassium ( $79.35 \text{ g g}^{-1}$ ) was observed in treatment T<sub>7</sub> followed by T<sub>8</sub>. The apparent recovery percentage of nitrogen 96.87 %, phosphorus 90.53 % and potassium 94.95 % and partial factor productivity of  $27.71 \text{ g g}^{-1}$  were recorded highest in T<sub>7</sub>.

**Key words :** Controlled release, multi nutrient tablets, nutrient use efficiency and yield.

### Introduction

Controlled-release fertilizer is a good alternative to soluble fertilizer to increase nutrient use efficiency and minimize nutrient losses [1]. It possess high maximum percentage recovery in order to attain a higher return to the production input and it has minimum adverse effects on soil, water and air. Multi nutrient fertilizers in the form of tablets are one among this category.

Slow release fertilizer containing urea and potassium dihydrogen phosphate developed based on natural attapulgite (APT) clay as a matrix, guar gum (GG) as an inner coating and guar gum-g-poly (itaconic acid-co-acrylamide)/ humic acid superabsorbent polymer as an outer coating was found to buffer the acidity and alkalinity so as to develop a more optimal pH for plant growth [2]. A slow release fertilizer polyolefin-coated urea increased potato yield compared to uncoated urea [3]. It has been reported that application of slow release fertilizers increased the grain and straw yield in rice [4]. Application of fertilizer tablets containing phosphogypsum-urea, ammonium sulphate, amophos, rock phosphate, muriate of potash, clay and gypsum (pelletized) increased wet rhizome yield in turmeric [5]. The nutrient content and uptake was found to be higher in early ripening rapeseed by the application of CRF [6].

### Materials and Methods

Multinutrient tablets containing major, secondary and

micronutrients were prepared using compatible fertilizer materials, binding agents and filler material (clay) in a tablet press.

| Treatments | Treatment details                                                                                                                               |
|------------|-------------------------------------------------------------------------------------------------------------------------------------------------|
| Tablet 1   | Urea, dicalcium phosphate, potassium sulphate, calcium sulphate, magnesium oxide, zinc EDTA, boric acid and binding agent polyvinyl pyrrolidone |
| Tablet 2   | Urea, diammonium phosphate, muriate of potash, calcium sulphate, magnesium sulphate, zinc EDTA, borax and binding agent methyl cellulose        |
| Tablet 3   | Urea, diammonium phosphate, muriate of potash, calcium sulphate, magnesium sulphate, zinc EDTA, borax and binding agent gelatin                 |
| Tablet 4   | Neem coated urea, factamphos, muriate of potash, magnesium oxide, phosphogypsum, zinc sulphate, borax and binding agent methyl cellulose.       |

The tablets prepared were 5 g in weight, 1.5 cm diameter and 2 cm length. The stability, disintegration time, nutrient content, pH, EC and moisture content of these tablets were analysed using standard procedures.

A pot culture experiment was carried out at College of Agriculture, Vellayani during October 2018 with tomato variety Vellayani Vijay as test up to evaluate the effect of these tablets on nutrient availability in soil, uptake of nutrients by plant, yield and quality. Multinutrient tablets were applied at 2 levels viz., 75 and 100 % of recommended dose of fertilizers and were compared with

Table-1 : Properties and nutrient content of multinutrient tablets.

| Treat-ments | Stability       | DT (hours) | Hygros-copcity | pH (1:10) | EC (dS m <sup>-1</sup> ) (1:10) | MC % | N %  | P %  | K %  | Ca % | Mg % | S %  | B %  | Zn % |
|-------------|-----------------|------------|----------------|-----------|---------------------------------|------|------|------|------|------|------|------|------|------|
| Tablet 1    | Hard and stable | 12         | Nil            | 8.21      | 9.75                            | 7.65 | 8.69 | 4.81 | 3.00 | 6.20 | 0.67 | 3.09 | 0.21 | 0.23 |
| Tablet 2    | Hard and stable | 10         | Nil            | 6.42      | 20.10                           | 6.46 | 8.42 | 4.67 | 2.43 | 6.29 | 0.66 | 2.42 | 0.22 | 0.21 |
| Tablet 3    | Hard and stable | 10         | Nil            | 6.43      | 19.93                           | 7.74 | 8.23 | 4.80 | 2.40 | 6.45 | 0.66 | 2.37 | 0.22 | 0.22 |
| Tablet 4    | Hard and stable | 12         | Nil            | 6.59      | 27.67                           | 8.01 | 8.55 | 4.72 | 2.40 | 6.33 | 0.66 | 3.27 | 0.22 | 0.24 |

DT-Disintegration time, MC-Moisture content

Tablet-2 : Effect of multinutrient tablets on nutrient availability in soil.

| Treatments      | N (kg ha <sup>-1</sup> ) | P <sub>2</sub> O <sub>5</sub> (kg ha <sup>-1</sup> ) | K <sub>2</sub> O (kg ha <sup>-1</sup> ) | Ca (mg kg <sup>-1</sup> ) | Mg (mg kg <sup>-1</sup> ) | S (mg kg <sup>-1</sup> ) | B (mg kg <sup>-1</sup> ) | Zn (mg kg <sup>-1</sup> ) |
|-----------------|--------------------------|------------------------------------------------------|-----------------------------------------|---------------------------|---------------------------|--------------------------|--------------------------|---------------------------|
| T <sub>1</sub>  | 286.81                   | 74.67                                                | 168.00                                  | 301.84                    | 103.67 <sup>ab</sup>      | 5.27                     | 0.23                     | 3.90                      |
| T <sub>2</sub>  | 303.51                   | 77.28                                                | 186.67                                  | 312.00                    | 104.81 <sup>ab</sup>      | 5.32                     | 0.29                     | 4.04                      |
| T <sub>3</sub>  | 295.48                   | 64.95                                                | 178.00                                  | 273.62                    | 98.00                     | 5.81                     | 0.27                     | 3.86                      |
| T <sub>4</sub>  | 312.21 <sup>ab</sup>     | 69.03                                                | 190.40                                  | 280.82                    | 99.73                     | 6.42                     | 0.30 <sup>ab</sup>       | 4.02                      |
| T <sub>5</sub>  | 303.54                   | 80.11                                                | 205.73                                  | 281.19                    | 106.00 <sup>ab</sup>      | 7.72                     | 0.31 <sup>ab</sup>       | 4.04                      |
| T <sub>6</sub>  | 315.46 <sup>ab</sup>     | 83.81 <sup>ab</sup>                                  | 209.47 <sup>ab</sup>                    | 296.43                    | 107.00 <sup>a</sup>       | 8.35 <sup>a</sup>        | 0.30 <sup>ab</sup>       | 4.08                      |
| T <sub>7</sub>  | 319.17 <sup>ab</sup>     | 84.75 <sup>ab</sup>                                  | 212.80 <sup>ab</sup>                    | 324.00 <sup>ab</sup>      | 99.51                     | 5.35                     | 0.31 <sup>ab</sup>       | 4.12 <sup>ab</sup>        |
| T <sub>8</sub>  | 321.96 <sup>a</sup>      | 88.18 <sup>a</sup>                                   | 216.53 <sup>a</sup>                     | 342.56 <sup>a</sup>       | 101.45 <sup>ab</sup>      | 5.46                     | 0.34 <sup>a</sup>        | 4.21 <sup>a</sup>         |
| T <sub>9</sub>  | 307.48                   | 74.85                                                | 182.93                                  | 298.10                    | 96.00                     | 4.72                     | 0.26                     | 3.92                      |
| T <sub>10</sub> | 318.85 <sup>ab</sup>     | 83.81 <sup>ab</sup>                                  | 209.07 <sup>ab</sup>                    | 302.86                    | 98.00                     | 5.05                     | 0.30 <sup>ab</sup>       | 4.21 <sup>a</sup>         |
| T <sub>11</sub> | 246.70                   | 52.99                                                | 120.40                                  | 250.59                    | 76.47                     | 2.29                     | 0.21                     | 3.76                      |
| SE (m ±)        | 4.02                     | 2.04                                                 | 7.33                                    | 5.24                      | 1.91                      | 0.08                     | 0.02                     | 0.05                      |
| CD (0.05)       | 11.85                    | 6.03                                                 | 21.64                                   | 15.47                     | 5.65                      | 0.24                     | 0.05                     | 0.13                      |

Table-3 : Effect of multinutrient tablets on growth and yield of tomato.

| Treatments      | Treatment details                                    | Plant height | No of branches plant <sup>-1</sup> | No of fruits per plant | Fruit weight (g) | Yield (g plant <sup>-1</sup> ) |
|-----------------|------------------------------------------------------|--------------|------------------------------------|------------------------|------------------|--------------------------------|
| T <sub>1</sub>  | 75% RDF as tablet 1                                  | 52.67        | 4.00                               | 12.00                  | 28.09            | 387.51                         |
| T <sub>2</sub>  | 100% RDF as tablet 1                                 | 52.67        | 3.67                               | 13.00                  | 27.54            | 403.99                         |
| T <sub>3</sub>  | 75% RDF as tablet 2                                  | 49.00        | 4.00                               | 12.67                  | 27.87            | 438.90                         |
| T <sub>4</sub>  | 100% RDF as tablet 2                                 | 49.33        | 4.00                               | 13.33                  | 27.24            | 416.35                         |
| T <sub>5</sub>  | 75% RDF as tablet 3                                  | 47.67        | 5.00                               | 12.67                  | 28.47            | 410.00                         |
| T <sub>6</sub>  | 100% RDF as tablet 3                                 | 58.00        | 4.67                               | 12.67                  | 31.32            | 419.29                         |
| T <sub>7</sub>  | 75% RDF as tablet 4                                  | 63.00        | 6.67                               | 16.00                  | 33.77            | 502.02                         |
| T <sub>8</sub>  | 100% RDF as tablet 4                                 | 45.00        | 4.33                               | 15.00                  | 32.27            | 495.66                         |
| T <sub>9</sub>  | KAU POP recommendation                               | 44.67        | 3.67                               | 12.67                  | 27.91            | 434.77                         |
| T <sub>10</sub> | T <sub>9</sub> + secondary and micronutrient mixture | 46.33        | 4.00                               | 13.67                  | 29.51            | 467.23                         |
| T <sub>11</sub> | Control (No fertilizers)                             | 38.67        | 2.67                               | 11.00                  | 22.24            | 343.33                         |
| SE (m±)         |                                                      | 2.45         | 0.49                               | 0.56                   | 0.63             | 13.12                          |
| CD (0.05)       |                                                      | 7.2          | 1.45                               | 1.69                   | 1.87             | 38.73                          |

RDF-recommended dose of fertilizers

package of practice recommendation of Kerala Agricultural University and absolute control. The design was CRD with 11 treatments and 3 replications.

The required quantity of nutrients as per the levels of 75 % and 100% of recommended dose of fertilizers for each plant was satisfied with 6 and 8 tablets respectively and were applied in two splits, one at basal and another at one month after planting. The tablets were placed at a depth of 5 cm and a distance of 5 cm away from the root zone.

The soil samples collected from the pot experiment were analysed for pH, EC, organic carbon, nutrients such as N, P, K, Ca, Mg, S, Zn and B as per standard procedures. The nutrient content and uptake in plant and quality parameters of tomato viz., lycopene, ascorbic acid and TSS were also analysed using standard procedures. The biometric observations viz., plant height, number of branches per plant, number of fruits per plant, fruit weight, yield and nutrient use efficiency were recorded. The results of various parameters obtained from experiments

Table-4 : Effect of multinutrient tablets on quality of tomato.

| Treatments      | Treatment details                                    | TSS % | Lycopene (g g <sup>-1</sup> ) | Ascorbic acid (mg 100 g <sup>-1</sup> ) |
|-----------------|------------------------------------------------------|-------|-------------------------------|-----------------------------------------|
| T <sub>1</sub>  | 75% RDF as tablet 1                                  | 4.83  | 13.52                         | 24.67                                   |
| T <sub>2</sub>  | 100% RDF as tablet 1                                 | 5.67  | 14.39                         | 25.00                                   |
| T <sub>3</sub>  | 75% RDF as tablet 2                                  | 5.83  | 13.02                         | 25.33                                   |
| T <sub>4</sub>  | 100% RDF as tablet 2                                 | 5.50  | 13.77                         | 26.33                                   |
| T <sub>5</sub>  | 75% RDF as tablet 3                                  | 5.50  | 14.60                         | 25.00                                   |
| T <sub>6</sub>  | 100% RDF as tablet 3                                 | 5.67  | 15.35                         | 26.00                                   |
| T <sub>7</sub>  | 75% RDF as tablet 4                                  | 5.70  | 16.73                         | 26.00                                   |
| T <sub>8</sub>  | 100% RDF as tablet 4                                 | 5.33  | 13.94                         | 26.00                                   |
| T <sub>9</sub>  | KAU POP recommendation                               | 4.17  | 13.07                         | 25.33                                   |
| T <sub>10</sub> | T <sub>9</sub> + secondary and micronutrient mixture | 4.83  | 11.98                         | 24.00                                   |
| T <sub>11</sub> | Control (No fertilizers)                             | 4.17  | 11.03                         | 25.33                                   |
| SE (m±)         |                                                      |       | 0.27                          |                                         |
| CD (0.05)       |                                                      | NS    | 0.79                          | NS                                      |

RDF-recommended dose of fertilizers

Table-5 : Effect of multinutrient tablets on uptake of nutrients in tomato.

| Treatments      | Treatment details                                    | N (g plant <sup>-1</sup> ) | P (g plant <sup>-1</sup> ) | K (g plant <sup>-1</sup> ) | Ca (g plant <sup>-1</sup> ) | Mg (g plant <sup>-1</sup> ) | S (g plant <sup>-1</sup> ) | B (mg plant <sup>-1</sup> ) | Zn (mg plant <sup>-1</sup> ) |
|-----------------|------------------------------------------------------|----------------------------|----------------------------|----------------------------|-----------------------------|-----------------------------|----------------------------|-----------------------------|------------------------------|
| T <sub>1</sub>  | 75% RDF as tablet 1                                  | 2.01                       | 0.14                       | 0.94                       | 0.69                        | 0.66                        | 0.26                       | 2.05                        | 5.33                         |
| T <sub>2</sub>  | 100% RDF as tablet 1                                 | 2.10                       | 0.16                       | 1.05                       | 0.73                        | 0.76                        | 0.30                       | 2.35                        | 6.40                         |
| T <sub>3</sub>  | 75% RDF as tablet 2                                  | 2.17                       | 0.19                       | 1.17                       | 0.56                        | 0.61                        | 0.25                       | 2.86                        | 6.23                         |
| T <sub>4</sub>  | 100% RDF as tablet 2                                 | 2.26                       | 0.20                       | 1.32                       | 0.74                        | 0.77                        | 0.27                       | 3.39                        | 5.59                         |
| T <sub>5</sub>  | 75% RDF as tablet 3                                  | 2.23                       | 0.18                       | 1.14                       | 0.63                        | 0.63                        | 0.28                       | 2.28                        | 6.56                         |
| T <sub>6</sub>  | 100% RDF as tablet 3                                 | 2.62                       | 0.21                       | 1.36                       | 0.72                        | 0.86                        | 0.37                       | 2.54                        | 6.71                         |
| T <sub>7</sub>  | 75% RDF as tablet 4                                  | 4.10                       | 0.31                       | 2.45                       | 1.51                        | 1.50                        | 0.53                       | 4.27                        | 10.54                        |
| T <sub>8</sub>  | 100% RDF as tablet 4                                 | 2.67                       | 0.19                       | 1.64                       | 0.88                        | 0.96                        | 0.32                       | 3.28                        | 7.86                         |
| T <sub>9</sub>  | KAU POP recommendations                              | 1.93                       | 0.15                       | 1.20                       | 0.63                        | 0.64                        | 0.21                       | 2.49                        | 4.98                         |
| T <sub>10</sub> | T <sub>9</sub> + secondary and micronutrient mixture | 1.86                       | 0.15                       | 1.24                       | 0.76                        | 0.62                        | 0.20                       | 3.15                        | 6.39                         |
| T <sub>11</sub> | Control (No fertilizers)                             | 1.13                       | 0.08                       | 0.55                       | 0.41                        | 0.37                        | 0.09                       | 1.73                        | 3.50                         |
| SE (m±)         |                                                      | 0.09                       | 0.01                       | 0.04                       | 0.04                        | 0.05                        | 0.03                       | 0.23                        | 0.34                         |
| CD (0.05)       |                                                      | 0.27                       | 0.03                       | 0.11                       | 0.13                        | 0.15                        | 0.08                       | 0.67                        | 1.01                         |

RDF-recommended dose of fertilizers.

were analysed statistically for the test of significance by standard procedures using OPSTAT software.

## Results and Discussion

**Properties and nutrient content of multinutrient tablets :** The properties of multinutrient tablets (Table-1) revealed that all the multinutrient tablets prepared were hard and stable and their disintegration time varied from 10 to 12 hours and were non hygroscopic. With respect to pH and EC, tablet 1 was found to be slightly alkaline and others were acidic and EC varied between 9.75 (T<sub>1</sub>) to 27.67 dS m<sup>-1</sup> (T<sub>4</sub>). The moisture content of the tablets ranged from 6.46 % (T<sub>2</sub>) to 8.01 % (T<sub>4</sub>). With respect to the nutrient content, these tablets contain 8.23 to 8.69 % nitrogen, 4.67 to 4.81% phosphorus, 2.40 to 3.00 % potassium, 6.20 to 6.45 % calcium, 0.66 to 0.67 % magnesium, 2.37 to 3.27 % sulphur, 0.21 to 0.22% boron

and 0.21 to 0.24 % boron. Similar results were reported by [7] in a novel multinutrient fertilizer tablet which contain 17.9 5 N, 11.3 % P<sub>2</sub>O<sub>5</sub> and 8.2 % K<sub>2</sub>O content. Similar findings like osmocote, ntricote, polyon and multicote in two compressed fertilizer tablets having an 11-18-11 and 8-8-16 composition [8].

**Nutrient availability in soil :** The available nutrients in soil was significantly influenced by the application of different multinutrient fertilizer tablets (Table-2). The available nitrogen (321.96 kg ha<sup>-1</sup>), phosphorus (88.18 kg ha<sup>-1</sup>), potassium (216.53 kg ha<sup>-1</sup>), calcium (342.56 mg kg<sup>-1</sup>), boron (0.34 mg kg<sup>-1</sup>) and zinc (4.21 mg kg<sup>-1</sup>) was found to be the highest in treatment T<sub>8</sub> receiving 100 % recommended dose of fertilizers as tablet 4, which was followed by T<sub>7</sub> receiving 75 % of recommended dose of fertilizers as tablet 4 and were found to be on par. With respect to available magnesium and sulphur the treatment

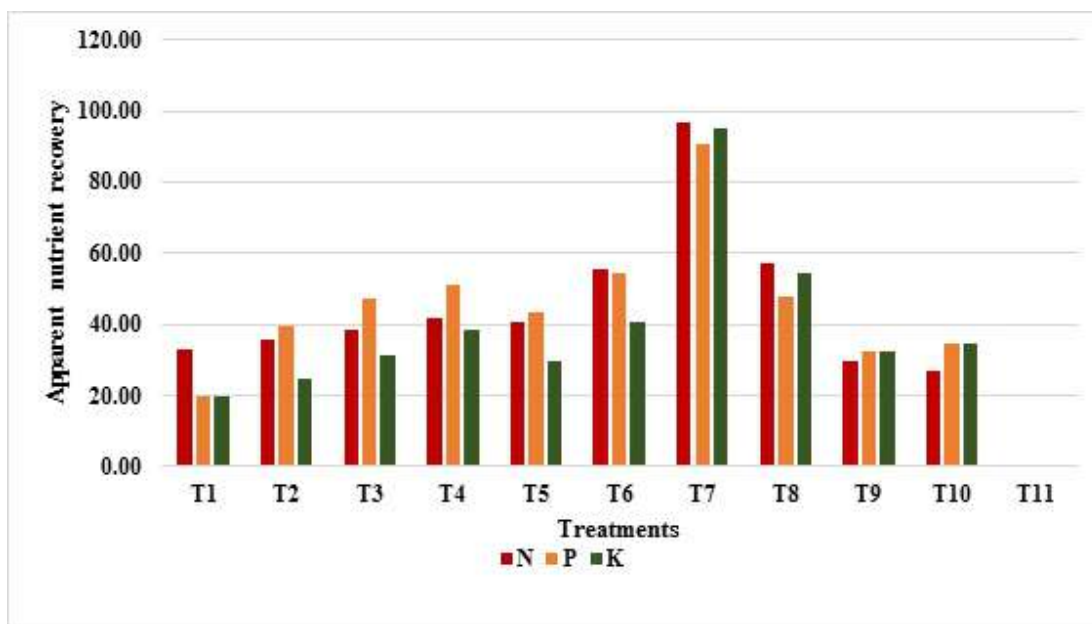


Fig-1 : Effect of multinutrient tablets on apparent nutrient recovery.  
X axis - Treatments, Y axis - Apparent nutrient recovery

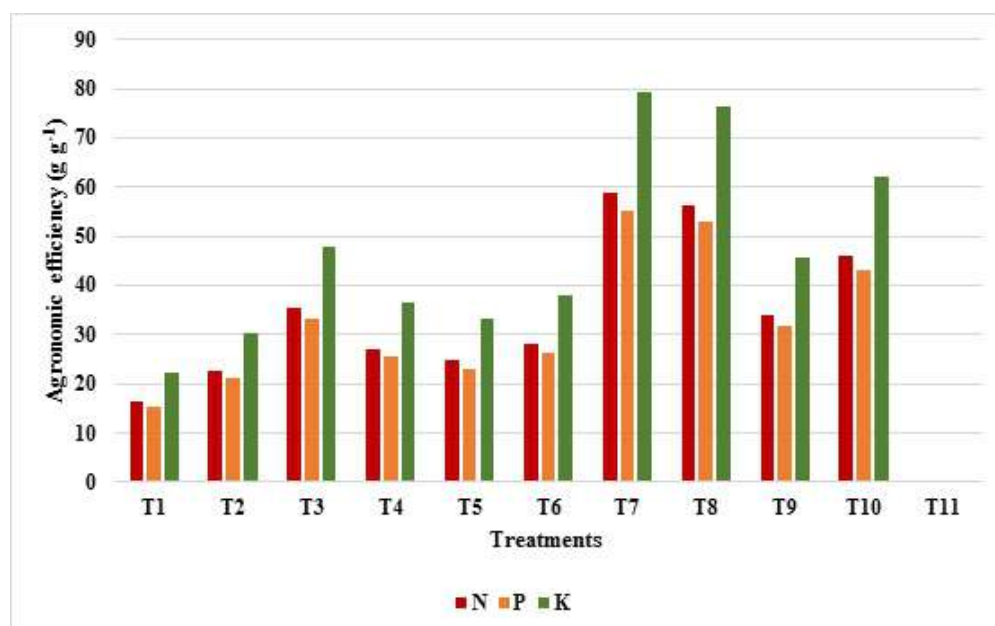


Fig-2 : Effect of multinutrient tablets on agronomic efficiency.  
X axis- Treatments, Y axis: Agronomic efficiency (g g<sup>-1</sup>)

T<sub>6</sub> receiving 100 % recommended dose of fertilizers as tablet 3 recorded the highest content of 107 mg kg<sup>-1</sup> and 8.35 mg kg<sup>-1</sup> respectively. This might be due to the release of nutrients from the tablets that gradually increased the availability in soil. Similar results were reported by other scientists [9, 10, 11].

**Growth and yield parameters :** The growth and yield of tomato was significantly influenced due to the application of different multinutrient tablets (Table-3). The maximum plant height (63 cm), number of branches per plant (6.67) and number of fruits per plant (16) were obtained from T<sub>7</sub>

receiving 75 % of recommended dose of fertilizers as tablet 4. The maximum fruit weight of 33.77 g was recorded in T<sub>7</sub> which was on par with T<sub>8</sub> (32.27 g) and were found to be significantly superior over all other treatments.

The results on yield of tomato revealed that the treatment T<sub>7</sub> receiving 75 % of recommended dose of fertilizer as tablet 4 recorded the highest yield of 502.02 g, followed by T<sub>8</sub> (495.66 g) receiving 100 % of recommended dose of fertilizers as tablet 4, which was on par. This might be due to the maximum uptake of nutrients

by crop that are slowly released from these multinutrient tablet. Similar results were reported by [4] in hybrid rice, where number of tillers hill<sup>-1</sup>, panicle length and weight were increased by the application of slow release fertilizer. An increase in dry matter and rhizome yield in turmeric was obtained due to the application of fertilizers as tablets [10]. [12] also reported an increase in growth and yield of snap bean by the application of Ensyabine a slow release N fertilizer. [13] reported that controlled-release urea is a promising N source for increasing the yield of potato. Encapsulated urea fertilizer applied to kale plant increased fresh weight, root fresh weight, stem dry weight and root dry weight [14].

**Quality parameters :** The effect of multinutrient tablets on quality of tomato are given in table-4. It was observed that the different tablet treatments had no significant influence on total soluble solids and ascorbic acid content whereas significant influence was noticed in case of lycopene content of tomato fruit. The TSS ranged from 4.17 to 5.83 % and the ascorbic acid content varied between 24 and 26.33 mg 100g<sup>-1</sup>. The highest lycopene content was noticed in treatment T<sub>7</sub> with a mean value of 16.73 µg g<sup>-1</sup>. It was found to be significantly superior to all other treatments. This might be due to the slow release of nutrients from multinutrient tablets that might have helped in the increased uptake of all nutrients required for improving the quality and thereby increased the lycopene content in tomato [15,16,17]. Quality parameters were influenced significantly by slow release fertilizers [18,19,20].

**Nutrient uptake in tomato :** The results on the total uptake of nutrients in tomato are represented in Table-5. A significant difference was noticed between the treatments. The uptake of N (4.10 g plant<sup>-1</sup>), P (0.31 g plant<sup>-1</sup>), K (2.45 g plant<sup>-1</sup>), Ca (1.51 g plant<sup>-1</sup>), Mg (1.50 g plant<sup>-1</sup>), S (0.53 g plant<sup>-1</sup>), B (4.27 mg plant<sup>-1</sup>) and Zn (10.54 mg plant<sup>-1</sup>) were found to be the highest in treatment T<sub>7</sub> receiving 75 % of recommended dose of fertilizers as tablet 4 containing neem coated urea, factamphos, muriate of potash, magnesium oxide, phosphogypsum, zinc sulphate, borax and binding agent methyl cellulose. This is attributed to the fact that when tablet is placed at a depth of 5 cm nearer to the rhizosphere, slow release coupled with reduced losses of nutrients by leaching and volatilization maintained the optimum nutrient status as well as uptake from the tablets [10]. Similar findings were reported in early ripening rapeseed due to the application of controlled release fertilizer [6].

Placement of tablets near the rhizosphere soil ensured a higher concentration of nutrients in the soil in the immediate vicinity of roots. Thus higher concentration gradient was set up for the nutrients from the tablets to diffuse faster to the plant roots as compared to other

sources [10]. Slow and steady release of nutrients from tablets near the rhizosphere matched the crop uptake.

**Nutrient use efficiency :** The nutrient use efficiency of multinutrient tablets are given in figure-1 and 2. The treatment T<sub>7</sub> receiving 75% of recommended dose of fertilizers as tablet-4 recorded the highest agronomic efficiency for nitrogen (58.77 g g<sup>-1</sup>), phosphorus (55.10 g g<sup>-1</sup>) and potassium (79.35 g g<sup>-1</sup>) followed by T<sub>8</sub> which was found to be on par with T<sub>7</sub>. With respect to apparent nutrient recovery also the highest recovery percentage was recorded by T<sub>7</sub> for N (96.87 %), P (90.53 %) and K (94.95 %). The partial factor productivity from the applied nutrients revealed that treatment T<sub>7</sub> was found to be superior (27.71 g g<sup>-1</sup>) while treatment T<sub>1</sub> (25.82 g g<sup>-1</sup>), T<sub>2</sub> (25.50 g g<sup>-1</sup>) were found to be on par with T<sub>7</sub>. Application of nutrients in the form of multinutrient tablets might have enhanced the nutrient use efficiencies [21,22,23]. The recovery percentage was increased by the application of slow release fertilizers [4,24]. Similar results were also reported for partial factor productivity [21,25,26].

Application of optimal amounts of nutrients and the release of nutrients in a steady manner to match the nutrient needs of crop over its growth period is required to increase the productivity.

Application of fertilizers in the form of tablets ensured slow and steady release of nutrients throughout the growth period of crop and thereby increased the growth and yield attributes, nutrient availability as well as nutrient use efficiency of crop. The present study indicates the possibilities of reducing the fertilizer dose of tomato by 25 % when applied as tablets in addition to increased growth and yield.

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## Population Dynamics of Stem Borer in Rice Agro-Ecosystem of Balaghat District

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### Abstract

Field experiment was conducted at the Research Farm, Jawaharlal Nehru Krishi Vishwa Vidyalaya-College of Agriculture, Balaghat, Madhya Pradesh. Pest activity started from 26th standard week and continued upto 40th standard week, meanwhile it reached peak twice in 3rd and 34th standard week. Thereafter, its population declined and finally no population was recorded. Correlation between weather parameters and the population of adult stem borer moth revealed that relative humidity (%) at 7 hr and relative humidity (%) at 14 hrs were positively significant correlated to the tune of  $r=0.672$  and  $r=0.606$  273, respectively and rainfall (mm) ( $r=0.285$ ) and evaporation (mm) ( $r=0.129$ ) non significant with the population of adult moth of stem borer, whereas, maximum temperature ( $^{\circ}\text{C}$ ) and mean temperature ( $^{\circ}\text{C}$ ) were negatively significant correlated ( $r=-0.591$  and  $-0.519$ ) to that.

### Introduction

Rice (*Oryza sativa* L.) belonging to the family Graminae, is one of the most important food crops not only in India but the world too. Intensive use of fertilizers especially nitrogenous fertilizers, high yielding varieties, sequential cropping and indiscriminate use of insecticides have resulted in the development of pests (5). In India, approximately 100 insect pests have been reported as pests of rice and 20 of these are considered to be major pests causing 30 per cent yield loss from seedling to maturity (2). Among them stem borer is the most destructive and widely occurring insect pest of rice at all stages of the crop due to its monophagy to rice. Newly emerged larva enters into the stem for feeding on inner tissues at vegetative and reproductive stage of the crop results in formation of deadheart (DH) and white earhead (WEH). Yield loss is found positively correlated with deadheart and white earhead infestations of the crop (10). Parwez *et al.* (11&12) observed that the critical infestation of the stem borer occurred during vegetative and panicle stages of rice. For developing any pest management programme for a specific agro-ecosystem, information on abundance and distribution of pest in relation to weather parameters is a basic requirement (13). The study of agricultural meteorology in relation to insects will be very useful to farmers in all areas where major insect pests are appearing year after year and causing serious damage to the crop (1). Light traps are the convenient tools to monitor adult male moth population of stem borer in rice. Light traps has been used for monitoring the adult population of stem borer with three reasons, the first is to detect the occurrence of the pest, the second is to identify occurrence of the pest and third is to estimate the actual field population density of the pest.

### Materials and Methods

In order to study the population dynamics of rice stem borer through light trap in Chhattisgarh plain climatic condition, a field trial was conducted at Research farm, Jawaharlal Nehru Krishi Vishwa Vidyalaya-College of Agriculture, Balaghat, Madhya Pradesh. during *Kharif*, 2019 and *Kharif*, 2020. For this purpose field preparation was done by ploughing once by tractor drawn disc plough and second by mould board plough. IPM package received seedling treatment and installation of light traps. Seven days before transplanting, seedlings of well established susceptible variety MTU-1010 were nursery treated with carbofuran (3G) @ 1.1kg a.i./ha while one light traps containing 24 W LED bulb was installed at experimental area before the date of transplanting to the harvesting of crop. Before transplantation, the recommended doses of fertilizers (N:P:K : 100:60:40) were applied main plots. However, the half of nitrogen was given as top dressing and remaining half of nitrogen was top dressed after 30 days after transplanting and balance half dose was applied at panicle initiation stage. All the recommended agronomic practices were observed. The observation of adult moth caught per trap, meteorological parameters *viz.*, maximum temperature ( $^{\circ}\text{C}$ ), minimum temperature ( $^{\circ}\text{C}$ ), relative humidity (%) and rainfall (mm) were recorded. Simultaneously the data of the pest population obtained during the course of investigation were correlated with meteorological parameters.

**Adult moth catch per trap :** It attracted and caught adult moth of the insect pest per trap were taken out and counted in morning (10:00 AM) at daily basis during the course of investigation. The mean values of adult moth caught per trap at weekly intervals were worked out from

Table-1: Population fluctuation of rice stem borer adult in relation to abiotic parameters during Kharif 2019.

| Standard week | Mean adult catch/light trap | Temperature (°C) |      |      | Relative Humidity (%) |          | Rainfall (mm) | Evaporation (mm) | Sunshine (hour) |
|---------------|-----------------------------|------------------|------|------|-----------------------|----------|---------------|------------------|-----------------|
|               |                             | Max.             | Min. | Mean | 07:00 hr              | 14:00 hr |               |                  |                 |
| 26            | 0.06                        | 36.8             | 27.5 | 32.1 | 78                    | 53       | 02.0          | 39.0             | 5.0             |
| 27            | 0.19                        | 29.5             | 24.7 | 27.1 | 91                    | 84       | 69.6          | 16.6             | 0.4             |
| 28            | 0.88                        | 33.5             | 26.1 | 29.8 | 82                    | 59       | 13.2          | 39.1             | 3.6             |
| 29            | 1.11                        | 35.5             | 26.4 | 30.9 | 84                    | 55       | 26.1          | 36.3             | 7.5             |
| 30            | 1.27                        | 32.3             | 25.5 | 28.9 | 88                    | 77       | 08.4          | 21.3             | 2.7             |
| 31            | 2.02                        | 28.0             | 24.4 | 26.2 | 90                    | 82       | 99.0          | 14.5             | 0.5             |
| 32            | 3.52                        | 30.2             | 25.3 | 27.7 | 89                    | 83       | 185.6         | 24.3             | 2.9             |
| 33            | 7.45                        | 30.8             | 25.4 | 28.1 | 90                    | 74       | 49.2          | 18.1             | 3.8             |
| 34            | 6.13                        | 31.7             | 25.2 | 28.4 | 92                    | 75       | 27.8          | 21.9             | 3.2             |
| 35            | 4.87                        | 30.9             | 25.1 | 28.0 | 92                    | 73       | 53.8          | 18.2             | 1.3             |
| 36            | 5.22                        | 29.5             | 24.9 | 27.2 | 94                    | 87       | 239.0         | 11.6             | 0.5             |
| 37            | 5.61                        | 30.7             | 25.0 | 27.8 | 92                    | 74       | 09.2          | 21.6             | 4.3             |
| 38            | 4.52                        | 33.0             | 25.5 | 29.2 | 88                    | 63       | 02.4          | 29.6             | 8.2             |
| 39            | 2.23                        | 30.2             | 24.2 | 27.2 | 91                    | 74       | 178.1         | 17.7             | 3.8             |
| 40            | 0.69                        | 32.0             | 24.3 | 28.1 | 90                    | 64       | 01.8          | 25.3             | 7.5             |

Table-2 : Population fluctuation of rice stem borer adult in relation to abiotic parameters during Kharif 2020.

| Standard week | Mean adult catch/light trap | Temperature (°C) |      |      | Relative Humidity (%) |          | Rainfall (mm) | Evaporation (mm) | Sunshine (hour) |
|---------------|-----------------------------|------------------|------|------|-----------------------|----------|---------------|------------------|-----------------|
|               |                             | Max.             | Min. | Mean | 07:00 hr              | 14:00 hr |               |                  |                 |
| 26            | 0.02                        | 33.9             | 26.0 | 30.0 | 85                    | 68       | 20.6          | 27.3             | 4.2             |
| 27            | 0.16                        | 33.6             | 25.8 | 29.7 | 88                    | 66       | 95.0          | 28.9             | 5.4             |
| 28            | 0.78                        | 33.4             | 25.0 | 29.2 | 88                    | 74       | 67.5          | 25.5             | 2.8             |
| 29            | 1.55                        | 33.0             | 26.1 | 29.6 | 86                    | 71       | 39.8          | 24.9             | 4.4             |
| 30            | 2.03                        | 32.3             | 25.9 | 29.1 | 86                    | 68       | 29.9          | 22.8             | 3.8             |
| 31            | 2.19                        | 33.3             | 26.0 | 29.7 | 89                    | 69       | 23.6          | 26.7             | 3.3             |
| 32            | 2.95                        | 30.5             | 25.5 | 28.0 | 92                    | 77       | 81.6          | 22.9             | 1.5             |
| 33            | 6.59                        | 28.4             | 25.1 | 26.8 | 93                    | 86       | 71.2          | 13.9             | 0.5             |
| 34            | 6.06                        | 31.0             | 25.5 | 28.3 | 89                    | 74       | 29.8          | 19.9             | 2.0             |
| 35            | 5.21                        | 29.8             | 24.6 | 27.2 | 93                    | 75       | 235.8         | 19.9             | 3.7             |
| 36            | 4.89                        | 32.9             | 26.0 | 29.5 | 91                    | 74       | 8.0           | 22.5             | 4.9             |
| 37            | 5.46                        | 33.2             | 26.0 | 29.6 | 91                    | 67       | 64.0          | 24.6             | 6.0             |
| 38            | 3.98                        | 32.7             | 25.8 | 29.3 | 89                    | 71       | 16.4          | 19.5             | 3.6             |
| 39            | 1.62                        | 32.8             | 25.3 | 29.1 | 90                    | 59       | 0.0           | 24.1             | 5.3             |
| 40            | 0.0                         | 31.8             | 25.0 | 28.4 | 90                    | 63       | 12.8          | 20.5             | 4.0             |

the collected data and daily trap catch were converted into weekly total and mean per day per week (weekly mean/day), finally its correlation with meteorological parameters was documented.

## Results and Discussion

Through understanding of the insect ecology forms a basis for effective pest management and conservation of natural enemies. A major part of insect ecology can be understood if the factors influencing its population are thoroughly investigated. Among these factors, weather parameters are the important and there is need to understand these influences, keeping this in view, The investigations was carried out to study the population dynamics of stem borer using light trap on rice during *kharif*, 2019 and *kharif*, 2020.

**Kharif, 2019 :** It is evident from the pooled data presented in (Table-1) that pest activity initiated from 26<sup>th</sup> standard week i.e., 4<sup>th</sup> week of June (0.06 moths/day) and the peak

trap catches of moth recorded during 33<sup>rd</sup> standard week i.e., 2<sup>nd</sup> week of August (7.45 moths/day). The findings of present study are in close agreement with (4) reported that peak catches of yellow stem borer moths were recorded during April-may in summer in Assam.

The present path analysis revealed that morning (7.00 o'clock) relative humidity ( $r=0.584^*$ ), had significant positive correlation on moth trap catches while all other meteorological factors showed non significant correlation on moth trap catches. The afternoon relative humidity (14.00 o'clock) ( $r=0.362$ ) rainfall (mm) ( $r=0.184$ ) has non significant positive correlation on adult moth trap catches, remaining weather parameters i.e. maximum temperature ( $^{\circ}\text{C}$ ) ( $r= -0.361$ ), minimum temperature ( $^{\circ}\text{C}$ ) ( $r= -0.221$ ), mean temperature ( $^{\circ}\text{C}$ ) ( $r= -0.335$ ), evaporation (mm) ( $r= -0.446$ ) and sunshine (hr) ( $r= -0.119$ ) had non significant negative correlation on moth trap catches (Table 4). The present findings are agreement with Somashekara and Javaregowda (16) reported that there was a positive

Table-3 : Population fluctuation of rice stem borer adult in relation to abiotic parameters (pooled mean of 2019 &amp; 2020).

| Standard week | Mean adult catch/light trap | Temperature (°C) |       |      | Relative Humidity (%) |          | Rainfall (mm) | Evaporation (mm) | Sunshine (hour) |
|---------------|-----------------------------|------------------|-------|------|-----------------------|----------|---------------|------------------|-----------------|
|               |                             | Max.             | Min.  | Mean | 07:00 hr              | 14:00 hr |               |                  |                 |
| 26            | 0.04                        | 35.35            | 26.75 | 31.1 | 81.5                  | 60.5     | 11.3          | 33.2             | 4.6             |
| 27            | 0.18                        | 31.55            | 25.25 | 28.4 | 89.5                  | 75.0     | 82.3          | 22.8             | 2.9             |
| 28            | 0.83                        | 33.45            | 25.55 | 29.5 | 85.0                  | 66.5     | 40.4          | 32.3             | 3.2             |
| 29            | 1.33                        | 34.25            | 26.25 | 30.3 | 85.0                  | 63.0     | 33.0          | 30.6             | 6.0             |
| 30            | 1.65                        | 32.3             | 25.7  | 29.0 | 87.0                  | 72.5     | 19.2          | 22.1             | 3.3             |
| 31            | 2.11                        | 30.65            | 25.2  | 27.9 | 89.5                  | 75.5     | 61.3          | 20.6             | 1.9             |
| 32            | 3.24                        | 30.35            | 25.4  | 27.9 | 90.5                  | 80.0     | 133.6         | 23.6             | 2.2             |
| 33            | 7.02                        | 29.6             | 25.25 | 27.4 | 91.5                  | 80.0     | 60.2          | 16.0             | 2.2             |
| 34            | 6.10                        | 31.35            | 25.35 | 28.4 | 90.5                  | 74.5     | 28.8          | 20.9             | 2.6             |
| 35            | 5.04                        | 30.35            | 24.85 | 27.6 | 92.5                  | 74.0     | 144.8         | 19.1             | 2.5             |
| 36            | 5.06                        | 31.2             | 25.45 | 28.3 | 92.5                  | 80.5     | 123.5         | 17.1             | 2.7             |
| 37            | 5.54                        | 31.95            | 25.5  | 28.7 | 91.5                  | 70.5     | 36.6          | 23.1             | 5.2             |
| 38            | 4.25                        | 32.85            | 25.65 | 29.3 | 88.5                  | 67.0     | 9.4           | 24.6             | 5.9             |
| 39            | 1.93                        | 31.5             | 24.75 | 28.1 | 90.5                  | 66.5     | 89.1          | 20.9             | 4.6             |
| 40            | 0.35                        | 31.9             | 24.65 | 28.3 | 90.0                  | 63.5     | 7.3           | 22.9             | 5.8             |

Table-4 : Correlation coefficient and multiple regression equation between meteorological parameters and population of rice stem borer adult per light trap.

| Meteorological parameters                            | Correlation coefficient (r)<br>Kharif, 2019 | Correlation coefficient (r)<br>Kharif, 2020 | Correlation coefficient (r)<br>(pooled Kharif, 2019 & 20) |
|------------------------------------------------------|---------------------------------------------|---------------------------------------------|-----------------------------------------------------------|
| Maximum temperature (°C)                             | -0.361                                      | -0.625*                                     | -0.591*                                                   |
| Minimum temperature (°C)                             | -0.221                                      | -0.129                                      | -0.229                                                    |
| Mean temperature (°C)                                | -0.335                                      | -0.540*                                     | -0.519*                                                   |
| Relative humidity (%) 7 hr                           | 0.584*                                      | 0.656*                                      | 0.672*                                                    |
| Relative humidity (%) 14 hr                          | 0.362                                       | 0.624*                                      | 0.606*                                                    |
| Rainfall (mm)                                        | 0.184                                       | 0.270                                       | 0.285                                                     |
| Evaporation (mm)                                     | 0.127                                       | 0.132                                       | 0.129                                                     |
| Sunshine (hr.)                                       | -0.119                                      | -0.349                                      | -0.313                                                    |
| *correlation is significant at 0.05 level (2-tailed) |                                             |                                             |                                                           |

correlation with maximum temperature, minimum temperature and negative correlation with the total rainfall, morning relative humidity, and afternoon relative humidity in Agricultural research station Sirsi.

**Kharif 2020 :** It is evident from the data presented in Table-2 that pest activity initiated from 26<sup>th</sup> standard week and continued upto 39<sup>th</sup> standard week. Pest population reached its peak twice in 33<sup>rd</sup> and 34<sup>th</sup> standard week. In beginning it was low which gradually increased and reached its first peak (6.59 adult moth catch/light trap/day) in 33<sup>rd</sup> standard week (2<sup>nd</sup> week of August) and after a short fall again increasing and reached to second peak (6.06 adult moth catch/light trap/day) in 34<sup>th</sup> standard week (3<sup>rd</sup> week, August). Thereafter its population declined and finally no population was recorded. The findings of present investigation are supported by the findings of (15) who observed that mean yellow stem borer (*Scirpophaga incertulas* Walker) catch per sex pheromone trap per week should two peaks –first (4.78) during 3<sup>rd</sup> week of August and second (9.77) during 2<sup>nd</sup> week of September. However, (17) reported three peak periods viz., July, August and September of *Scirpophaga incertulas* moth activity during Kharif season. Similar observations were also reported by (5) as yellow stem

borer moth exhibiting their peak activity in the month of September.

The correlation studies made between stem borer catches and weather parameters showed (Table-4) that, relative humidity (%) had significant positive correlation on moth trap catches in case of morning (7.00 o'clock) RH% ( $r=0.656$ ) and afternoon (14.00 o'clock) RH% ( $r=0.624$ ), while maximum temperature ( $r=-0.625$ ), mean temperature (°C) ( $r=-0.540$ ) shows negative significant correlation with moth trap catches. Remaining weather parameters i.e. rainfall ( $r=0.270$ ) and evaporation ( $r=0.132$ ) show non significant positive correlation with moth trap catches, while minimum temperature ( $r=-0.129$ ) and sunshine (hr) ( $r=-0.349$ ) shows negative non significant correlation with moth trap catches. The findings of the present study are in close agreement with (6) has investigated that maximum temperature, rainfall, relative humidity were negatively correlated with yellow stem borer moth catches while, (14) reported that minimum temperature sunshine hours were positively correlated with yellow stem borer moth population at Agricultural University, Andhra Pradesh.

**Pooled mean data of both year kharif, 2019 and kharif, 2020 :** It is evident from the pooled data presented in

Table-3, that pest activity initiated from 26<sup>th</sup> standard week i.e. 4<sup>th</sup> week of June (0.04 moths/day) and the peak trap catches of moth observed during 33<sup>rd</sup> standard week i.e. 2<sup>nd</sup> week of August (7.02 moths/day). The findings of the present study is in agreement with (15) who reported that mean yellow stem borer catch per sex pheromone trap per week should two peaks during 3<sup>rd</sup> week of August and 2<sup>nd</sup> week of September. However (17) reported that three peak periods viz., July August and September yellow stem borer moth activity during kharif season, similar observations were also reported by (5) as yellow stem borer moth exhibiting their peak activity in the month of September onwards.

Correlation between weather parameters and the population of stem borer moth revealed that the relative humidity (%) at 7 hr and relative humidity (%) at 14 hrs, were positively significant correlated to the tune of  $r=0.672$  and  $0.606$ , respectively with the population of adult moth stem borer, whereas, maximum temperature ( $^{\circ}\text{C}$ ) and mean temperature ( $^{\circ}\text{C}$ ) were negatively significant correlated ( $r=-0.591$ ) and ( $r=-0.519$ ), respectively in population fluctuation of stem borer. The remaining weather parameters i.e. evaporation and rainfall non significant positive correlated with the value of  $r=0.245$  and  $r=0.129$ , respectively but minimum temperature ( $^{\circ}\text{C}$ ), and sun shine hr non significant negatively correlated with the value of  $r=-0.229$  and  $r=-0.313$ , respectively to the population of adult moth of stem borer (Table-4).

The findings of the present study are in close agreement with (11) as he reported that weather conditions had no significant effect on pheromone trap capture during *Kharif* season. However, (12) found that low temperature, high relative humidity and rainfall resulted in YSB outbreak. (10) reported that YSB moth population had no effect of temperature while it was positively correlated to maximum relative humidity and sunshine but negatively correlated with rainfall. (6) investigated that maximum temperature, rainfall and relative humidity were negatively correlated while minimum temperature, evaporation and sunshine were positively correlated to YSB moth population but (14) reported that YSB moth population had positive correlation with temperature, rainfall and relative humidity.

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## Evaluation of Pre-Harvest Spraying of Insecticides for Management of Pulse Beetle (*Callosobruchus spp.*) in Chickpea

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### Abstract

The experiment was conducted to study the effect of insecticides and stages of insecticidal sprays on field infestation of pulse beetle. The field experiment was carried out for three consecutive years from rabi season of the year 2018 to 2020. The experiment was laid in factorial randomized block design (FRBD) consisted of 15 treatment combinations involving two factors with three replications. Among the four test insecticides, spraying of Profenofos 50 EC @ 1 ml/l, was the best treatment with 0.22 adult emergence at 8<sup>th</sup> week of storage of chickpea and was followed by spraying of Emamectin benzoate 5 SG @ 0.3 g/l (2.66), Malathion 5 % @ 10Kg/acre (3.46), Azadirachtin 10000 ppm @ 5 ml/l (7.02). Similarly, among spraying schedule, spraying at 50 per cent pod maturity and at maturity (S3) was better than spraying at 50 per cent maturity (S1) and maturity stage (S2) but it was statistically non significant.

### Introduction

Chickpea (*Cicer arietinum* L.) is an important food legume with good source of protein for human consumption. Chickpea is an important pulse crop grown in *rabi* season. In Maharashtra, chickpea is grown over an area of 20.00 lakh ha with production of 17.61 lakh tonnes (Anonymous, 2019). Significant losses in pulses, both quantitative and qualitative, occur during storage and storing pulses in storehouses to keep them free from being damaged by insect pests is a major problem. Amongst the stored grain pests of pulses, the pulse beetle, *Callosobruchus chinensis* L., is the economic pest. Gujar and Yadav (1978) reported 55-60% losses in seed weight and 45.50-66.30% losses in protein content due to its damage and the post harvest seed losses may reach up to 100% (Mahendran and Mohan, 2002) and the seeds become unfit for human consumption as well as planting. The infestation of pulse beetle generally starts in the field where the adults lay eggs on green or drying pods. After hatching of eggs, the first instar larvae bore into the seeds through the pod cover, but no clear cut evidence or symptoms of damage is visualized on seeds during threshing. Generally, the damage in the field is low, but huge damage occurs in stored infested seeds due to rapid multiplication of bruchids in a very short time (Nahdy, *et al.*, 1999). Under such situation, it is necessary to find out such strategy which will be helpful to manage the pest. Accordingly to damaging pattern of this pest (Infestation starts right from the field) pre-harvest sanitation spray is a novel method to arrest these pathogens / insects in the field itself thereby delimiting the damage during storage. It involves the spraying of botanicals or insecticides during the formation and development of pod and seed at needy concentrations at suitable intervals.

### Materials and Methods

The field experiment was conducted at the Seed Technology Research Unit Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri for three consecutive years during rabi season, 2018 to 2020 to evaluate the performance of pre-harvest insecticidal spray at pod maturity stage against field incidence of pulse beetle, *Callosobruchus spp* and carry over bruchid infestation in freshly harvested seed. Laboratory studies were carried out in Seed Entomology laboratory to assess the residual effect of insecticides on seed quality parameters against build up carry over bruchid incidence during storage. The experiment was laid out in factorial RBD comprising of 5 treatments (4 insecticides i.e., Emamectin benzoate SG @ 0.3 g/l(I1), Malathion dust 5% @ 10Kg/acre(I2), Profenofos 50 EC @ 1 ml/l(I3), and Azadirachtin 10000 ppm @ 5 ml/l (I4) and untreated control (I5) and 3 spraying schedules i.e., at 50% pod maturity stage (S1), pod maturity stage (S2) and at 50% pod maturity and pod maturity stages (S3). The response of insecticide and botanicals against infestation of *Callosobruchus spp* was evaluated on the basis of number of adult emergence after harvest. After harvest 500 gm seed was kept for storage for recording of observations. The number of adult emerged during storage of chickpea was recorded on 100 seed from each treatment at an interval of one week (7days) for two months. The data obtained from the experiments were statistically analyzed as per Panse and Sukhatme, 1976.

### Results and Discussion

The interaction effect of pre harvest spray of insecticides and spray schedule on adult emergence of pulse beetle in

**Table-1 : Interaction effect of insecticides and spray schedule on adult emergence of pulse beetle in chickpea (Pooled mean of three years data from 2018-2020).**

| Sr. No. | Treatment                                                                                                         | Number of adult emerged 8th week after storage/500gm seed |                 |                 |                 |
|---------|-------------------------------------------------------------------------------------------------------------------|-----------------------------------------------------------|-----------------|-----------------|-----------------|
|         |                                                                                                                   | 2018                                                      | 2019            | 2020            | Pooled mean     |
| 1.      | I <sub>1</sub> S <sub>2</sub> (Eamectin benzoate 5SG@ 0.3 g/L, Spray at 50% pod maturity)                         | 3.66<br>(2.04)                                            | 4.00<br>(2.12)  | 3.00<br>(1.86)  | 3.55<br>(2.01)  |
| 2.      | I <sub>1</sub> S <sub>2</sub> (Eamectin benzoate 5SG@ 0.3 g/L, Spray at 100 % pod maturity)                       | 2.67<br>(1.78)                                            | 2.33<br>(1.68)  | 3.33<br>(1.96)  | 2.78<br>(1.81)  |
| 3.      | I <sub>1</sub> S <sub>3</sub> (Eamectin benzoate 5SG@ 0.3 g/L, Spray at 50 % pod maturity and 100 % pod maturity) | 1.00<br>(1.22)                                            | 2.00<br>(1.58)  | 2.00<br>(1.56)  | 1.67<br>(1.46)  |
| 4.      | I <sub>2</sub> S <sub>1</sub> (Malathion dust 5% @ 10 kg/acre, Spray at 50% pod maturity)                         | 4.66<br>(2.27)                                            | 5.00<br>(2.35)  | 4.00<br>(2.11)  | 4.55<br>(2.25)  |
| 5.      | I <sub>2</sub> S <sub>2</sub> (Malathion dust 5% @ 10 kg/acre, Spray at 100 % pod maturity)                       | 3.33<br>(1.96)                                            | 3.33<br>(1.96)  | 3.00<br>(1.86)  | 3.22<br>(1.93)  |
| 6.      | I <sub>2</sub> S <sub>3</sub> (Malathion dust 5% @ 10 kg/acre, Spray at 50 % pod maturity and 100 % pod maturity) | 2.22<br>(1.64)                                            | 3.00<br>(1.87)  | 2.67<br>(1.74)  | 2.63<br>(1.77)  |
| 7.      | I <sub>3</sub> S <sub>1</sub> (Profenofos 50 EC @ 1 ml/L, Spray at 50% pod maturity)                              | 0.33<br>(0.91)                                            | 0.66<br>(1.08)  | 0.33<br>(0.88)  | 0.44<br>(0.97)  |
| 8.      | I <sub>3</sub> S <sub>2</sub> (Profenofos 50 EC @ 1 ml/L, Spray at 100 % pod maturity)                            | 0.33<br>(0.91)                                            | 0.00<br>(0.71)  | 0.33<br>(0.88)  | 0.22<br>(0.84)  |
| 9.      | I <sub>3</sub> S <sub>3</sub> (Profenofos 50 EC @ 1 ml/L, Spray at 50 % pod maturity and 100% pod maturity)       | 0.00<br>(0.71)                                            | 0.00<br>(0.71)  | 0.00<br>(0.71)  | 0.00<br>(0.71)  |
| 10.     | I <sub>4</sub> S <sub>1</sub> (Azadirachtin 10000 ppm @ 1 ml/L @ 0.3 g/L, Spray at 50% pod maturity)              | 8.95<br>(3.07)                                            | 8.33<br>(2.97)  | 8.00<br>(2.92)  | 8.43<br>(2.99)  |
| 11.     | I <sub>4</sub> S <sub>2</sub> (Azadirachtin 10000 ppm @ 1 ml/L @ 0.3 g/L, Spray at 100% pod maturity)             | 7.67<br>(2.86)                                            | 6.33<br>(2.61)  | 8.33<br>(2.97)  | 7.44<br>(2.81)  |
| 12.     | I <sub>4</sub> S <sub>3</sub> (Azadirachtin 10000 ppm @ 1 ml/L @ 0.3 g/L, Spray at 50 % and 100% pod maturity)    | 4.56<br>(2.25)                                            | 5.67<br>(2.48)  | 5.33<br>(2.41)  | 5.19<br>(2.38)  |
| 13.     | I <sub>5</sub> S <sub>1</sub> (Control)                                                                           | 17.33<br>(4.22)                                           | 17.67<br>(4.26) | 17.33<br>(4.22) | 17.44<br>(4.24) |
| 14.     | I <sub>5</sub> S <sub>2</sub> (Control)                                                                           | 16.00<br>(4.06)                                           | 15.66<br>(4.02) | 15.00<br>(3.94) | 15.55<br>(4.01) |
| 15.     | I <sub>5</sub> S <sub>3</sub> (Control)                                                                           | 14.67<br>(3.89)                                           | 13.33<br>(3.72) | 14.33<br>(3.85) | 14.11<br>(3.82) |
|         | S.Em. +                                                                                                           | 0.21                                                      | 0.16            | 0.21            | 0.32            |
|         | CD at 5%                                                                                                          | 0.64                                                      | 0.49            | 0.61            | 0.97            |

Figures in parenthesis are  $v + 0.5$  transformed value

I<sub>1</sub> : Eamectin benzoate @ 0.3 ml/L,

S<sub>1</sub> : Spray at 50% pod maturity,

I<sub>2</sub> : Malathion dust 5% @ 10 kg/acre

S<sub>2</sub> : Spray at pod maturity

I<sub>3</sub> : Profenofos 50 EC @ 1 ml/L

S<sub>3</sub> : Spray at 50% pod maturity and maturity

I<sub>4</sub> : Azadirachtin 10000 ppm @ 1 ml/L

I<sub>5</sub> : Control

chickpea are given in table-1. Results of pre harvest spray and spraying schedule alone are given in table-2. Three years pooled data on number of adult emerged after pre-harvest spraying of insecticide and botanicals on chickpea revealed that adult emergence was noticed from third week onwards in stored chickpea. The response of insecticide and botanicals against infestation of *Callosobruchus* spp. was evaluated on the basis of number of adult emerged in stored chickpea after harvest. The number of adult emerged during storage of chickpea was recorded at an interval of one week (7days) upto two months.

The interaction effect of pre harvest spray of insecticides and spray schedule (Table-1) revealed that among the different treatment combinations T9 treatment

i.e. I<sub>3</sub>S<sub>3</sub> spraying of Profenofos 50 EC @ 1 ml/L at 50% pod maturity and maturity was the best treatment which checked the field infestation and further pulse beetle adult emergence upto 8<sup>th</sup> week of storage of chickpea. The average adult emergence was ranged from 0-17.44 number. Next better treatment combination was T8 (I<sub>3</sub>S<sub>2</sub>) i.e. preharvest spraying of Profenofos 50 EC @ 1 ml/L, at 100% pod maturity with 0.22 pulse beetle adult emergence at 8<sup>th</sup> week of storage followed T7 (I<sub>3</sub>S<sub>1</sub>) i.e. Profenofos 50 EC @ 1 ml/L spray at 50 % pod maturity with 0.44 pulse beetle adult emergence at 8<sup>th</sup> week of storage of chickpea. There was 17.44 number of mean adult emergence in control at 8<sup>th</sup> week of storage.

Results of pre harvest spray and spraying schedule alone are given in table-2. Pooled mean of three years

**Table-2 : Effect of pre harvest spray of insecticides on adult emergence of pulse beetle in chickpea (Pooled mean of three years data from 2018-2020).**

| Treatment                            | 2018         | 2019         | 2020         | Pooled mean  |
|--------------------------------------|--------------|--------------|--------------|--------------|
| <b>Insecticides (I)</b>              |              |              |              |              |
| Emamectin benzoate @ 0.3 ml/L (I1)   | 2.44 (1.71)  | 2.77 (1.81)  | 2.77 (1.81)  | 2.66 (1.78)  |
| Malathion dust 5% @ 10 kg/acre (I2)  | 3.40 (1.97)  | 3.77 (2.07)  | 3.22 (1.93)  | 3.46 (1.99)  |
| Profenofos 50 EC @ 1 ml/L (I3)       | 0.22 (0.85)  | 0.22 (0.85)  | 0.22 (0.85)  | 0.22 (0.85)  |
| Azadirachtin 10000 ppm @ 1 ml/L (I4) | 7.06 (2.75)  | 6.77 (2.70)  | 7.22 (2.78)  | 7.02 (2.74)  |
| Control (I5)                         | 16.00 (4.06) | 15.55 (4.01) | 15.33 (3.98) | 15.63 (4.02) |
| S.E m. +                             | 0.04         | 0.08         | 0.11         | 0.07         |
| CD at 5%                             | 0.14         | 0.28         | 0.35         | 0.25         |
| <b>Spraying Schedule (S)</b>         |              |              |              |              |
| 50% Maturity (S1)                    | 6.98 (2.73)  | 7.13 (2.76)  | 6.53 (2.65)  | 6.88 (2.72)  |
| Maturity (S2)                        | 6.00 (2.55)  | 5.53 (2.46)  | 5.99 (2.55)  | 5.84 (2.52)  |
| 50% Maturity & Maturity (S3)         | 4.49 (2.23)  | 4.80 (2.30)  | 4.86 (2.32)  | 4.72 (2.28)  |
| S.E m. +                             | 0.03         | 0.04         | 0.11         | 0.07         |
| CD at 5%                             | NS           | NS           | NS           | NS           |

data revealed that the lowest number of adult emergence (0.22) in freshly harvested seeds of chickpea was recorded in preharvest insecticidal spraying of Profenofos 50 EC @ 1 ml/L (I3) as compared to maximum number of adult emergence (15.63 %) in control at 8<sup>th</sup> week of storage in chickpea. Next better preharvest insecticidal spray was preharvest spraying of Emamectin benzoate @ 0.3 ml/L (I1) which recorded 2.66 number of adult emergence followed by preharvest treatment of Malathion dust 5% @ 10 kg/acre (I2). Azadirachtin 10000 ppm @ 1 ml/L (I4) recorded 7.02 pulse beetle adult emerged at 8<sup>th</sup> week of storage. There was 15.63 number of mean adult emergence in control at 8<sup>th</sup> week of storage. Similarly, among spraying schedules, spraying at 50 per cent pod maturity and at maturity (S3) was better than spraying at maturity (S2) and 50 per cent maturity (S1) stage but it was statistically non significant. Results of these experiments are in conformity with Raghu *et al* (2016) and Patoliya *et al* (2020) in green gram.

From the above experiments it can be concluded that spraying of Profenofos 50 EC @ 1 ml/L at 50% pod maturity and maturity stage prevented carry over bruchid infestation from field to storage godowns in chickpea.

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## Enhancement of Seed Cotton Yield by Adopting HDPS Technology

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### Abstract

Present investigation carried out at Cotton Improvement Project, MPKV, Rahuri to compared the straight varieties and Bt cotton hybrids under HDPS planting system and normal cotton sowing with three replication using RBD design during Kharif-2020. It was observed that all varieties were shown early maturity, sowing was done at spacing of 60 x 20 cm. The lower number of monopodia per plants recorded in varieties under HDPS, while hybrids shown more number of monopodia and sympodia per plant. The significantly higher number of bolls per plant recorded by hybrid Ajeet-111 (54.67), however it shown lower number of boll per metre square (75.44). in contrast number of boll per plant minimum under HDPS, but maximum number of boll per meter square area and its affect on higher seed cotton yield per plot and per hecter. The variety RHC-1651 recorded highest seed cotton yield under HDPS planting (65.58 qtl/ha), followed by RHC-1406 (52.35 qtl/ha), however in normal sowing Bt cotton hybrids [Ajeet-111 (36.63 qtl/ha), Dhandev (34.73 qtl/ha) recorded lower seed cotton yield as compared to varieties under HDPS. The variety RHC-1651 (65.58 qtl/ha) and RHC-1406 (52.35 qtl/ha), recorded highest seed cotton yield under HDPS planting. This two varieties will be adapted in HDPS system that can boost the yield of cotton under rainfed condition with minimum production cost.

**Key words :** Seed cotton yield, cotton, HDPS planting (high density planting system).

### Introduction

Cotton (*Gossypium hirsutum* L.) is the major fiber and cash crop, in world. It is cultivated in tropical as well as sub-tropical regions of more than seventy countries of the World. Cotton is a crop of global significance playing a significant role in the agricultural and industrial economy. Around 60% of fiber to Indian textiles is from cotton. The recent statistics released from USDA - Foreign Agricultural Service (September, 2020) indicates that India (13.40 million ha) has more than one third of the World's area (32.94 million ha) under cotton with a productivity of 487 kg/ha, which is far below than the World's productivity of 775 kg/ha. Many of the countries like Brazil, China, Turkey, Australia have the productivity of more than 1500 kg/ha. China with 3.25 million ha of cultivation (less than one fourth of the area of India) could result in a production of 27.25 million 480 lb. bales (as projected by USDA) compared to the Indian production projected at 30.00 million 480 lb. bales from 13.40 million ha. This clearly signifies the productivity gap prevailing at India for cotton.

Moreover, the present day hybrids put forth biomass enormously and are of speed and spread growing in nature. Thus, the ratio of bolls to biomass if worked out would be much lesser. For having a match between the growth, water requirement, duration, yield, per unit and day productivity etc. a system was arrived which is High Density Planting System (HDPS) with early maturing, semi compact genotypes for realizing higher yields with

low production costs under rainfed condition primarily. The main tenets of this proposition covers tailoring a genotype suiting to high density planting (more than one lakh plants per hectare), its uniformity in boll development, maturation and bursting, its adoptability to the given condition and efficiency in the nutrient utilization etc.

The newly developed concept of 'High Density Planting Systems' (HDPS) that has potential to improve yields of rainfed cotton. Its shown that the productivity of cotton in HDPS with straight varieties was found to be a viable option to improve the productivity of cotton particularly under rainfed conditions at reduced production costs. The HDPS cotton plants produce fewer bolls than conventionally planted cotton but retain a higher percentage of the total bolls per meter square.

Experiment was conducted on field at Cotton Improvement Project MPKV, Rahuri to access the yield potential of straight varieties under HDPS planting in comparison with Bt cotton hybrids under normal sowing.

### Materials and Methods

Experiment was conducted at Cotton Improvement Project MPKV, Rahuri during the *Kharif-2020* in three replications with Randomised Block Design. Experimental material consist of three straight cotton varieties developed by MPKV, Rahuri and three Bt cotton Hybrids developed by private companies. Straight varieties were planted under HDPS by spacing 60x20 cm with 12 lines and Bt cotton hybrids were planted with normal sowing by

spacing 120x60 cm with 6 lines. Observation were recorded of 10 plant of each variety from three replication and data were analysed by using statistical software.

## Results and Discussion

Results on yield, yield contributing characters as influenced by different varieties under HDPS and normal sowing conditions are presented in table-1.

**Table-1 : Experimental material and details.**

| Name of Genotype | Source       | Planting Spacing |
|------------------|--------------|------------------|
| Phule 688        | MPKV, Rahuri | 60x20 cm         |
| Phule Yamuna     | MPKV, Rahuri | 60x20 cm         |
| RHC-1406         | MPKV, Rahuri | 60x20 cm         |
| RHC-1651         | MPKV, Rahuri | 60x20 cm         |
| RHC-1217         | MPKV, Rahuri | 60x20 cm         |
| Rasi Magic       | Rasi Seeds   | 120x60 cm        |
| Dhandev          | Mahyco seeds | 120x60 cm        |
| Ajeet 111        | Ajeet seeds  | 120x60 cm        |

**Phenological and Growth characteristics :** All varieties were shown early maturity, sowing was done at spacing of 60 x 20 cm. The lower number of monopodia per plants recorded in varieties under HDPS, while hybrids shown more number of monopodia and sympodia per plant. Similar type of results was reported by Wankhade *et al.*, (2003); Narayana *et al.*, (2007), Sisodia and Khamparia (2007). The maximum number of sympodia was recorded in hybrid Ajeet 111 (13.67) followed by variety RHC-1651 (13.0). In HDPS planting system lower no of monopodia and higher number of sympodia are feasible characters which increases the more number of boll per plant and yield per plant and that type of plant are very suitable for HDPS planting.

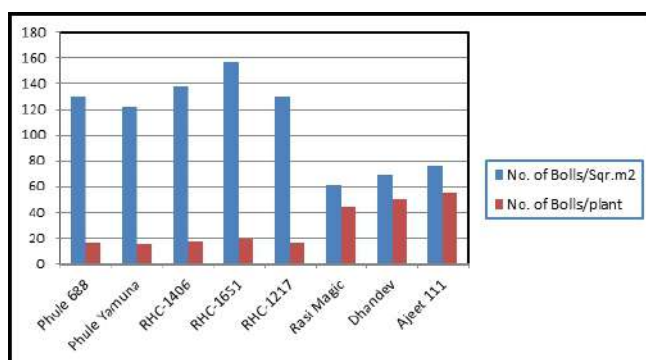


**Fig.-1 : Significant differences in number of boll per plant and per hector.**

### Yield contributing characters and seed cotton yield :

The HDPS cotton plants produce fewer bolls than conventionally planted cotton but retain a higher number of the total bolls per unit area. The significantly higher number of bolls per plant recorded by hybrid Ajeet-111 (54.67), however it shown lower number of boll per metre

square (75.44), in contrast number of bolls per plant minimum under HDPS but maximum per meter square area and its effected on seed cotton yield per plot and per hectare Under wider plant spacing of 120 x 60 cm due to better development of individual plant in wider plant spacing crop, the number of boll per plant higher but number of boll per meter square were minimum. The widely spaced plant received optimum microclimate and the beneficial influence on plant development. Similar results were observed by Nehra and Chandra (2001). The mean boll weight was significantly influenced by different plant densities as reported by Moola and Giri (2006). The sowing of cotton at 60 x 20 cm<sup>2</sup> plant spacing produced considerably least boll weight as compared to wider spacing. The variety RHC-1651 recorded highest seed cotton yield under HDPS planting (65.58 qtl/ha), followed by RHC-1406 (52.35 qtl/ha), however, in conventional sowing Bt cotton hybrids [Ajeet-111 (36.63 qtl/ha), Dhandev (34.73 qtl/ha) recorded lower seed cotton yield as compared to varieties under HDPS. At 120 x 60 cm spacing seed cotton yield was decreased because the reduction in yield per meter square due to both interplant and intra- plant competition for resources, was more than compensated by increase in the number of plants per unit area. These above results are in accordance with those obtained by Giri and Gore (2006); Buttar and Singh (2007); Narayana and Aparna (2011).

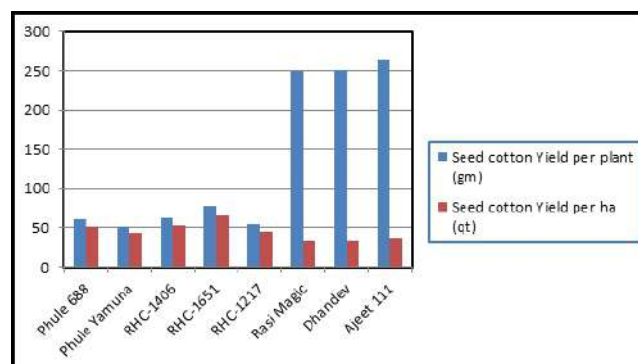


**Fig.-2 : Significant differences in seed cotton yield per plant and per hector.**

## Conclusion

The concept of 'High Density Planting Systems' (HDPS) that has potential to improve yields of rainfed cotton. Its shown higher productivity of cotton in HDPS with straight varieties was found to be a viable option to improve the productivity of cotton particularly under rainfed conditions at reduced production costs. The obvious advantage of this system is earliness since HDPS needs less bolls / plant to achieve the same yield as conventional cotton and the crop does not have to maintain the late formed bolls to mature. The HDPS cotton

plants produce fewer bolls than conventionally planted cotton but retain a higher percentage of the total number bolls per unit area.

The variety RHC-1651 (65.58 qtl/ha) and RHC-1406 (52.35 qtl/ha), recorded highest seed cotton yield under HDPS planting. This two varieties will be adapted in HDPS system that can boost the yield of cotton under rainfed condition with minimum production cost.

HDPS planting is the new option to increase the productivity of cotton under rainfed as well as irrigated conditions. By this system the attack of pink bollworm can be escaped by early maturity and uniform maturity. On the basis of experimental study of cotton varieties can be sown at plant spacing of 60×20cm for obtaining higher seed cotton yield over the Bt cotton hybrids spacing 120 x 60 cm.

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## Food and Feeding Habits of *Labeo rohita* (Ham.) from Daya Reservoir, Udaipur, Rajasthan

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### Abstract

In the present study, an attempt has been made to investigate the food and feeding habits of an Indian major carp *Labeo rohita* from Daya reservoir, Udaipur. On the basis of qualitative and quantitative analysis of gut contents, it has been observed that *Labeo rohita* is herbivorous and feeds mainly on decayed organic matter followed by bacillariophyceae, plants materials, chlorophyceae, myxophyceae, mud and sand. Gastro somatic indices were found to be higher during winter months as compared to summer.

**Key words :** *Labeo rohita*, food and feeding habits, gastro somatic index and reservoir.

### Introduction

In general, the growth of a fish is influenced by the quality and quantity of food materials available and consumed. Thus, any variation in quality and quantity of food materials will affect the growth rate of the fish. The qualitative and quantitative variations of natural food materials in a water body are under the influence of several abiotic and biotic factors. These variations could be known by qualitative and quantitative analysis of gut contents of a fish and/or by the estimation of gastro somatic index.

Food and feeding habits of carps have been a field of interest to fisheries researchers since very long. Khan and Jhingran (1975) have given a report on the food and feeding habits of an Indian major carp *Labeo rohita* (Ham.). Pathak (1975) conducted a study on food habits of *Labeo calbasu* from Loni reservoir. Rajgopal (1978) described the foods and feeding habits of some commercial fishes from the Tungabhadra reservoir.

Sharma (1994) reported that the gut contents of *Cyprinus carpio* Linn. in size range of 50-860 mm showed the fish to be omnivorous and bottom feeder mainly feeding on decayed organic matter which form the bulk of gut contents followed by diatoms, algae, desmids and crustaceans. Yadav (1997) reported the food and feeding habits of *Catla catla* and *Labeo rohita*. Panicker (2000) reported the food and feeding habits of several important fish species including *Catla catla* and *Labeo rohita* from Chulliar and Malampuzha reservoirs of Kerala. Selvaraj *et al.* (2000) conducted the study on the food and feeding habits of several important fishes of Thirumoorthy reservoir

Ujjania (2003) studied the Gastroscopic index of

*Catla catla*, *Labeo rohita* and *Cirrhinus mrigala* from Mahi bajaj sagar, Surwania dam and Aasan pond of Southern Rajasthan.

### Materials and Methods

In order to study the food and feeding habits of *Labeo rohita*, total 30 samples of species were collected from the commercial catches during winter (Oct. – Jan) and summer months (March–June) of the fishing year 2004-2005 at landing centre of Daya reservoir. All the fish specimens were weighed separately and then gutted for the collection of gut contents. The collected guts were weighed and their contents emptied in the watch glass. The same were analysed qualitatively as well as quantitatively by eye estimation volumetrically (Pillay, 1952) and occurrence method (Hynes, 1950). For evaluating the relative importance of all food items, the index of preponderance (Natarajan and Jhingran, 1961) was obtained using formula :

$$I = \frac{V_i O_i}{\sum V_i O_i} \times 100$$

Where,

I = Index of preponderance

V<sub>i</sub> = Volume percentage

O<sub>i</sub> = Occurrence percentage

= Summation

Gastroscopic Index (GaSI) was calculated using the formula given by Biswas (1993) :

$$GaSI = \frac{\text{Weight of gut (g)}}{\text{Weight of fish (g)}} \times 100$$

Table-1 : Grading of various food items of gut contents in *Labeo rohita* from Daya reservoir, Udaipur.

| S. No. | Food items             | % Composition of items by |                      | $V_i O_i$                  | Index of preponderance<br>'I' = $V_i O_i \times 100 / \sum V_i O_i$ | Grading |
|--------|------------------------|---------------------------|----------------------|----------------------------|---------------------------------------------------------------------|---------|
|        |                        | Volume ( $V_i$ )          | Occurrence ( $O_i$ ) |                            |                                                                     |         |
| 1.     | Decayed organic matter | 63.52                     | 42.86                | 2722.47                    | 87.07                                                               | I       |
| 2.     | Bacillariophyceae      | 10.50                     | 14.29                | 150.05                     | 4.80                                                                | II      |
| 3.     | Chlorophyceae          | 7.93                      | 10.71                | 84.93                      | 2.72                                                                | IV      |
| 4.     | Myxophyceae            | 4.5                       | 7.14                 | 32.13                      | 1.03                                                                | V       |
| 5.     | Plant material         | 8.29                      | 12.5                 | 103.63                     | 3.31                                                                | III     |
| 6.     | Mud and sand           | 2.95                      | 7.14                 | 21.06                      | 0.67                                                                | VI      |
| 7.     | Miscellaneous          | 2.31                      | 5.36                 | 12.38                      | 0.40                                                                | VII     |
|        |                        |                           |                      | $\sum V_i O_i$<br>=3126.65 |                                                                     |         |

## Results and Discussion

**Composition of gut contents :** Various food items and their percentage composition (by volume and occurrence) found in the gut of *Labeo rohita* are enumerated in Table-1. The Table-1 also shows the preponderance indices of different food items observed in the guts of *Labeo rohita*.

In case of *Labeo rohita*, decayed organic matter forming the main items of gut contents was represented by 63.52 per cent (volume) and 42.86 per cent (occurrence). Bacillariophyceae (diatoms) group was next in the order of dominance constituting 10.50 per cent (volume) and 14.29 per cent (occurrence). The major genera of bacillariophyceae in the diet were *Cyclotella*, *Diatoma*, *Fragilaria*, *Navicula*, *Pinnularia*, *Nitzschia*, *Synedra* and *Tabellaria*. The plant remnants were the next important portion of the gut contents and were contributed by 8.29 per cent (volume) and 12.5 per cent (occurrence). These plant materials in the gut contents of *Labeo rohita* were of unidentified plants *Najas*, *Hydrilla*, *Vallisneria* and fragments of the leaves and roots of aquatic plants. Chlorophyceae (green algae and desmids) group formed 7.93 per cent in volume and 10.71 per cent by occurrence in the gut content. The major genera under chlorophyceae were *Cosmarium*, *Pediastrum*, *Spirogyra*, *Volvox* and *Hydrodictyon*. Mud and sand particles were next in the order of occurrence being 2.95 per cent by volume and 7.14 per cent by occurrence. In addition to the above, miscellaneous foods comprising of zooplankton (rotifers, cladocerans) formed 2.31 per cent by volume and 5.36 per cent by occurrence in the gut contents of *Labeo rohita*.

**Gastro somatic index (GaSI) :** Gastro somatic index (GaSI) of *Labeo rohita* was calculated from the fish samples, collected during winter (Nov.-Feb.) and summer (April-June) months only, for the study of feeding intensity. This was because of the legal restrictions on fishing. The values of GaSI were higher during winter months as compared to summer months (Table-2).

In the case of *Labeo rohita*, the gut contents were mainly of decayed organic matter as a dominant component followed by bacillariophyceae, other plant materials, chlorophyceae, myxophyceae, mud and sand. Besides these, meagre amount of zooplankton consisting mainly of crustaceans and rotifers were found in the gut content. These observations tend to indicate that the basic food of rohu of Daya reservoir is of decayed organic matter, phytoplankton and plants. Other food items found in the gut may be regarded as occasional or accidental as they were encountered in negligible amount. From the observations of food items, the fish may be termed as herbivorous in nature. Yadav (1997) also reported that *Labeo rohita* is herbivorous in nature and its adults feed mainly on plants, microscopic plants, decaying higher plants, detritus and mud. Panicker (2000) while studying gut contents of *L. rohita* observed that the major components were detritus (50.0%) followed by green algae (27.6%), blue green algae (15.62%), diatoms (1.2%), rotifers and cladocerans (4.0%) and sand particles (1.4%). By and large the food spectrum observed in the *L. rohita* of Daya reservoir grossly match with the reported work from certain other water bodies.

Studies on gastro somatic index (GaSI) of *Labeo rohita* revealed that the feeding intensity remained high during winter months (non-spawning period) which was reduced during summer months (pre-spawning period). It is reported that generally during spawning season, feeding rate would be relatively lower and it increases immediately after spawning as the organisms feed voraciously to recover from fast (Rao *et al.* 1998). Low feeding rate during spawning has also been reported by Hatikakoty and Biswas (2003). Ujjania (2003) again observed the high GaSI among Indian Major Carps during winter months and low during summer months. On comparing the above references with the present results we came to know that the findings of present study are in confirmation to the observations of Rao *et al.* (1998), Ujjania (2003) and Hatikakoty and Biswas (2003).

Table-2 : Gastro somatic Index (GaSI) of Labeo rohita from Daya reservoir, Udaipur.

| Fish S.No. | Winter season      |                   |       | Summer season      |                   |       |
|------------|--------------------|-------------------|-------|--------------------|-------------------|-------|
|            | Weight of fish (g) | Weight of gut (g) | GaSI  | Weight of fish (g) | Weight of gut (g) | GaSI  |
| 1          | 1100               | 27.17             | 2.470 | 3300               | 69.13             | 2.095 |
| 2          | 1400               | 26.90             | 1.921 | 1300               | 19.51             | 1.501 |
| 3          | 2000               | 28.35             | 1.939 | 1750               | 30.09             | 1.719 |
| 4          | 1500               | 25.70             | 1.713 | 2000               | 28.35             | 1.418 |
| 5          | 3100               | 64.20             | 2.071 | 1900               | 34.08             | 1.790 |
| 6          | 1900               | 35.39             | 1.863 | 2200               | 26.74             | 1.215 |
| 7          | 2500               | 47.74             | 1.910 | 2400               | 31.80             | 1.325 |
| 8          | 1900               | 39.60             | 2.084 | 3700               | 49.53             | 1.339 |
| 9          | 1600               | 33.06             | 2.066 | 3400               | 62.68             | 1.844 |
| 10         | 1300               | 26.41             | 2.032 | 2500               | 39.21             | 1.568 |
| 11         | 1200               | 23.15             | 1.929 | 2250               | 31.46             | 1.398 |
| 12         | 1400               | 28.57             | 2.036 | 3250               | 37.45             | 1.152 |
| 13         | 1250               | 24.31             | 1.945 | 2700               | 51.64             | 1.913 |
| 14         | 2000               | 36.95             | 1.848 | 2300               | 43.09             | 1.873 |
| 15         | 2300               | 41.10             | 1.787 | 1200               | 21.79             | 1.816 |
| Mean       | 1763.333           |                   | 1.974 | 2410.000           |                   | 1.598 |

## Acknowledgement

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## Comparative Evaluation of Positive Mental Health among IGKV Students Based on Participation in Sports

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### Abstract

The positive mental health of varsity students from Indira Gandhi Krishi Vishwavidyalaya, Raipur was evaluated in the background of their participation in sports. This study was carried out on 99 male students of IGKV, Raipur. The mean age of selected students was 22.19 years and the sample comprise of 53 male student athletes and 46 male students nonathletes. The positive mental health of selected subjects was measured with the help of a three dimensional positive mental health inventory prepared by Agashe and Helode (2007). It was found that the student athletes had significantly better positive mental health as compared to student non-athletes. The mean scores for student athletes group was also found to be higher on self acceptance, ego strength and philosophy of life dimensions of positive mental health as compared to student non-athletes. It was concluded that participation in sports is a major factor that differentiates positive mental health among varsity students pursuing courses in agricultural field.

**Key words :** Positive mental health, agricultural stream, participation in sports.

### Introduction

There is no denying the fact about the physical benefits of participation in sports. In recent years the beneficial effect of participation in sports has also been observed on mental health. It has been reported that sports triggers brain chemicals that enhance our mood states. Participation in sports is also useful in increasing mental sharpness, concentration, self confidence while help to reduce depression and anxiety. It also helps to develop leadership skills, life skills and good personal habits. The benefits of regular participation in sports has also been documented in various research work conducted by Gahlawat and Gahlawat (2012), Talyabee *et al.* (2013), Sidhu *et al.* (2013), Singh *et al.* (2013), Mittal (2014), Busing (2016), Yadav (2017), Chowdhary and Shrivastava (2017), Tripathy (2019).

It has been opined by sports psychologists that sports participation reduces the risk of developing mental health related issues. Basically the researchers have majorly explored the negative side of mental health but there is positive aspect of mental health also and it is termed as positive mental health. Strupp and Hadley (1977) defined positive mental health as sum total of self acceptance, ego strength and philosophy of life and looking towards positive aspects of mental health. Positive mental health is important in many activities such as, ability to learn new perspectives, ability to express both positive and negative emotions, ability to connect effortlessly with other people, ability to possess good coping skills. The positive mental health is essential for an individual to realize full potential. The positive mental health also enhances work productivity because it

provides a base for an individual to cope with stressful situation in an efficient manner. The three main aspects of positive mental health are self acceptance, ego strength and philosophy of life. These three dimensions form our positive mental health. The self acceptance dimension gives us power to acknowledge own shortcomings and strength while having a realistic view about talent. The ego strength is associated with self confidence and intrinsic motivation while philosophy of life means general attitude towards life.

Like any other professional course, agriculture stream requires students to be inquisitive and motivated to excel in academics. It is a challenging field and success is determined by environmental factors also. So it is essential for students pursuing agriculture courses to have sound mental make-up. This study is conducted to see whether sports participation can be used as medium to boost positive mental health among varsity students pursuing agriculture as a professional course.

**Objectives :** The aim of the present study was to compare positive mental health between varsity student athletes and student non athletes pursuing agriculture as professional course.

**Hypothesis :** It was hypothesized that the positive mental health of student athletes will be significantly better as compared to student non-athletes.

### Research Methodology

The following methodological steps were taken in order to conduct the present study.

**Sample :** This study was carried out on 99 male students

**Table-1 : Comparison of Dimensions of Positive Mental Health between Varsity Student Athletes and Non-athletes pursuing their Professional Course in Agriculture.**

| Dimensions of PMHI | Student Athletes (N=53) |      | Student Non-athletes (N=46) |      | Mean Diff. | 't'  |
|--------------------|-------------------------|------|-----------------------------|------|------------|------|
|                    | M                       | S.D. | M                           | S.D. |            |      |
| Self Acceptance    | 7.20                    | 1.76 | 6.10                        | 2.32 | 1.09       | 2.66 |
| Ego strength       | 7.22                    | 2.30 | 6.39                        | 1.81 | 0.83       | 1.98 |
| Philosophy of Life | 7.45                    | 2.34 | 7.02                        | 1.90 | 0.43       | 0.99 |

t(df=97) at .05 =1.98 , t(df=97) at .01 = 2.63

**Table-2 : Comparison of Positive Mental Health between Varsity Student Athletes and Non-athletes pursuing their Professional Course in Agriculture.**

| Variable               | Student Athletes (N=53) |      | Student Non-athletes (N=46) |      | Mean Diff. | 't'  |
|------------------------|-------------------------|------|-----------------------------|------|------------|------|
|                        | M                       | S.D. | M                           | S.D. |            |      |
| Positive Mental Health | 21.88                   | 4.16 | 19.52                       | 4.80 | 2.36       | 2.62 |

t(df=97) at .05 =1.98 , t(df=97) at .01 = 2.63

of IGKV, Raipur. The mean age of selected students was 22.19 years and the sample comprise of 53 male student athletes and 46 male students nonathletes. Random sampling was used for selection of subjects.

#### Tools :

**Positive Mental Health Inventory :** The positive mental health inventory prepared by Agashe and Helode (2007) was preferred in this study for data collection. This inventory is based on three dimensions namely self acceptance, ego strength and philosophy in life respectively. Each dimension is measured with 12 statements. This inventory enjoys statistical reliability (r=0.72) and constructed validity (r=-0.42).

**Procedure :** PMHI prepared by Agashe and Helode (2007) was administered to each subject according to guidelines given in author's manual. The scoring pattern given in the manual was followed to evaluate the response. After tabulation of data for each subject on PMHI, independent sample 't' test was used for data analysis. The results are shown in table-1 and 2 respectively.

Perusal of statistical entries shown in table-1 indicate that mean scores on all three dimensions of positive mental health namely self acceptance, ego strength and philosophy of life was higher for student athletes group as compared to student non-athlete group. The self acceptance in student athletes was noted to be significantly higher (M=7.20) as compared to student non athletes M=6.10) with t=2.66 being statistically significant at .01 level. The ego strength of student athletes was also significantly higher (M=7.22) as compared to student non-athletes (M=6.39) with t=1.98 being statistically significant at .05 level. Although mean scores on philosophy of life dimension for student athlete group (M=7.45) was higher as compared to student non-athlete

group (M=7.02) but t=0.99 did not give statistical confirmation on this finding.

The positive mental health in student athletes was found to be significantly higher (M=21.88) as compared to student non athletes M=19.52) with t=2.62 being statistically significant at .05 level.

#### Results and Discussion

The awareness regarding one's shortcomings and strengths as well as subjective appraisal of abilities i.e. self acceptance was significantly higher in varsity student athletes of Indira Gandhi Krishi Vishwavidyalaya, Raipur Chhattisgarh as compared to varsity student non-athletes of Indira Gandhi Krishi Vishwavidyalaya, Raipur Chhattisgarh.

Intrinsic motivation to excel and self confidence i.e. ego strength was significantly higher in varsity student athletes of Indira Gandhi Krishi Vishwavidyalaya, Raipur Chhattisgarh as compared to varsity student non-athletes of Indira Gandhi Krishi Vishwavidyalaya, Raipur Chhattisgarh.

Attitude and purpose towards life was found to be better in varsity student athletes of Indira Gandhi Krishi Vishwavidyalaya, Raipur Chhattisgarh as compared to varsity student non-athletes of Indira Gandhi Krishi Vishwavidyalaya, Raipur Chhattisgarh.

The positive mental health was found to be significantly higher in varsity student athletes of Indira Gandhi Krishi Vishwavidyalaya, Raipur Chhattisgarh as compared to varsity student non-athletes of Indira Gandhi Krishi Vishwavidyalaya, Raipur Chhattisgarh.

Participation in sports involves winning and losing. It is not possible to win every time. When we lose a match it teaches us our limitation and winning rediscovers our

hidden talent. When a player loses a match it gives them intrinsic motivation to work harder and winning gives them self confidence. Hence it is not surprising for varsity student athletes of Indira Gandhi Krishi Vishwavidyalaya, Raipur Chhattisgarh to show more magnitude of positive mental health as compared to varsity non-student athletes of Indira Gandhi Krishi Vishwavidyalaya, Raipur Chhattisgarh

## Conclusion

On the basis of results it may be concluded that sports participation gives that extra edge in terms of superior positive mental health to varsity students pursuing professional course in agriculture.

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## Personal, Socio-Economic, Communication and Psychological Traits of Chickpea Growers

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### Abstract

Pulses are the important sources of proteins, vitamins and minerals and are popularly known as “Poor man’s meat” and “rich man’s vegetable”, contribute significantly to the nutritional security of the country. Chickpea is very important pulse crop of India in terms of area and production. It was observed that most of the respondents 44.5 per cent belonged to middle age group, 29.5 per cent of respondents were found to middle school, 62.5 per cent had medium farming experience in chickpea cultivation, 47.5 per cent found that low socio political participation, 47 per cent had medium category in occupation, 46 per cent had medium level of annual income, 61 per cent belonged to medium level of material possession, 38 per cent of respondents had small size of land holding, 58.5 per cent had medium source of information, 56.50 per cent respondents had medium mass media exposure, 59 per cent respondents had medium cosmopolitaness, 46.5 per cent had medium scientific orientation, 63 per cent respondents had medium attitude toward improved production technology and 51.5 per cent respondents had medium information seeking behavior of chickpea growers.

**Key words :** Personal, socio-economic, communication, chickpea growers

### Introduction

Chickpea (*Cicer arietinum*.) is one of the important Pulse crops of the world and India is the world leader in chickpea (Bengal gram) production, and produces some 15 times as much as the second-largest producer, Australia. Other key producers are Pakistan, Turkey, Burma, Ethiopia, and Iran. Chickpea is the major pulse crop of Madhya Pradesh. The chickpea can be grown in loamy to heavy soils under rain fed conditions and hence assumes importance in the arid region of Madhya Pradesh. Chickpea is a suitable crop under change climate of semi-arid tropics grown mostly on depleted soil fertility, marginal and undulated land. It is grown in the areas receiving less rainfall as its water requirement is less as compared to other crops.

### Materials and Methods

The present study was conducted purposively in Dhar district of Madhya Pradesh state during 2015-16. Tirla block of Dhar district was selected for the study. A list of chickpea growing villages of Tirla block was prepared and 10 villages were selected randomly. After the selection of the villages, a village wise list of the chickpea growing farmers from the selected 10 villages was prepared and 20 farmers from each village were randomly selected. Thus, the total sample comprised of 200 farmers spread over ten selected villages.

### Results and Discussion

Socio-personal, socio-economic, communication and

psychological traits of chickpea growers towards Improved Production Technologies

**Age :** The data presented in Table 1 revealed that most of the respondents 44.5 per cent belonged to middle age group, followed by old age group (37%) and young age group (18.5%) respectively. The present results are similar with the findings of Rathod *et al.* (2013), Sharma *et al.* (2014) and Sharma *et al.* (2015)

**Education :** The data in Table-1 shows that maximum numbers 29.5 per cent of respondents were found to middle school, followed by 22 per cent respondents were high school level, 17.5 per cent respondents were illiterate, 17 per cent respondents were primary school and only 14 per cent respondents were educated above the high school. The present results are similar with the findings of Sharma *et al.* (2014) and Sharma *et al.* (2015).

**Farming experience :** The data in Table-1 reveal that majority of the respondents (62.5%) had medium farming experience in chickpea cultivation, followed by high experience in chickpea cultivation 22 per cent and the respondents had low experience in chickpea cultivation were 15.5 per cent. The present results are similar with the findings of Raghuvansi (2014).

**Socio political participation :** The data presented in Table-1 reported that most of the respondents 47.5 per cent found that low socio political participation, followed by medium socio political participation 46 per cent and the respondents found high socio political participation were

**Table-1 : Distribution of respondents according to the personal, socio-economic, communication and psychological traits of chickpea growers.**

| S. No. | Particulars                                           | Respondents       |          |
|--------|-------------------------------------------------------|-------------------|----------|
|        |                                                       | Frequency (n=200) | Per cent |
| 1      | <b>Age (years)</b>                                    |                   |          |
|        | Young (up to 35 yrs)                                  | 37                | 18.50    |
|        | Middle (36 to 50 yrs)                                 | 89                | 44.50    |
|        | Old (above 50 yrs)                                    | 74                | 37.00    |
| 2      | <b>Education</b>                                      |                   |          |
|        | Illiterate                                            | 35                | 17.50    |
|        | Primary school                                        | 34                | 17.00    |
|        | Middle school                                         | 59                | 29.50    |
|        | High school                                           | 44                | 22.00    |
|        | Above high school                                     | 28                | 14.00    |
| 3      | <b>Farming experience</b>                             |                   |          |
|        | Low (less than 8.68 score)                            | 31                | 15.50    |
|        | Medium (8.68-30.26 score)                             | 125               | 62.50    |
|        | High (above 30.26 score)                              | 44                | 22.00    |
| 4      | <b>Socio political participation</b>                  |                   |          |
|        | Low (less than 0.08 score)                            | 95                | 47.50    |
|        | Medium (0.08-3.00 score)                              | 92                | 46.00    |
|        | High (above 3.00 score)                               | 13                | 6.50     |
| 5      | <b>Occupation</b>                                     |                   |          |
|        | Low (less than 4.01 score)                            | 59                | 29.50    |
|        | Medium (4.01-7.37 score)                              | 94                | 47.00    |
|        | High (above 7.37 score)                               | 47                | 23.50    |
| 6      | <b>Annual income</b>                                  |                   |          |
|        | Low (below Rs.50,000)                                 | 66                | 33.00    |
|        | Medium (Rs.50,000 to 100,000)                         | 92                | 46.00    |
|        | High (above Rs.100,000)                               | 42                | 21.00    |
| 7      | <b>Material possession</b>                            |                   |          |
|        | Low (less than 33.02 score)                           | 43                | 21.00    |
|        | Medium (33.02-39.74 score)                            | 122               | 61.00    |
|        | High (above 39.74 score)                              | 35                | 17.50    |
| 8      | <b>Size of land holding</b>                           |                   |          |
|        | Marginal (up to 1 ha)                                 | 42                | 21.00    |
|        | Small (1.01 to 2.00 ha)                               | 76                | 38.00    |
|        | Medium (4.01 to 10.00 ha)                             | 60                | 30.00    |
|        | Large (above 10.00 ha)                                | 22                | 11.00    |
| 9      | <b>Sources of information</b>                         |                   |          |
|        | Low (less than 14.06 score)                           | 37                | 18.50    |
|        | Medium (14.06-18.12 score)                            | 119               | 59.50    |
|        | High (above 18.12 score)                              | 44                | 22.00    |
| 10     | <b>Mass media exposure</b>                            |                   |          |
|        | Low (less than 0.20 score)                            | 60                | 30.00    |
|        | Medium (0.20-1.46 score)                              | 113               | 56.50    |
|        | High (above 1.46 score)                               | 27                | 13.50    |
| 11     | <b>Cosmopoliteness</b>                                |                   |          |
|        | Low (less than 2.24 score)                            | 51                | 25.50    |
|        | Medium (2.24-3.62 score)                              | 118               | 59.00    |
|        | High (above 3.62 score)                               | 31                | 15.50    |
| 12     | <b>Scientific orientation</b>                         |                   |          |
|        | Low (less than 12.01 score)                           | 58                | 29.00    |
|        | Medium (12.01-25.47 score)                            | 93                | 46.50    |
|        | High (above 25.47 score)                              | 49                | 24.50    |
| 13     | <b>Attitude toward improved production technology</b> |                   |          |
|        | Low (less than 30.16 score)                           | 23                | 11.50    |
|        | Medium (30.16-43.70 score)                            | 126               | 63.00    |
|        | High (above 43.70 score)                              | 51                | 25.50    |
| 14     | <b>Information seeking behaviour</b>                  |                   |          |
|        | Low (less than 9.02 score)                            | 75                | 37.50    |
|        | Medium (9.02-15.62 score)                             | 103               | 51.50    |
|        | High (above 15.62 score)                              | 22                | 11.00    |

6.5 per cent. The present results are similar with the findings of Mishra (2008).

**Occupation :** The data presented in Table-1 reveal that maximum number of the respondents (47%) had medium category in occupation followed by low category 29.5 per cent and the respondents belonging to high occupation were 23.5 per cent. The possible reason for medium category occupation could be due to poor education and low socio political participation of the respondents.

**Annual income :** For fostering rapid use of improved production technology in chickpea cultivation, the respondent must inculcate the nature of annual income. The data in Table-1 show that out of the total 200 respondents, 46 per cent had medium level of annual income, while 33 per cent were having low annual income and only 21 per cent were found to have high annual income. The present results are similar with the findings of Singh *et al.* (2010).

**Material possession :** The data presented in Table-1 reveal that majority of the respondents 61 per cent belonged to medium level of material possession, followed by low material possession 21.5 per cent and the respondents belonging to high material possession were 17.5 per cent. The present results are similar with the findings of Uikey (2016).

**Size of land holding :** The data in Table-1 regards to size of land holding of the respondents, it was observed that maximum 38 per cent of respondents had small size of land holding followed by 30 per cent of respondents had medium size of land holding, 21 per cent respondents had marginal land holding and only 11 per cent respondents had large land holding. The present results are similar with the findings of Sharma *et al.* (2014).

**Sources of information :** The data presented in Table-1 reveal that majority of the respondents 59.5 per cent had medium source of information, followed by high source of information 22 per cent and the respondents belonging to low source of information were 18.5 per cent. The present results are similar with the findings of Deshmukh (2007).

**Mass media exposure :** More than half of the respondents (56.5%) had medium mass media exposure, followed by low mass media exposure 30 per cent and the respondents belonging to low mass media exposure were 13.5 per cent. The present results are similar with the findings of Sharma *et al.* (2014).

**Cosmopoliteness :** The majority of the respondents (59%) had medium cosmopoliteness followed by low cosmopoliteness 25.5 per cent and the respondents had high cosmopoliteness were 15.5 per cent. The present results are similar with the findings of Sharma *et al.* (2014)

**Scientific orientation** : The data presented in Table-1 found that maximum respondents (46.5%) had medium scientific orientation followed by low scientific orientation 29 per cent and the respondents had high scientific orientation were 24.5 per cent. The present results are similar with the findings of Ganesan and seethalkshmi (2002).

**Attitude toward improved production technology** : The data presented in Table-1 reported that majority of the respondents (63%) had medium attitude toward improved production technology, followed by high attitude toward improved production technology 25.5 per cent and the respondents had low attitude toward improved production technology were 11.5 per cent. The present results are similar with the findings of Sharma *et al.* (2014).

**Information seeking behavior** : More than half of the respondents (51.5%) had medium Information seeking behaviour of chickpea growers followed by low Information seeking behaviour 37.5 per cent and only 11 per cent respondents had high Information seeking behaviour. The present results are similar with the findings of Sharma *et al.* (2014).

## Conclusion

The results revealed that education, farming experience, occupation, annual income, size of land holding, mass media exposure, cosmopolitaness, scientific orientation and attitude toward improved production technology showed positive and significant relationship with level of adoption their perception and extent of knowledge. Better

perception and comprehension could be observed among better educated than others who will have a good economic orientation for a chickpea crop. Their active participation with extension agents and activities with the help of mass media like radio, television, newspapers and Mobile etc. will enhance their knowledge and adoption of improved chickpea production technologies. It also requires adoption of new ideas and scientific practices for the successful management improved chickpea production technologies.

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## The Secrets of Soil Seed Bank—A Tool for Forecasting and Managing Weed Flora Menace

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### Abstract

Soil seed bank include seeds, bud banks and diaspore which decide coming weed flora. Accurate forecast of potential weed seedling density would allow the farmers to implement control measures more efficiently. Seeds, either born and produced on site or carried to the site by a dispersal agent, become incorporated into the soil. Persistence is a measure of the adaptive potential of a weed that enables it to grow any environment decide future flora of weeds. A single plant of an annual weed can produce enough seeds in one season to cover the entire area of one acre with this weed species in the next year. Many species are capable of persisting for a year in dormancy, and many more can maintain viability for many years. The weed seeds can be measured by seedling emergence method, direct counts using sieves and elutriation and by chemical methods. The management of weed need to emphasis on reduction to the seed rain which cause ultimate weed seed deposit and strategy to reduce the seed load which already in the deposit of soil bank.

**Key words :** Soil seed bank, soil seed dynamics, maximising weed seed loss.

### Introduction

The soil seed bank is the sum of viable weed seeds and vegetative propagules that are present in the soil and thus contribute to weed pressure in future crops (Menalled, 2013). It includes both new weed seeds recently shed and older seeds that have persisted in the soil for several years (Fernandez *et al.*, 1991). Soil seed banks have been part of theories in plant ecology regarding species evolution, traits, and succession since Darwin (1859) who noticed the presence of seeds stored in soil of pond ecosystems and the potential of these seeds to facilitate plant recruitment. Weed seed banks have been studied intensely in agricultural science because of their important economic impacts; other fields interested in soil seed banks include forest regeneration and restoration ecology.

**Soil seed bank components :** It include seeds, bud banks and diaspore.

**Seeds :** Mostly annual plant produces seeds for their propagation

**Bud bank :** perennial plants have vegetative propagules which include dormant and adventitious buds, stolon, rhizomes, and bulbs.

**Diaspore :** spores produced by non-flowering plants such as ferns and bryophytes.

The purpose of the soil seed bank as far as the species is concerned is that it allows plant species to survive the harsh environmental conditions and enhance the survival of that species by buffering against harsh

environmental conditions or highly effective control methods (Gulden and Shirliffe, 2009).

**Importance of soil seed bank :** Soil seed bank has impact on the distribution of annual and perennial weeds over the years and it affects the spread of the weed community. According to Abella *et al.* (2013), the assessments of seed banks have key relationships with understanding ecological processes and many cornerstone topics of major interest in plant ecology and biological conservation. It is a tool to predict the degree to which crop-weed competition will affect crop yield and quality. Accurate forecast of potential weed seedling density would allow the farmers to implement control measures more efficiently. It also gives an idea about the possible exotic invaders. When an exotic species not yet established in the vegetation shows up in the seed bank, it warns land managers to carefully monitor the site and remove or treat the establishing plants before they take over. Accurate forecast of potential weed seedling density would allow the farmers to implement control measures more efficiently. Thus the knowledge of soil seed bank help the farmers to avoid inappropriate and over use of herbicides.

**Types of seed bank :** The composition of seed banks is variable, and is classified as temporary or persistent. Temporary banks are composed of seeds of short life, which do not present dormancy and are dispersed in time for short periods during the year (Garwood, 1989). Species like *Avena fatua*, *Alopecurus myosuroides*, *Galium aparine*, *atricaria perforata*, *Centaurea cyanus*, are

classified as temporary, having a rate of decrease around 80%. Persistent seed banks are composed of seeds that have more than one year of age and reserves of seeds remain in the soil year after year generally buried into the soil. *Chenopodium album*, *Sinapis arvensis*, *Aethusacynapium*, *Papaverrhoeas*, *Viola arvensis*, *Kickiaspuria*, *Capsela bursa pastoris* and *Amaranthus retroflexus* are examples of persistent soil seed banks (Barralis *et al.*, 1988).

**Soil seed dynamics :** Weed seeds can reach the soil surface and become part of the soil seed bank through several avenues. The main source of weed seeds in the seed bank is from local matured weeds that set seed. Agricultural weeds can also enter a field on animals, wind, and water, as well as on machinery during activities like cultivation and harvesting. Maintaining excellent weed control for several consecutive seasons can eliminate a large majority of the weed seed bank, but a small percentage of viable, highly dormant seeds persist, which can be difficult to eliminate (Egley, 1996). The weed species have survived throughout time, because of their ability to resist to several adverse climatic conditions, tolerating high and low temperatures, dry and humid environments and variations in oxygen supply ( Harbuck *et al.*, 2009).

Of the many seeds in the seed bank, very few will actually emerge and produce a plant. Most seeds will die, decompose or be eaten before ever germinating. Of those that do germinate, some will die before a mature plant is produced (Menalled, 2013).

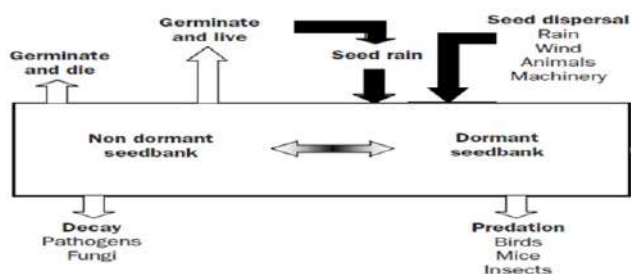


**Fig.-1 : Fate of weed seeds. Inputs to the soil seed bank are shown with black arrows and lossess with white arrows (Menalled, 2013).**

The seed bank includes all viable seeds present on, or in the soil or associated litter. Contributions are derived from the seed rain, which includes dispersal from the local vegetation, but may also include major contributions from spatially and temporally distant sources (Simpson *et al.* 1989). Seed losses from the soil are generally due to germination, fire, predation, decomposition, physiological death induced by deep burial, and physical removal due to erosion or other disturbances (Leck, 1989).

## Evolution of soil seed bank

The annual weed seed return from reproductively mature weeds in the field or in field margins.

Production of new rhizomes, tubers, and other vegetative reproductive structures by perennial weeds.

Weed seeds brought into the field through inputs and farm operations, such as manure, mulch hay, irrigation water, farm machinery, and custom operators.

Weed seeds introduced by natural forces beyond the farmer's control, such as wind, floodwaters, and migrating birds (Forcella, 2003).

The term seed rain refers to the process by which seeds enter the seed bank. Seeds, either born and produced on site or carried to the site by a dispersal agent, become incorporated into the soil. If seeds can remain viable for many years, and new seeds continue to "rain" down, it's easy to see where the term seed bank comes from, as the seeds accumulate over time, and form a reserve of seeds in the soil.

These patterns arise because species that successfully form persistent seed banks are the species with greatest seed longevity. It is one of two contrasting strategies plants may employ to realize success in replacing themselves and insuring maintenance of the species. A plant dispersing its seed is most successful, evolutionarily speaking, if it can place its seed in an environment suitable for germination and growth. Plants with high seed longevity have evolved the strategy of waiting patiently for the right time. New weed seeds periodically added to the existing seed population in soil by weeds, wind, water, humans, animals and miscellaneous dispersing agents. According to Gohil *et al.* (2016), 5 Lakh/m<sup>2</sup> seeds were added to the reservoir of soil seed bank.

## Application of cow dung enriches the seed bank :

Manure application to cropland may serve as a source of weed introduction and dispersal (Pleasant and Schlather, 1994). Studies were conducted to determine the effect of ensiling and / or rumen digestion by cattle on the germination and viability of several common weed species. Green foxtail (17%) and wild oats (0 to 88%) seeds survived digestion in the rumen but were killed by the ensiling process. But Kochia, pigweed, lambsquarters, wild buckwheat remained viable after rumen digestion (15 to 98%), viable after ensiling (3 to 30%), while ensiling plus rumen digestion helped to reduce the viable weed seed bank to 2-19% (Blackshaw and Rode, 1991).

**Depletion of soil seed bank :** Seeds in the soil get

depleted by seed germination, senescence and death and predation.

**(i) Seed germinate to plants :** Germination take place readily from the top 1.25 cm. Surface top soil (0-5 cm) contain greater number of seeds than sub soil (Walia, 2014).

**(ii) Weed seed predation :** Consumption of weed seeds by ground beetles, crickets, earthworm, slugs, field mice, birds, and other organisms. Seed predation is greatest when weed seeds remain on the surface and there is sufficient residue cover for predators (i.e. no-till). Ground beetles or crickets can reduce weed seed emergence by 5 to 15%. Rodents and birds can consume significant amounts of weed seeds. Seeds of most plant species can become nourishing food for birds, insects, and other organisms, and weed seeds are no exception. Insects and other organisms consume weed seeds while they are still on the parent plant and after they have been shed. This predispersal predation by specialist insects (species that eat only one kind of weed seed) has been documented in velvetleaf, lambsquarters, pigweeds, and Canada thistle (White *et al.*, 2007).

Post dispersal weed seed predation has a more widespread impact on weed seed banks. A clean up crew of insects, other invertebrates, small rodents, and seed-eating birds removes millions of weed seeds from farmers' fields every year, especially during the weeks following weed seed shed. Field studies have documented seed predation rates high enough to reduce current-season inputs to the weed seed bank substantially. The deer mouse (*Peromyscus maniculatus*) invertebrates, small rodents, and seed-eating birds removes millions of weed seeds after weed seed shed (Shearin *et al.*, 2008).

**(iii) Fatal germination :** The seed or propagule sprouts but fails to reach the soil surface due to excessive depth or death from allelochemicals, microbial pathogens, insects, or other organisms in the soil.

(iv) Loss of viability or decay of seeds over time.

**Persistence capacity :** Persistence capacity is the fundamental point in the success of weed survival. Persistence is a measure of the adaptive potential of a weed that enables it to grow any environment. A consequence of a great number of seeds produced, long term viability, continuous germination, phenotypic and genetic plasticity decides the successful persistence of a weed (Freitas, 1990). The weed seeds get dispersed by different agents like rain splash, ants, winds, soil erosion, tillage, agricultural equipment etc. The seeds travelled may range to within the field to between the regions and may travel more than ten lakhs feet (Mohler, 2001).

**High seed production capacity :** The survival of weed of weed species depends upon its production of sufficient numbers of viable seeds to survive the hazards faced by the species in the environment. A single plant of an annual weed can produce enough seeds in one season to cover the entire area of one acre with this weed species in the next year. *Cyperus rotundus* populations of 10 million per hectare (Rao, 1968). *Imperata cylindrica* annually produce six tones of rhizomes per hectare (Soerjani, 1970). Seed banks of annual weeds in arable soils contain from 1000 - 10,000 seeds per m<sup>2</sup> while in grassland this range extend to 1 million per m<sup>2</sup> (Mortimer, 1994).

**Seed dormancy and longevity :** Seeds are mysterious organisms even when plainly visible in the palm of our hand. It's hard to think of them for what they really are - a living baby plant. The real offspring of a plant is the seed. For a seed, one year of dormancy is not a much of a big deal. Many species are capable of persisting for a year in dormancy, and many more can maintain viability for many years. Seed dormancy or longevity is what makes possible the existence of a seed bank. The seeds are alive and patient, waiting for the right time to germinate.

Interaction of many factors, viz., intrinsic dormancy of the seed population, depth of seed burial, frequency of disturbance, environmental conditions (light, moisture, temperature), and biological processes such as predation, allelopathy, and microbial attack (Davis *et al.*, 2005). The seed dormancy is another characteristic that affects the seed bank reservoir. The seed populations of several vegetable species behave in different ways with respect to germination; the weeds produce polymorphic seeds, with a certain proportion that is dormant and another not (Freitas, 1990).

Longevity of seeds is very variable and depends on many factors; few species exceed 100 years. In typical soils the longevity of seeds can range from nearly zero (germinating immediately when reaching the soil or even before) to several hundred years. Some of the oldest still-viable seeds were those of Lotus (*Nelumbonucifera*) found buried in the soil of a pond; these seeds were estimated by carbon dating to be around 1,200 years old (Bewley *et al.*, 2006).

The seed bank study in the aquatic system estimated total seed bank as 1136.48 million/ha, of which 62.35% (708.60 million seedlings ha<sup>-1</sup>) germinated within 12 months and 37.65% (427.88 million seeds ha<sup>-1</sup>) remained ungerminated. Based on importance value the five most dominant species in terms of emerged seedling were *Fimbristylis miliacea*, *Lepochloa chinensis*, *Cyperus difformis*, *C. Iria*. Total seed reserves (seedlings + remaining seeds) were similar to emerged seedling

indicating that emerged seedlings reflect the actual weed flora in that area (Begum *et al.*, 2006).

**The longest-running experiment in history :** Dr. William James Beal started the longest running experiment during 1879, filled 20 bottles with 50 seeds each of 23 different plant types and buried in a Secret spot in Michigan. The bottles are unearthed one at a time, and the seeds are planted. Out of 15 bottles *Verbascum* consistently in every bottle “of the 50 seeds of that particular plant, 23 of them germinated” in 2000. The last bottle is set to be unearthed in the year 2100 (Giaimo, 2016).

**Distribution of weed seeds in soil profile :** Horizontal distribution of weeds seeds depends on the direction of crop rows while the vertical distribution is decided by the method of tillage adopted. In ploughed fields, the majority of weed seeds are buried 4-6 inches below the soil surface. In reduced ploughed fields, the majority of weed seeds remain at or near the top soil surface. 80 to 90 % of the weed seeds are distributed in the top four inches of the soil profile (Menalled, 2013). The mould board plough incorporate the weed seeds to deeper layer of soil when compared to chisel plough and no till methods. The burial of weed seeds is more in loamy sand than silty loam with mould board ploughing (Clements *et al.*, 1996) ( Fig.-2).

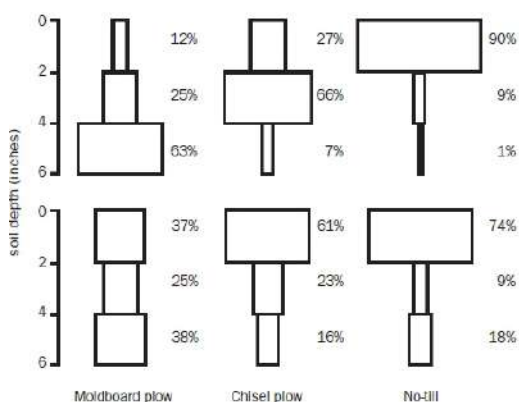


**Fig.-2 : Vertical distribution of weed seeds in loamy sand and silty loam with different ploughing methods (Clements *et al.*, 1996).**

### Strategies for Management

Weed seed bank estimation

Minimize annual deposits to the weed seed bank

Maximize losses from the weed seed bank

**Weed seed bank estimation :** Many techniques are using to estimate the number of weeds in the soil. Some are;

**Seedling emergence technique :** The most common

method of seed bank analysis is the seedling emergence technique, where soil samples are extracted and brought back to a greenhouse or lab to be observed under conditions favorable for germination. Under this method, germinating species are removed from the soil as they are identified, and the treatment continues until all seedlings have emerged from the soil. In a review of several methods for estimating seed numbers in the soil, Gross (1990) found that the seedling emergence technique underestimates the seed bank because, under any experimental condition, germination requirements for some species will not be met. However, this method does provide the most complete listing of species present in the seed bank.

**Direct counts using sieves and elutriation :** Soil samples were taken and direct counts using sieves to separate seeds and elutriation (Bonis *et al.*, 1995). The elutriator uses water ( at pressure 275-345 k Pa) to separate weed seeds from clay and silt particles in soil cores. This methods gives better results of actual seed numbers in the soil, however, the methods are severely limited by the necessity of identifying species by seed alone.

**Chemical methods :** Several chemical substances have been used for seed separation, mainly cheap salts not highly toxic to weed seeds. Potassium and sodium carbonate and zinc calcium chlorine are examples. For soils with high clay content it is necessary to use a dispersant, like sodium hexametaphosphate + sodium bicarbonate (Roberts, 1981). Buhler & Maxwell (1993) using a solution of potassium carbonate at 10,000 rpm centrifugation, recovered about 100% of the seeds of giant foxtail (*Abutilon theophrasti*). The germination of *Chenopodium album*, *giant foxtail* and *Abutilon theophrasti* was reduced by the exposition to carbonate.

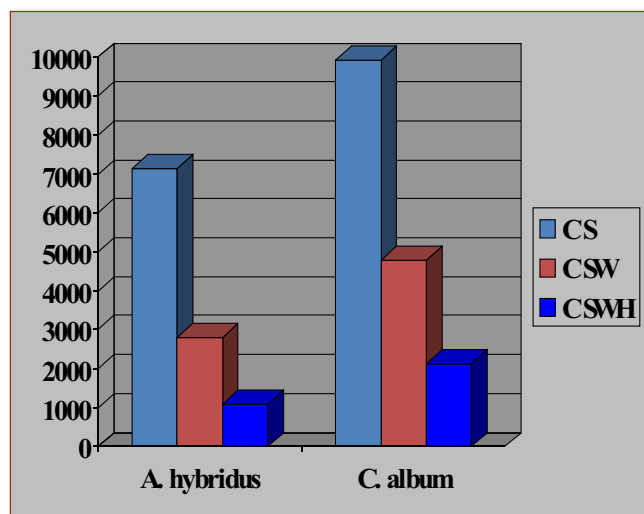
**Minimize annual deposits to the weed seed bank :** Is the most important field strategy to minimize the addition of seed rain deposit. Major among are:

**Kill weeds before they set seed :** Killing the weed before they flowering to be safe, for weed management. However *Senecio vulgaris* (groundsel) can mature seeds from flowers that are pollinated before the weeds are pulled or severed. Panicles of wild oats can set viable seeds even cut or pulled in milky stage (Walia, 2014). Control perennial weeds before they form new rhizomes, tubers, or other propagules. Utilize good sanitation practices to prevent introduction of new weed species into the field.

**Harvest weeds :** Weed seeds can be collected and destroyed during or soon after harvesting of a crop. Harvest weed seed control has been developed in Australia and has shown promising results. The strategy

can be implemented with the Harrington Seed Destructor , chaff carts, narrow windrow burning and bale direct. Each technology is based on the principal of weed-seed collection during grain crop harvest and seed destruction to avoid the replenishment of the seed bank (Walsh *et al.*, 2014).

**Crop rotation :** Farming systems research project undertaken during 1996-2002 with the treatments of Organic – Two year : Corn-Soybean, Organic – Three year: Corn-Soybean-Wheat/fallow , Organic – Four year: Corn-Soybean-Wheat/Hay-Hay revealed that inclusion of suitable crop combinations in cropping system (Organic – Four year: Corn-Soybean-Wheat/Hay-Hay) helped to reduce the subsequent population. Rotations with higher phenological diversity can reduce seed bank. Rotation sequences beginning with hay are better than sequences beginning with corn and lower initial seed bank can increase success of weed control in subsequent corn (Teasdale *et al.*, 2004) (Fig.-3).



CS- 2 Year Corn-Soybean CSW-3 Year corn-Soybean-wheat/fallow

CSHW-4 year corn-Soybean-Wheat/Hay

**Fig.-3 : Fluctuations of the weed seed bank at the long-term Farming Systems Project (Teasdale *et al.*, 2004).**

The crop rotation and continuous disturbance affected the soil seed bank. Continuous cropping of irrigated wheat, dry land wheat ,chickpea/wheat rotation , wheat/chickpea rotation, sugarbeet/wheat rotation, wheat/sugarbeet rotation significantly reduced the soil seed bank of top soil( 0-5 cm ) when compared to orchard and pasture cultivation (Hosseini *et al.*, 2014).

**Cover crops :** The mulch of dead plant residue on the soil surface impacts the seed bank in no-till systems. Crop residues create micro-environments that provide cover for animals that feed on them. In addition, residues have a moderating effect on temperature fluctuations in the soil, which in turn can impact seed dormancy of many of the

smaller seeded broadleaf weeds that use daily temperature fluctuations to gauge burial depth. Crop residues of plant species such as rye (*Secale cereal* L.), clover (*Trifoliums* pp. L.) and recently incorporated canola contain allelopathic chemicals which inhibit seed germination (Moyer *et al.*, 2000). Weed suppression by resource competition during the cover crop growing cycle, and physical and chemical effects occur when cover-crop residues are left on soil surface as a dead mulch or ploughed down (Barberi and Mazzoncini, 2001).

**Mixed cropping and inter cropping :** Mixed cropping provides to reduce the build up of crop associated weeds and discourage the build up of endemic pests. Cultivation of diverse species of crops depending on site specific agro climatic conditions reduces the weed seed bank (Mesagran *et al.*, 2008).

**Maximize losses from the weed seed bank :** In practical sense the field agronomic management have crucial role to deplete the weed seeds from soil. Major methods are:

**Tillage :** The effect of primary tillage on weeds is mainly related to the type of implement used and to tillage depth. These factors considerably influence weed seed and propagule distribution over the soil profile and therefore they directly affect the number of weeds that can emerge in a field. No tillage enhanced weed population because of higher seedling recruitment from the topsoil, and consequently an increased requirement for herbicide application. Deep ploughing can substituted with minimal tillage in the long-term (Barberi and Cascio, 2001) (Fig.-4).

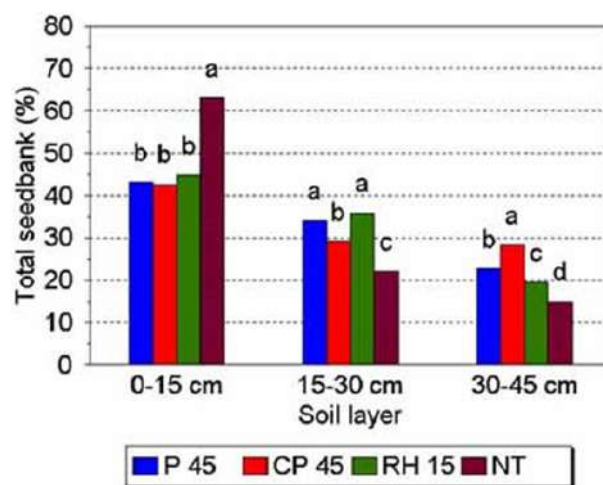


**Fig.-4 : Effect of type of tillage implements on soil seed bank (Barberi and Cascio, 2001).**

Relative abundance of perennial species in a weed community is also favoured by reduced tillage frequency over a crop sequence. The inclusion of a perennial ley in a crop rotation means that the soil is not tilled yearly. Lack of soil disturbance, coupled with higher control of annual

weeds by repeated mowing in the ley, can shift weed community composition towards a higher presence of biennials and perennials. Ploughing reduced the weedy rice seed bank when compared to no tillage.

**Tricking the Weed Seeds :** (Stale Seedbed and False Seedbed) - Smaller-seeded annual broadleaf species, germinate in response to stimuli at the soil surface. Weed species germinate during specific times of year after a certain amount of soil warming (Davis *et al.*, 2005). Stale Seedbed is the techniques in which the soil is tilled to prepare for seeding and planting is delayed for 2-3 weeks to allow a new flush of weeds to emerge. Just before sowing the crop, emerged weeds are killed with no or minimal soil disturbance (Abrham and Jose, 2014., Jose, 2015). In False seed bank weeds emerging in response to tillage are killed by 2-3 additional shallow cultivations at weekly intervals. The crop is planted immediately after the final cultivation.

**Ploughing and stale seed bed :** The off season ploughing (Summer ploughing), combined with stale seed bed helped to reduce in the weed seeds propagules in the soil and resulted in the significant reduction in weed count. Summer ploughing helped the desiccation of vegetative propagules (*Cyprus* sp.) and subsequent stale seed bed resulted the depletion of weed seed bank (Renjan and Sheela, 2012) (Fig.-5).

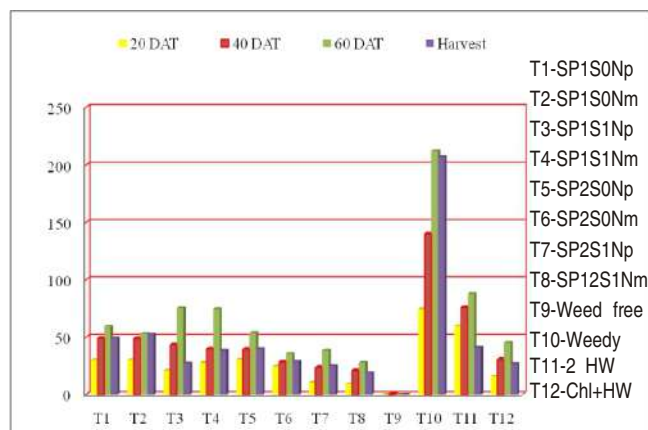


**Fig.-5 : Effect of summer ploughing(SP), stale seed bed(S) and method of nitrogen application (N) on weed count (Number m<sup>-2</sup>) (Renjan and Sheela, 2012).**

**Conditioning Weed Seeds :** A dense, shading plant canopy can also deepen the dormancy of some weed seeds. The dim green light under such a canopy can actually be more effective than continuous darkness in inhibiting the germination of light-responsive seeds. Reduced weed emergence has been observed in the season *after* a dense-canopy crop such as a cereal grain/clover intercrop, or August-planted forage radish. Martens and Martens (2008) suggested that the light quality under such foliage may have rendered weed seeds

more dormant. Dense crop canopies may also reduce subsequent weed emergence by reducing seed production or increasing seed mortality. For example, dense crop or cover crop canopies can provide favorable habitat for seed predators, resulting in reductions in the seed bank and subsequent weed emergence (Davis and Liebman, 2003).

**Water management :** Water management has become an important tool in weed management. Variation in soil moisture conditions can affect weed seed emergence and viability differently. In lowland rice, Begum *et al.*, (2016) observed that flooding to 5.1 cm effectively reduced the germination of *Echinochloa colona* seeded 1.3 cm deeper with a 35 % germination in Nova 66 rice seeds. The other associated weed species, *Bracharia* and *Sesbania*, responded similarly (Hossain and Begum, 2016).

Ismail *et al.* (1996) revealed that the seeds of broad leaved weeds, namely *Utricularia aurea* and *Sphenochloa zeylanica* were most dominant in dry and wet seeded rice fields compared to sedges and grasses. Contaminated irrigation water, water level, temperature, salinity and nutrient levels in the soil influence species composition in the seed bank, longevity of seeds, germination success, and seedling recruitment from the seed bank. Flooding conditions reduced the number of viable seeds in the soils especially grasses and sedges (Johnson, 2004). Kamoshita *et al.* (2010) also found that extreme water deficiency in the previous season had a negative influence on the size of the weed seedbank in the following year.

The water management by flooding significantly reduced the seeds of grasses. The *Leptochloa chinensis*, *Cyprus difformis* and *Sphenoclea zeylanica* population declined in next season. Aquatic broadleaved weed *Monochoria* was found to be dominant in soils under flooded condition (Juraim *et al.*, 2012).

**Soil solarisation :** Soil solarisation is a special technique in which moist soil is covered by transparent polyethylene film (TPE) and heated by solar radiation for several weeks. Ismaileh (1991) opined that weed seeds or other structures kept in the soil layer at which the temperature was not raised to lethal levels would not be adversely affected or might be stimulated to germinate and emerge.

The longer duration of soil solarisation with TPE of 0.05 mm recorded the least emergence of weed seedlings at 5 cm, 10 cm and 15 cm soil depth. At 20 cm soil depth there was no such variations on emergence of weed seedlings due to the effect of solarisation. The highest emergence of weed seed reserves was recorded with non solarized control. The effect of soil solarization was observed after cropping also. The least emergence of weed seedling was observed in thinner TPE of 0.05 mm

sheet compared to the thickest TPE of 0.1 mm sheet (Sundari, 2004) (Fig.-6).

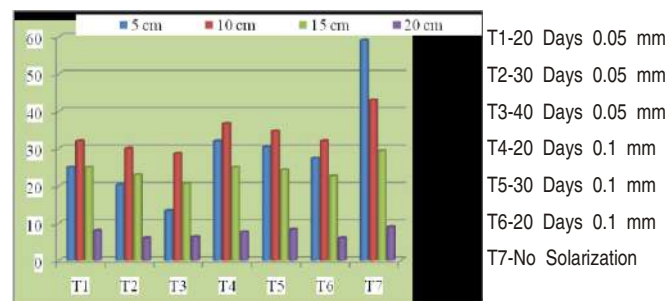


**Fig.-6 : The effect of soil solarisation on weed seed count at different soil depth (Sundari, 2004).**

**Fertilizer management :** The effects of organic and inorganic fertilization on weed seed bank composition, density and diversity were studied in the soil of a long-term fertilizer experiment established four decades ago in CRRI, Cuttack, India. Both inorganic and organic fertilizers had significant effects on weed communities; organic fertilizers could reduce weed density and increase weed-community species diversity and evenness (Major *et al.*, 2005). Highest weed seed density was observed in farm yard manure (FYM) treatment whereas, lowest was in NK treatment. Weed species diversity was reduced significantly with application of inorganic N either applied with K or alone; therefore, lowest diversity and species richness was observed in NK treatment followed by N alone (Lal *et al.*, 2016).

**Herbicide application :** When weeds were controlled by cultivation alone, the seed bank was approximately 25 times greater than where herbicides in conjunction with cultivation practices were adopted for weed control . Raj (2016) reported application of Penoxsulam + Cyhalofop butyl @ 125, 130 and 135 g ha<sup>-1</sup> significantly reduced weed seed bank under the direct seeded rice system (Fig.-7).

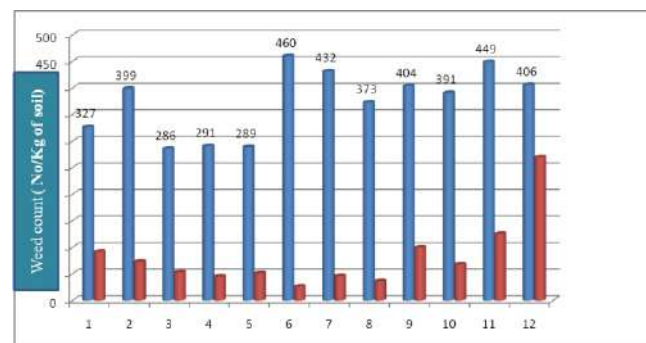


**Fig.-7 : Effect of herbicide in soil seed bank ( Raj, 2016)**

## Conclusion

None of the management strategies can be expected to eliminate the weed seed bank because it contains not only many seeds, but many different kinds of seed. There will almost always be some weeds that tolerate whatever combination of management strategies the farmer adopts. The best approach is to design the management strategy around a few most serious weeds present, then monitor changes in the weed flora over time and change the strategy accordingly. Soil seed banks play an important role in the natural environment of many ecosystems. The rapid re-vegetation of sites disturbed by wildfire, catastrophic weather, agricultural operations, and timber harvesting is largely due to the soil seed bank. Forest ecosystem and wetlands contain a number of specialized plant species forming persistent soil seed banks.

Again, as we hike through and enjoy the natural landscapes, we can have a greater appreciation for the thousands - perhaps tens of thousands - of seeds lying beneath our feet.

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## Genotypic Response of Planting Materials of Tea (*Camellia sinensis* (L.) O. Kuntze) to Microbial Bio-Inoculation

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### Abstract

Tea is one of the important plantation crops of India as well as West Bengal, contributes considerably in national economy and earns foreign exchange. During 2014-15, total production of tea in India was 1233.14 m kg, out of which only 100 m kg were organic tea. Mainly due to importers demand of organic tea, there is urgent need to enhance organic production of tea crop. Indiscriminate use of inorganic agricultural inputs-fertilizers, weedicides, pesticide and fungicides and lesser use of organic matters deplete soil health, residues remain beyond MRL in processed tea, ultimately reduction in export. Tea Board provides 55% subsidy for organic tea production. For organic cultivation of tea, the planting materials should also be organically produced in nursery, which is very scanty for perennial crops in general and plantation crops in particular. With this background, the present investigation was carried out at instructional farm of the department of Plantation Crops and Processing, UBKV, Pundibari, located at 26°19'86" N Latitude and 89°23'53" E Longitude at an elevation of 43 m msl with the objective to study the genotypic response of planting materials of tea to microbial bio-inoculation. The experiment was conducted from 2013 to 2015 and laid out in completely randomized block design. The planting materials of tea chosen to study genotypic response of tea with different bio inoculants are TS-462, TS-491, TS-491, TS-506 as biclonal seedstocks and TV 9, TV23, TV 26, Teen Ali 17/1/54 as vegetative clones. Out of which TS-462 and Teen Ali 17/1/54 out-performed other planting materials of tea with respect to genotypic response to microbial bio inoculation, among the seed stocks and clones chosen.

**Key words :** Tea nursery, genotypic response, bio-inoculants and planting materials.

### Introduction

Tea (*Camellia sinensis* (L.) O. Kuntze) belongs to family Theaceae is one of the most economically important evergreen woody plantation crops predominantly grown in the subtropical regions of India. It is most popular and low cost beverage in the world and consumed by a large number of people. Tea is grown mainly for young tender apical two leaves and a bud, which is a rich source of polyphenols, caffeine etc. Owing to its increasing demand, tea is considered to be one of the major components of world beverage market.

The plantation crops are high value commercial crops of great economic importance and play a vital role in Indian economy. India was the second largest producer of tea in the world, grown in an area of about 563.98 thousand ha with a production of 1,233.14 million kg which was about 23% of total world production. About 80% of the production was consumed internally which was about 21% of the total world consumption. During the same period India exported 232.92 million kg and valued at US\$ 686.67 million and ranked fourth in terms of export of tea. The tea industry is India's second largest employer with over 3.5 million people across some 1,686 estates and 1,57,504 small holdings; most of them are women. In

West Bengal, tea was grown in an area of 140.44 thousand ha and production was about 312.10 million kg (IBEF, 2016). Over the last 20 years, India's world ranking as an exporter of tea has come down from number one to number four, in the face of stiff competition from Sri Lanka, Kenya, and China (Majumdar *et al.*, 2012). Main importing countries of Indian tea were Russian Federation (48.23 million kg), Iran (22.13 million kg) and Pakistan (19.37 million kg). Recent trends showed drastic reduction in tea exports from India, as the importing countries preferred residue free superior quality tea. Only one per cent of total tea produced in India is organic tea. However, organic tea constituted only two per cent of the total organic products exported from India during 2012-13 (FAO, 2014). United State Department of Agriculture (USDA) report on organic farming during 1980 defined, organic farming as a production system, which avoids or largely excludes the use of synthetically compounded fertilizers, pesticides, growth regulators and livestock additives. To the maximum extent feasible, organic farming system rely upon crop rotation, crop residues, animal manures, legumes, green manures, off farm organic wastes, mechanical cultivation, nutrient bearing rocks and aspects of biological pest control to maintain soil productivity and tilth, to supply plant nutrients and to control insects, weeds and other pests. This is the most

widely recognised alternative farming system in the modern era. An organic product is free from chemicals, antibiotics, synthetic hormones, genetic modifications and field use of sewage sludge as fertiliser. Organic cultivation is a sustainable way to combat climate change. Use of naturally available products, such as organic manure or compost, increases climate resilience. A minimum of three years is needed for an established conventional garden to be converted to organic, which has to be certified by a certifying agency. The problems for established tea gardens that wish to go organic are two fold, *i.e* yield drop up to an extent of 44 per cent and over 65 per cent increase in cost of production as compared to the conventional cultivation (Goswami, 2015; FAO, 2014). In India, the cultivation of organic tea started during 1986 and gradually spread to the tea areas of West Bengal, Assam and South India (Prayukth, 2005).

For establishment of organic tea plantation, the planting materials also have to be produced following organic methods. Tea nurseries generally use chemical inputs especially fertilizers and plant protection chemicals for production of planting materials which affect the physical and chemical properties of soil, leaves residues and disturb ecosystem. Therefore, inputs chosen for better planting material production also play key role to guarantee the desired crop performance and economic returns to the farmers. For producing planting materials of tea using nutrients in elemental forms and organic inputs like farm yard manure, vermicompost, biofertilizers and biopesticides. Biofertilizers are carrier based preparations containing beneficial microorganisms in a viable state. They improve soil fertility and help in plant growth by improving nutrient availability. Nitrogen fixers and phosphate solubilizers are naturally present in almost all soils but their population level may not be sufficient to bring out these biological processes to a significant level. Addition of efficient strains of these microorganisms was successfully practised in many crops (Pandya and Saraf, 2010). The use of biofertilizers and organic manure offer a great opportunity to increase the crop productivity with less cost. With this objective, experiments were conducted to find out the success of biofertilizers in an organic farming system. The beneficial microorganisms are generally applied through various carrier materials. Without carrier materials, the applied beneficial microorganisms will not survive for longer period. The carrier materials should have high organic matter content, high water holding capacity, neutral pH for better survival of the organisms. Various organic materials and agricultural wastes such as composted coir pith, lignite, organic manure, vermicompost and vermiculite were tested as carrier materials *in vitro* and field conditions to select the best ones. Selected strains were mass multiplied and conditions for mass multiplication were

standardized (Bhagyaraj and Suvarna, 1999). Tea is one of the important plantation crops of West Bengal, particularly North Bengal, known all over the world for the best quality. Most of the tea gardens follow conventional cultivation practices using various chemical inputs. Though, there are a few gardens cultivating tea organically but there are few reports on cultivation practices and more particularly production of planting materials. Keeping this in view the present investigation was conducted with the following objective to study the genotypic response of planting materials of tea to microbial bio-inoculation.

## Materials and Methods

For the present investigation, a temporary nursery was laid out in the instruction cum research plot of the Department of Plantation Crops and Processing, UBKV, Pundibari, during August, 2013. The details of various materials used and methods employed in the investigation have been presented below.

**Location and climate :** The experimental site was the instruction cum research plot of Department of Plantation Crops and Processing, UBKV, located at 26°19'86" N Latitude and 89° 23'53" E Longitude at an elevation of 43 m above mean sea level. Agroclimatologically, the location represents Terai region of West Bengal and is characterized by subtropical climate. The place experiences hot summers, hot and humid rainy season and cool winters. In the nursery, beds of size 1.2 m width and 13 m length were prepared in East-West direction with a drain of 30 cm in between the two beds. All the beds were covered using green coloured agronet (50% light transmittance) on all the sides, a height of 2.0 m on Northern side and 1.5 m on Southern side was maintained. For filling (black polythene) sleeves of size 20 x 30 cm, lay flat 250 gauge thickness, sealed at the bottom, punctured eight holes on the lower one-third, which can hold 2.5 kg soil. Top soil from the plantation area was collected dried, pulverized and sieved through an 8 mm mesh size of sieve. Similarly, FYM and VC were also dried, pulverized, sieved and heaped separately, then mixed with the soil at required rates. The experimental plot was situated at the experimental plot of the Department of Plantation Crops and Processing, UBKV, Pundibari. The experimental plot was laid out in shade net under young aged (6 years) arecanut garden in North South direction, the interspaces among the garden are utilized by preparing raised beds with proper drainage facilities in East-West direction. The polythene sleeves filled up with fine sieve soils and organic manures are kept systematically *i.e* treatment wise.

**Nursery sowings and transplanting :** Seeds were placed in aluminium trays containing 5-7 cm thick layer of

**Treatment details :**

| Treat-ments        | Treatment detail                                    | No. of plants |
|--------------------|-----------------------------------------------------|---------------|
| <b>Seed Stocks</b> |                                                     |               |
| T <sub>1</sub>     | TS-462 + VC @ 50 g + Bio- inoculants #10 g          | 150           |
| T <sub>2</sub>     | TS-463 + VC @ 50 g + Bio-inoculants #10 g           | 150           |
| T <sub>3</sub>     | TS-491 + VC @ 50 g + Bio-inoculants #10 g           | 150           |
| T <sub>4</sub>     | TS-506 + VC @ 50 g + Bio-inoculants #10 g           | 150           |
| <b>Clones</b>      |                                                     |               |
| T <sub>1</sub>     | TV 26 + VC @ 50 g + Bio-inoculants #10 g            | 150           |
| T <sub>2</sub>     | TV 23 + VC @ 50 g + Bio-inoculants #10 g            | 150           |
| T <sub>3</sub>     | Teen Ali 17/1/54 + VC @ 50 g + Bio-inoculants #10 g | 150           |
| T <sub>4</sub>     | TV 9 + VC @ 50 g + Bio-inoculants #10 g             | 150           |

# (*Azotobacter* + *Azospirillum* + PSB\* + *Trichoderma* + VAM\*\* @ 2.0 g each)

\* phosphorous solubilising bacteria \*\*vesicular arbuscular mycorrhiza

sand then covered with fine shallow layer of sieved sand for proper cracking and then moisture provided at alternate days for proper sprouting and germination. It took 18 days to complete cracking and sprouting. Later on cracked seeds are sown at depth of 3-5 cm in polythene sleeves filled up with fine sieve soils and organic manures which are kept systematically *i.e* treatment wise.

**Cultural practices :** Irrigation- After transplanting once light irrigation was given for quick establishment of seedlings followed by pouring water whenever irrigation is required. Hoeing and weeding- The experimental beds and sleeves are kept free from weeds by hand weeding. Drainage channels around the raised beds are cleared at periodic intervals. Sometimes water accumulated in polythene sleeves are removed by puncturing with nail, which allow excess water to drain out. Pest and disease management- Incidence of pests were observed, to check the infestation of pests neem oil at a concentration of 0.1% was sprayed at monthly intervals. There was no incidence of disease during the period of experimentation.

**Experimental materials :** The experimental materials for the present investigation comprised of four biclonal seed stocks of tea *viz.*, TS-462, TS-463, TS-491, TS-506 released by Tocklai Experimental Station (Tocklai Tea Research Institute), Tea Research Association, Jorhat, Assam and the vegetative clones TV 9, TV 23, TV 26 and estate clone Teen Ali 17/1/54 released by TRA respectively. Details of seed stocks and clones chosen have been mentioned in Table-1.

Different organic nutrients sources such as farm yard manure (FYM) and vermicompost (VC) were collected from Directorate of Farms, UBKV, Pundibari and bio- inoculants such as *Azotobacter*, *Azospirillum*, Phosphate solubilising bacteria (PSB), *Trichoderma*, vesicular arbuscular mycorrhiza (VAM) were collected

from bio-control unit of the Department of Plant Pathology, UBKV, Pundibari. All other chemicals used during investigation for analysis of soil, FYM, VC and for microbial culture requisite chemicals with AR or GR grades were purchased from the authorized dealer of Hi-Media and Merck Mumbai, India located at Jalpaiguri, West Bengal.

The genotypes will be exposed to consortium of microbial bio-inoculants and the percentage advantage will be recorded in terms of morphological and physiological parameters. Numbers of seed stocks chosen are 4 *viz.*, TS-462, TS-463, TS-491, TS-506 and clones chosen 4 *viz.*, TV 26, TV 23, Teen Ali 17/1/54, TV 9. The treatment details are, total 4 treatments of different planting materials with 5 replications each and 150 sleeves per treatment taken. For statistical analysis complete randomized design is opted.

**Results and Discussion**

Various observations on genotypic response of four seed stocks *viz.*, TS-462, TS-463, TS-491 and TS-506 and four clones of tea *i.e.*, TV 9, TV 23, TV 26 and Teen Ali 17/1/54 to microbial bio inoculation with regard to morphological and physiological parameters have been recorded here.

**Plant height :** Observations recorded on plant height for all the planting materials chosen *i.e.*, four seed stocks and four clones from 120 to 480 DAS have been presented in Table-2. It is clear from table that, on 120 DAS maximum plant height of 11.65 cm was observed in the seedlings of Stock TS-491 followed by 11.35 cm in stock TS-506. In all other observations *i.e.*, on 210, 300, 390 and 480 DAS, TS-462 produced consistently maximum plant height (up to 72.93 cm) as compared to other seed stocks. Minimum height in all the observations was recorded in TS-506 (29.93 cm) on 480 DAS. In case of clones, Teen Ali 17/1/54 produced maximum plant height of 33.64, 38.25, 42.87, 73.27 on 210, 300, 390 and 480 DAT. Only on 120 DAT, TV 23 produced maximum plant height of 12.65 cm. In other observations *i.e.*, on 210, 300, 390 and 480 DAT, TV 23 plant height was minimum. Which reflected that the response of TV 23 to microbial bio inoculation along with vermicompost and soil was inferior than other clones *i.e.*, Teen Ali 17/1/54, TV 9 and TV 26. It can be concluded that genotypic responses to microbial bio inoculation were significant for all the four seed stocks and clones on height of the plants produced up to 480 days except in case of clones on 120 DAT.

**Number of leaves per plant :** Various observations recorded on number of leaves produced per plant for all the seed stocks *viz.*, TS-462, TS-463, TS-491, TS-506 and clones *i.e.*, TV 9, TV 23, TV 26 and Teen Ali 17/1/54 chosen have been presented in Table-3. It is clear from Table 03 that, on 120 DAS maximum number of 8.95

**Table-2 : Genotypic response of different tea seed stocks and clones to microbial bio-inoculation on plant height.**

|             | Plant height (cm) on DAS / DAT    |       |       |       |       |        |
|-------------|-----------------------------------|-------|-------|-------|-------|--------|
|             | Treatment                         | 120   | 210   | 300   | 390   | 480    |
| Seed stocks | T <sub>1</sub> (TS-462)           | 9.35  | 38.01 | 42.91 | 47.80 | 72.93  |
|             | T <sub>2</sub> (TS-463)           | 10.70 | 35.79 | 36.80 | 37.80 | 55.27  |
|             | T <sub>3</sub> (TS-491)           | 11.65 | 27.31 | 30.46 | 33.60 | 46.60  |
|             | T <sub>4</sub> (TS-506)           | 11.35 | 25.97 | 26.89 | 27.80 | 29.93  |
|             | SEm (±)                           | 0.404 | 1.651 | 1.425 | 2.105 | 4.361  |
|             | CD at (0.05)                      | 1.210 | 4.949 | 4.272 | 6.311 | 13.074 |
|             | CD at (0.01)                      | 1.667 | 6.819 | 5.886 | 8.695 | 18.014 |
| Clones      | T <sub>1</sub> (TV 26)            | 12.25 | 28.19 | 32.30 | 36.40 | 46.87  |
|             | T <sub>2</sub> (TV 23)            | 12.65 | 26.95 | 30.81 | 34.66 | 45.54  |
|             | T <sub>3</sub> (Teen Ali 17/1/54) | 12.10 | 33.64 | 38.25 | 42.87 | 73.27  |
|             | T <sub>4</sub> (TV 9)             | 12.40 | 29.89 | 32.68 | 35.47 | 48.87  |
|             | SEm (±)                           | 0.993 | 1.680 | 1.482 | 2.231 | 4.856  |
|             | CD at (0.05)                      | NS    | 5.035 | 4.443 | 6.688 | 14.558 |
|             | CD at (0.01)                      | 4.101 | 6.937 | 6.121 | 9.214 | 20.057 |

**Table-3 : Genotypic response of different tea seed stocks and clones to microbial bio-inoculation on number of leaves.**

|             | Number of leaves per plant on DAS / DAT |       |       |       |       |        |
|-------------|-----------------------------------------|-------|-------|-------|-------|--------|
|             | Treatment                               | 120   | 210   | 300   | 390   | 480    |
| Seed stocks | T <sub>1</sub> (TS-462)                 | 8.95  | 12.93 | 18.57 | 24.20 | 36.27  |
|             | T <sub>2</sub> (TS-463)                 | 6.80  | 8.40  | 11.03 | 13.67 | 21.73  |
|             | T <sub>3</sub> (TS-491)                 | 6.20  | 8.13  | 9.03  | 9.93  | 18.67  |
|             | T <sub>4</sub> (TS-506)                 | 7.65  | 8.74  | 11.13 | 13.53 | 24.20  |
|             | SEm (±)                                 | 0.659 | 0.989 | 1.274 | 2.379 | 2.693  |
|             | CD at (0.05)                            | 1.975 | 2.966 | 3.818 | 7.132 | 8.073  |
|             | CD at (0.01)                            | 2.721 | 4.086 | 5.261 | 9.826 | 11.123 |
| Clones      | T <sub>1</sub> (TV 26)                  | 4.35  | 10.40 | 12.83 | 15.27 | 16.34  |
|             | T <sub>2</sub> (TV 23)                  | 4.15  | 9.53  | 11.93 | 14.33 | 16.00  |
|             | T <sub>3</sub> (Teen Ali 17/1/54)       | 4.55  | 12.87 | 17.43 | 22.00 | 29.93  |
|             | T <sub>4</sub> (TV 9)                   | 4.40  | 11.40 | 13.93 | 16.47 | 16.80  |
|             | SEm (±)                                 | 0.350 | 0.711 | 0.967 | 1.646 | 1.765  |
|             | CD at (0.05)                            | NS    | 2.132 | 2.899 | 4.936 | 5.292  |
|             | CD at (0.01)                            | NS    | 2.937 | 3.995 | 6.800 | 7.292  |

leaves in case of TS-462 and minimum of 6.20 leaves were observed in TS-491. Similarly on 210, 300, 390 and 480 DAS also, maximum number of 12.93, 18.57, 24.20 and 36.27 leaves was recorded in tea seedlings of Stock TS-462. While, minimum number of 8.13, 9.03, 9.93 and 18.67 leaves were observed in stock TS-491. The seedlings of Stock TS-462 produced consistently maximum number leaves per plant (8.95 on 120 DAS to 36.27 leaves on 480 DAS), whereas, the seedlings of Stock TS-491, generally produced minimum number of leaves (6.20 to 18.67) on all the observations taken *i.e.*, on 120, 210, 300, 390 and 480 DAS.

The data revealed non significant differences among four clones chosen on 120 DAT for number of leaves per plant. However on 210, 300, 390 and 480 DAT, behaviour of the clones with respect to production of leaves varied significantly with maximum number of 12.87, 17.43, 22.00, 29.93 leaves was recorded from clone Teen Ali 17/1/54. On the other hand, minimum of 9.53, 11.93,

14.33 and 16.00 was observed in clone TV 23 on 210, 300, 390 and 480 DAT respectively. For the clones, Teen Ali 17/1/54 performed better producing 4.55 leaves on 120 DAS to 29.93 leaves on 480 DAS, while TV 23 produced minimum number of leaves in all the observation taken. Perusal of the data revealed that response to bio inoculation was observed to be best in case of TS-462 as compared to other three seed stocks. Least response in producing number of leaves per seedling was observed in seedlings of stock TS-491. Tea clone Teen Ali 17/1/54 out performed all other three clones namely TV 9, TV 23 and TV 26 in producing up to 29.93 leaves per cutting as a response to addition of vermicompost and biofertilizers with soil as potting mixture up to 480 days.

**Number of branches :** Various observations recorded on number of branches per plant for all the seed stocks and clones chosen have been presented in Table-4. It is clear from Table-4 that, on 120 DAS maximum number of 1.43

**Table-4 : Genotypic response of different tea seed stocks and clones to microbial bio-inoculation on number of branches.**

|              | Number of branches per plant on DAS / DAT |       |       |       |       |       |
|--------------|-------------------------------------------|-------|-------|-------|-------|-------|
|              | Treatment                                 | 120   | 210   | 300   | 390   | 480   |
| Seed stocks  | T <sub>1</sub> (TS-462)                   | 1.00  | 1.13  | 2.95  | 3.70  | 5.20  |
|              | T <sub>2</sub> (TS-463)                   | 1.00  | 1.38  | 1.75  | 2.60  | 3.70  |
|              | T <sub>3</sub> (TS-491)                   | 1.10  | 1.18  | 1.50  | 1.77  | 2.63  |
|              | T <sub>4</sub> (TS-506)                   | 1.43  | 1.67  | 1.77  | 2.20  | 2.80  |
| SEm (±)      |                                           | 0.096 | 0.348 | 0.352 | 0.498 | 0.649 |
| CD at (0.05) |                                           | NS    | NS    | 1.056 | 1.492 |       |
| CD at (0.01) |                                           | NS    | NS    | 1.455 | 2.055 |       |
| Clones       | T <sub>1</sub> (TV 26)                    | 0.00  | 1.00  | 2.43  | 3.47  | 3.67  |
|              | T <sub>2</sub> (TV 23)                    | 0.00  | 1.30  | 1.33  | 2.20  | 2.80  |
|              | T <sub>3</sub> (Teen Ali 17/1/54)         | 0.00  | 1.50  | 2.48  | 4.07  | 5.10  |
|              | T <sub>4</sub> (TV 9)                     | 0.00  | 2.00  | 2.33  | 3.20  | 5.03  |
| SEm (±)      |                                           | 0.00  | 0.229 | 0.232 | 0.351 | 0.760 |
| CD at (0.05) |                                           | 0.00  | NS    | 0.696 | 1.051 |       |
| CD at (0.01) |                                           | 0.00  | NS    | 0.959 | 1.448 |       |

**Table-5 : Genotypic response of different tea seed stocks and clones to microbial bio-inoculation on collar girth.**

| Collar girth (mm) of plant on DAS /DAT |                                   |       |       |       |       |       |
|----------------------------------------|-----------------------------------|-------|-------|-------|-------|-------|
|                                        | Treatment                         | 120   | 210   | 300   | 390   | 480   |
| Seed stocks                            | T <sub>1</sub> (TS-462)           | 4.49  | 11.56 | 13.52 | 15.48 | 18.99 |
|                                        | T <sub>2</sub> (TS-463)           | 4.54  | 10.22 | 12.33 | 14.45 | 17.75 |
|                                        | T <sub>3</sub> (TS-491)           | 4.10  | 9.91  | 11.46 | 13.01 | 16.31 |
|                                        | T <sub>4</sub> (TS-506)           | 4.40  | 9.50  | 11.15 | 12.80 | 14.04 |
| SEm (±)                                |                                   | 0.277 | 0.391 | 0.427 | 0.897 | 1.006 |
| CD at (0.05)                           |                                   | NS    | 1.172 | 1.282 | 2.689 | 3.017 |
| CD at (0.01)                           |                                   | NS    | 1.615 | 1.766 | 3.705 | 4.156 |
| Clones                                 | T <sub>1</sub> (TV 26)            | 3.99  | 9.16  | 11.18 | 13.21 | 14.66 |
|                                        | T <sub>2</sub> (TV 23)            | 4.75  | 9.43  | 12.04 | 14.66 | 17.34 |
|                                        | T <sub>3</sub> (Teen Ali 17/1/54) | 4.57  | 9.18  | 11.92 | 14.66 | 23.74 |
|                                        | T <sub>4</sub> (TV 9)             | 4.47  | 9.62  | 11.82 | 14.04 | 17.96 |
| SEm (±)                                |                                   | 0.165 | 0.259 | 0.236 | 0.426 | 1.379 |
| CD at (0.05)                           |                                   | 0.494 | NS    | 0.708 | 1.276 | 4.134 |
| CD at (0.01)                           |                                   | 0.681 | NS    | 0.976 | 1.758 | 5.695 |

branches was observed in tea seedlings of Stock TS-506 followed by 1.10 branches in TS-491. Minimum of only a branch was produced in case of both TS-462 and TS-463. On 210 DAS non significant variation with respect to number of branches produced was observed, on further observations *i.e.*, 300, 390 and 480 DAS maximum number of branches 2.95, 3.70 and 5.20 was recorded in stock TS-462 and minimum of 1.50, 1.77 and 2.63 was observed in seedlings of stock TS-491. In case of clones there were no branches up to 120 days. On 210 DAT the number of branches range from 1.00 (TV 26) to 2.00 (TV 9), which showed non significant variation. On 300, 390 and 480 DAT Teen Ali 17/1/54 produced consistently higher number of 2.48, 4.07 and 5.10 branches per plant while minimum of 1.33, 2.20 and 2.80 branches produced in clone TV 23. As a result of addition of biofertilizers namely *Azotobacter*, *PSB*, *Azospirillum*, *Trichoderma*, *VAM* along with soil and vermicompost enhanced the

production of branches in both seedlings and clones up to 480 days. Among the four seed stocks TS-462 performed better producing up to an average of 5.20 branches per seedlings and clone Teen Ali 17/1/54 also was at par on 480 days after sowing or transplanting.

**Collar girth of plant :** Various observations recorded on girth of plants at collar region for all the seed stocks and clones chosen have been presented in Table 05. It is evident from Table-5 that, initially on 120 DAS among the seedlings of stocks chosen *viz.*, TS-462, TS-463, TS-491 and TS-506 showed non significant variation. Later on, 210 DAS maximum plant girth of 11.56 mm for TS-462, 10.22 mm (TS-463), 9.91 (TS-491) and 9.50 mm for TS-506 was noticed. Similarly on 300, 390 and 480 DAS, maximum plant girth 13.52 mm, 15.48 mm, 18.99 mm was recorded in case of seedlings of Stock TS-462 respectively. Minimum girth of 11.15 mm, 12.80 mm and 14.04 mm on 300, 390 and 480 DAS was observed from

**Table-6 : Genotypic response of different tea seed stocks and clones to microbial bio-inoculation on fresh weight.**

| Fresh weight (g) of whole plant on DAS / DAT |                                   |       |       |       |       |       |
|----------------------------------------------|-----------------------------------|-------|-------|-------|-------|-------|
|                                              | Treatment                         | 120   | 210   | 300   | 390   | 480   |
| Seed stocks                                  | T <sub>1</sub> (TS-462)           | 3.69  | 10.35 | 18.00 | 25.64 | 37.45 |
|                                              | T <sub>2</sub> (TS-463)           | 2.80  | 7.33  | 8.79  | 10.25 | 28.57 |
|                                              | T <sub>3</sub> (TS-491)           | 2.54  | 6.11  | 8.07  | 10.03 | 20.88 |
|                                              | T <sub>4</sub> (TS-506)           | 3.66  | 8.68  | 12.12 | 15.54 | 31.86 |
|                                              | SEm ( $\pm$ )                     | 0.315 | 0.772 | 1.144 | 2.418 | 2.002 |
|                                              | CD at (0.05)                      | 0.943 | 2.314 | 3.429 | 7.249 | 6.001 |
| Clones                                       | CD at (0.01)                      | 1.299 | 3.188 | 4.724 | 9.987 | 8.268 |
|                                              | T <sub>1</sub> (TV 26)            | 2.77  | 5.42  | 7.06  | 8.69  | 12.65 |
|                                              | T <sub>2</sub> (TV 23)            | 3.84  | 6.52  | 9.59  | 12.65 | 17.10 |
|                                              | T <sub>3</sub> (Teen Ali 17/1/54) | 4.52  | 7.49  | 10.68 | 13.88 | 21.43 |
|                                              | T <sub>4</sub> (TV 9)             | 3.77  | 6.40  | 9.88  | 13.35 | 15.41 |
|                                              | SEm ( $\pm$ )                     | 0.370 | 0.334 | 0.747 | 1.325 | 1.092 |
| CD at (0.05)                                 |                                   | 1.109 | 1.002 | 2.239 | 3.973 | 3.275 |
| CD at (0.01)                                 |                                   | 1.527 | 1.380 | 3.084 | 5.475 | 4.512 |

**Table-7 : Genotypic response of different tea seed stocks and clones to microbial bio-inoculation on dry weight.**

| Dry weight (g) of plant on DAS / DAT |                                   |       |       |       |       |       |
|--------------------------------------|-----------------------------------|-------|-------|-------|-------|-------|
|                                      | Treatment                         | 120   | 210   | 300   | 390   | 480   |
| Seed stocks                          | T <sub>1</sub> (TS-462)           | 1.41  | 2.43  | 6.16  | 9.89  | 16.69 |
|                                      | T <sub>2</sub> (TS-463)           | 1.12  | 1.54  | 3.00  | 4.45  | 11.22 |
|                                      | T <sub>3</sub> (TS-491)           | 1.12  | 1.86  | 3.03  | 4.21  | 10.28 |
|                                      | T <sub>4</sub> (TS-506)           | 0.90  | 1.87  | 4.38  | 6.89  | 13.89 |
|                                      | SEm ( $\pm$ )                     | 0.100 | 0.277 | 0.587 | 1.080 | 1.186 |
|                                      | CD at (0.05)                      | 0.298 | 0.830 | 1.759 | 3.238 | 3.557 |
| Clones                               | CD at (0.01)                      | 0.411 | 1.143 | 2.424 | 4.461 | 4.900 |
|                                      | T <sub>1</sub> (TV 26)            | 0.72  | 1.84  | 2.80  | 3.76  | 5.75  |
|                                      | T <sub>2</sub> (TV 23)            | 1.63  | 2.83  | 4.19  | 5.55  | 9.06  |
|                                      | T <sub>3</sub> (Teen Ali 17/1/54) | 1.32  | 2.03  | 3.38  | 4.73  | 8.93  |
|                                      | T <sub>4</sub> (TV 9)             | 1.21  | 2.26  | 3.40  | 4.54  | 7.75  |
|                                      | SEm ( $\pm$ )                     | 0.105 | 0.136 | 0.220 | 0.382 | 0.409 |
| CD at (0.05)                         |                                   | 0.315 | 0.407 | 0.659 | 1.144 | 1.226 |
| CD at (0.01)                         |                                   | 0.434 | 0.560 | 0.908 | 1.576 | 1.690 |

stock TS-506. It can be concluded that with respect to girth at collar, TS-462 responded better than other seed stocks to microbial bio inoculation. From Table 05 it is evident that data on girth of plant for clones chosen at 120 DAT showed maximum of 4.75 mm in case of clone TV-23, followed by Teen Ali 17/1/54 (4.57 mm), TV 9 (4.47 mm) and TV 26 (3.99 mm) respectively. Observations on 210 DAT plant girth shows non significant variation among the treatments *i.e.*, clones chosen. At 300 DAT maximum girth (12.04 mm) at collar region was found in treatment (T<sub>2</sub>) for clone TV 23, Later on at 390 and 480 DAT, maximum plant girth (14.66 mm), (23.74mm) was recorded from clone Teen Ali 17/1/54 and minimum (13.21 mm), (14.66 mm) was observed in clone TV 26. So it can be concluded that among the clones chosen Teen Ali 17/1/54 performed better than others. So it is depicted from table that there were significant differences for plant girth at collar region among all the treatments *i.e.*, seed stocks and clones

chosen at all observations, except in seedling stocks at 120 DAS and in clonal plants at 210 DAT, which was observed to be non significant values.

**Fresh weight of plant :** Observations recorded on fresh weight for all the plants raised from seed stocks *viz.*, TS-462, TS-463, TS-491 and TS-506 and clones chosen *i.e.*, TV 9, TV 23, TV 26 and Teen Ali 17/1/54 have been presented in Table-6. It is clear from data that fresh weight per plant on 120 DAS, TS-462 and TS-506 responded similarly with a fresh weight of total plant 3.69 and 3.66 g respectively in general during all the observations up to 480 days. Seedlings of TS-462 showed higher values in comparison to other seed stocks. While minimum fresh weight ranging from 2.54 g (120 DAS) to 20.88 g (480 DAS) was observed in case of TS-491. Maximum fresh weight of seedlings (37.45 g) was recorded for the seedlings of TS-462 followed by 31.86 g per seedling in

**Table-8 : Genotypic response of different tea seed stocks and clones to microbial bio-inoculation on volume of plants.**

| Volume of root and shoot (cc) per plant on DAS /DAT |                                   |       |       |       |       |       |       |       |       |       |       |
|-----------------------------------------------------|-----------------------------------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Treatment                                           |                                   | 120   |       | 210   |       | 300   |       | 390   |       | 480   |       |
|                                                     |                                   | R     | S     | R     | S     | R     | S     | R     | S     | R     | S     |
| Seed stocks                                         | T <sub>1</sub> (TS-462)           | 1.38  | 3.37  | 2.84  | 6.96  | 4.88  | 11.93 | 6.90  | 16.91 | 8.45  | 20.68 |
|                                                     | T <sub>2</sub> (TS-463)           | 0.77  | 1.88  | 1.33  | 3.27  | 2.31  | 5.64  | 3.28  | 8.02  | 4.80  | 11.76 |
|                                                     | T <sub>3</sub> (TS-491)           | 0.78  | 1.92  | 1.70  | 4.15  | 2.59  | 6.34  | 3.48  | 8.52  | 4.41  | 10.81 |
|                                                     | T <sub>4</sub> (TS-506)           | 0.89  | 2.17  | 2.22  | 5.43  | 4.11  | 10.05 | 5.99  | 14.67 | 7.01  | 17.16 |
| SEm ( $\pm$ )                                       |                                   | 0.122 | 0.299 | 0.327 | 0.801 | 0.358 | 0.877 | 0.652 | 1.597 | 0.781 | 1.913 |
| CD at (0.05)                                        |                                   | 0.367 | 0.897 | 0.982 | 2.402 | 1.074 | 2.631 | 1.956 | 4.788 | 2.343 | 5.734 |
| CD at (0.01)                                        |                                   | 0.506 | 1.236 | 1.353 | 3.309 | 1.480 | 3.624 | 2.695 | 6.597 | 3.228 | 7.900 |
| Clones                                              | T <sub>1</sub> (TV 26)            | 0.86  | 2.73  | 1.60  | 5.07  | 2.33  | 7.38  | 3.06  | 9.68  | 4.26  | 13.48 |
|                                                     | T <sub>2</sub> (TV 23)            | 1.18  | 3.74  | 1.90  | 6.03  | 2.64  | 8.36  | 3.38  | 10.69 | 4.71  | 14.91 |
|                                                     | T <sub>3</sub> (Teen Ali 17/1/54) | 1.15  | 3.64  | 2.05  | 6.47  | 2.81  | 8.91  | 3.58  | 11.35 | 4.84  | 15.34 |
|                                                     | T <sub>4</sub> (TV 9)             | 1.06  | 3.35  | 1.83  | 5.79  | 2.37  | 7.50  | 2.91  | 9.22  | 5.29  | 16.74 |
| SEm ( $\pm$ )                                       |                                   | 0.038 | 0.121 | 0.045 | 0.144 | 0.356 | 1.126 | 0.708 | 2.242 | 0.731 | 2.315 |
| CD at (0.05)                                        |                                   | 0.115 | 0.363 | 0.135 | 0.431 | 1.067 | 3.377 | 2.123 | 6.722 | 2.191 | 6.941 |
| CD at (0.01)                                        |                                   | 0.159 | 0.500 | 0.186 | 0.594 | 1.470 | 4.653 | 2.924 | 9.262 | 3.019 | 9.563 |

**Table-9 : Genotypic response of different tea seed stocks and clones to microbial bio-inoculation on number of growing and dormant buds.**

| Number of Growing and dormant buds percentage per plant on DAS /DAT |                                   |        |       |       |       |       |       |       |       |       |       |
|---------------------------------------------------------------------|-----------------------------------|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| Treatment                                                           |                                   | 120    |       | 210   |       | 300   |       | 390   |       | 480   |       |
|                                                                     |                                   | GB     | DB    | GB    | DB    | GB    | DB    | GB    | DB    | GB    | DB    |
| Seed stocks                                                         | T <sub>1</sub> (TS-462)           | 63.33  | 36.67 | 46.33 | 53.67 | 30.91 | 69.09 | 17.33 | 82.67 | 85.33 | 14.67 |
|                                                                     | T <sub>2</sub> (TS-463)           | 40.00  | 60.00 | 88.33 | 11.67 | 45.24 | 54.76 | 22.33 | 77.67 | 83.67 | 16.33 |
|                                                                     | T <sub>3</sub> (TS-491)           | 50.00  | 50.00 | 93.33 | 6.67  | 43.81 | 56.19 | 5.00  | 95.00 | 96.00 | 4.00  |
|                                                                     | T <sub>4</sub> (TS-506)           | 60.00  | 40.00 | 90.00 | 10.00 | 57.57 | 42.43 | 35.67 | 64.33 | 81.00 | 19.00 |
| Clones                                                              | T <sub>1</sub> (TV 26)            | 100.00 | 0.00  | 85.00 | 15.00 | 27.05 | 72.95 | 3.33  | 96.67 | 87.62 | 12.38 |
|                                                                     | T <sub>2</sub> (TV 23)            | 80.00  | 20.00 | 50.00 | 50.00 | 43.24 | 56.76 | 39.67 | 60.33 | 96.67 | 3.33  |
|                                                                     | T <sub>3</sub> (Teen Ali 17/1/54) | 100.00 | 0.00  | 61.67 | 38.33 | 55.40 | 44.60 | 51.00 | 49.00 | 96.00 | 4.00  |
|                                                                     | T <sub>4</sub> (TV 9)             | 100.00 | 0.00  | 88.33 | 11.67 | 36.71 | 63.29 | 2.86  | 97.14 | 96.67 | 3.33  |

TS-506. Statistical analysis on genotypic response of microbial bio inoculation to planting material showed significant variation among the seed stocks. From table 06, it's clearly indicated that for clones chosen, Teen Ali 17/1/54 produced maximum fresh weight of 4.52 g on 120 DAT. While minimum was recorded as 2.77 g under clone TV26. Similarly on 210, 300, 390 and 480 DAT maximum fresh weight of 7.49 g, 10.68 g, 13.88 g, 21.43 g was recorded from clone Teen Ali 17/1/54 and minimum 5.42 g, 7.06 g, 8.69 g and 12.65 g was observed in clone TV 26. Overall it is concluded that maximum fresh weight was reported from clone Teen Ali 17/1/54 and minimum from TV 26 among clones chosen at all observations. The data in Table 06 revealed that there were significant differences for fresh weight per plant among all the treatments *i.e.*, for both seed stocks and clones chosen at all observations.

**Dry weight of plants :** Various observations recorded on dry weight for all the seed stocks and clones chosen have been presented in Table 07. It is clear from data that dry weight per plant, TS-462 produced maximum dry weight of

1.41 g on 120 DAT, While minimum was recorded as 0.90 g under seed stock TS-506. Similarly on 210, 300, 390 and 480 DAT maximum dry weight of 2.43 g, 6.16 g, 9.89 g, 16.69 g was recorded from seed stock TS-462 and minimum 1.54 g, 3.00 g was observed in seed stock TS-463 on 210 and 300 DAS. While on final observations minimum dry weight 4.21 g and 10.28 g reported from TS-491 on 390 and 480 days after sowing respectively. Overall it is concluded that maximum dry weight was reported from seed stock TS-462 and minimum varied from time to time out of all observations. It is evident from table that for clones chosen, TV 23 produced maximum dry weight of 1.63 g on 120 DAT, While minimum was recorded as 0.72 g under clone TV26. Similarly on 210, 300, 390 and 480 DAT maximum dry weight of 2.83 g, 4.19 g, 5.55 g, 9.06 g was recorded from clone TV 23 and minimum 1.84 g, 2.80 g, 3.76 g and 5.75 g was observed in clone TV 26. Overall it is concluded that maximum dry weight was reported from clone TV 23 and minimum from TV 26 among clones chosen at all observations.

**Table-10 : Genotypic response of different tea seed stocks and clones to microbial bio-inoculation on length weight and volume of two leaf and a bud per plant.**

| Length(cm) Weight(g) and Volume(cc) of two leaf and a bud per plant on DAS / DAT |                                   |         |       |       |         |       |       |         |       |       |         |       |       |         |       |       |
|----------------------------------------------------------------------------------|-----------------------------------|---------|-------|-------|---------|-------|-------|---------|-------|-------|---------|-------|-------|---------|-------|-------|
|                                                                                  | Treatment                         | 120 DAT |       |       | 210 DAT |       |       | 300 DAT |       |       | 390 DAT |       |       | 480 DAT |       |       |
|                                                                                  |                                   | L       | W     | V     | L       | W     | V     | L       | W     | V     | L       | W     | V     | L       | W     | V     |
| Seed stocks                                                                      | T <sub>1</sub> (TS-462)           | 3.82    | 0.36  | 1.17  | 3.77    | 0.44  | 1.14  | 3.85    | 0.52  | 1.25  | 3.93    | 0.59  | 1.36  | 4.11    | 0.25  | 1.36  |
|                                                                                  | T <sub>2</sub> (TS-463)           | 3.30    | 0.24  | 1.04  | 2.75    | 0.21  | 1.15  | 3.35    | 0.40  | 1.21  | 3.94    | 0.59  | 1.28  | 4.11    | 0.25  | 1.28  |
|                                                                                  | T <sub>3</sub> (TS-491)           | 3.55    | 0.38  | 1.00  | 3.52    | 0.27  | 1.16  | 3.54    | 0.49  | 1.26  | 3.55    | 0.71  | 1.36  | 3.85    | 0.25  | 1.36  |
|                                                                                  | T <sub>4</sub> (TS-506)           | 3.51    | 0.46  | 0.96  | 4.91    | 0.20  | 1.22  | 4.60    | 0.38  | 1.33  | 4.28    | 0.56  | 1.45  | 3.97    | 0.28  | 1.45  |
| SEm (±)                                                                          |                                   | 0.028   | 0.016 | 0.040 | 0.020   | 0.015 | 0.038 | 0.026   | 0.011 | 0.036 | 0.049   | 0.016 | 0.066 | 0.028   | 0.020 | 0.066 |
| CD at (0.05)                                                                     |                                   | 0.084   | 0.049 | 0.121 | 0.060   | 0.046 | 0.114 | 0.078   | 0.032 | 0.106 | 0.146   | 0.048 | 0.198 | 0.085   | 0.061 | 0.198 |
| CD at (0.01)                                                                     |                                   | 0.115   | 0.067 | 0.167 | 0.083   | 0.064 | 0.157 | 0.201   | 0.066 | 0.273 | 0.117   | 0.084 | 0.273 | 0.168   | 0.129 | 0.291 |
| Clones                                                                           | T <sub>1</sub> (TV 26)            | 4.20    | 0.18  | 0.93  | 3.51    | 0.28  | 1.21  | 3.12    | 0.41  | 1.35  | 2.72    | 0.55  | 1.49  | 4.60    | 0.25  | 1.49  |
|                                                                                  | T <sub>2</sub> (TV 23)            | 3.93    | 0.21  | 0.96  | 3.76    | 0.45  | 1.14  | 3.80    | 0.40  | 1.23  | 3.84    | 0.35  | 1.31  | 3.71    | 0.17  | 1.22  |
|                                                                                  | T <sub>3</sub> (Teen Ali 17/1/54) | 3.58    | 0.19  | 0.93  | 3.32    | 0.22  | 0.96  | 3.54    | 0.27  | 1.09  | 3.75    | 0.31  | 1.22  | 4.31    | 0.21  | 1.10  |
|                                                                                  | T <sub>4</sub> (TV 9)             | 4.22    | 0.24  | 0.97  | 3.85    | 0.25  | 0.96  | 3.38    | 0.37  | 1.08  | 2.91    | 0.49  | 1.19  | 4.40    | 0.23  | 0.95  |
| SEm (±)                                                                          |                                   | 0.145   | 0.020 | 0.026 | 0.041   | 0.018 | 0.033 | 0.029   | 0.017 | 0.027 | 0.029   | 0.025 | 0.044 | 0.024   | 0.020 | 0.071 |
| CD at (0.05)                                                                     |                                   | 0.435   | 0.060 | 0.078 | 0.124   | 0.054 | 0.098 | 0.088   | 0.051 | 0.081 | 0.088   | 0.076 | 0.131 | 0.071   | 0.060 | 0.213 |
| CD at (0.01)                                                                     |                                   | 0.599   | 0.082 | 0.108 | 0.171   | 0.075 | 0.136 | 0.121   | 0.070 | 0.111 | 0.121   | 0.104 | 0.180 | 0.098   | 0.083 | 0.293 |

**Table-11 : Genotypic response of different tea seed stocks and clones to microbial bio-inoculation on total chlorophyll content.**

| Total chlorophyll content (SPAD units) of leaf on DAS / DAT |                                   |       |       |       |       |       |
|-------------------------------------------------------------|-----------------------------------|-------|-------|-------|-------|-------|
|                                                             | Treatment                         | 120   | 210   | 300   | 390   | 480   |
| Seed stocks                                                 | T <sub>1</sub> (TS-462)           | 29.11 | 40.56 | 43.44 | 46.33 | 48.87 |
|                                                             | T <sub>2</sub> (TS-463)           | 24.58 | 37.55 | 41.30 | 45.05 | 47.53 |
|                                                             | T <sub>3</sub> (TS-491)           | 22.42 | 35.25 | 40.55 | 45.85 | 44.07 |
|                                                             | T <sub>4</sub> (TS-506)           | 21.80 | 34.97 | 37.81 | 40.65 | 42.53 |
| SEm (±)                                                     |                                   | 1.205 | 1.847 | 1.465 | 2.392 | 1.715 |
| CD at (0.05)                                                |                                   | 3.612 | 5.536 | 4.391 | 7.172 | 5.141 |
| CD at (0.01)                                                |                                   | 4.977 | 7.628 | 6.050 | 9.882 | 7.084 |
| Clones                                                      | T <sub>1</sub> (TV 26)            | 21.26 | 46.51 | 51.45 | 56.38 | 62.13 |
|                                                             | T <sub>2</sub> (TV 23)            | 30.01 | 52.89 | 54.16 | 55.42 | 55.70 |
|                                                             | T <sub>3</sub> (Teen Ali 17/1/54) | 27.04 | 59.99 | 60.43 | 60.87 | 61.25 |
|                                                             | T <sub>4</sub> (TV 9)             | 25.18 | 54.96 | 55.34 | 55.71 | 58.59 |
| SEm (±)                                                     |                                   | 1.761 | 2.213 | 1.195 | 1.863 | 2.276 |
| CD at (0.05)                                                |                                   | 5.280 | 6.634 | 3.584 | 5.586 | 6.824 |
| CD at (0.01)                                                |                                   | 7.275 | 9.140 | 4.938 | 7.696 | 9.402 |

The data in Table 07 revealed that there were significant differences for dry weight per plant among all the treatments *i.e.*, for both seed stocks and clones chosen at all observations.

**Volume of root and shoot of plant :** Various observations recorded on volume of root and shoot for all the seedlings of stocks and clones chosen have been presented in Table 08. It is clear from Table-8 that, in case of seedlings of stock TS-462 (T<sub>1</sub>) total volume of root and shoot showed consistently higher values. Maximum volume of root were observed to be 1.38 cc, 2.84 cc, 4.88 cc, 6.90 cc and 8.45 cc on 120, 210, 300, 390 and 480 DAS respectively. While, minimum volume of root was

observed to be in treatment T<sub>2</sub> (TS-463), respective volumes recorded were 0.77 cc, 1.33 cc, 2.31 cc and 3.28 cc on 120, 210, 300 and 390 DAS. On 480 DAS minimum volume of root 4.41 cc were observed from treatment T<sub>3</sub> (TS-491). In case of shoot, maximum volume were observed to be 3.37 cc, 6.96 cc, 11.93 cc, 16.91 cc and 20.68 cc in seedlings of stock TS-462 and minimum volume of 1.88 cc, 3.27 cc, 5.64 cc, 8.02 cc were reported from stock TS-463 on 120, 210, 300 and 390 DAS respectively. On final observation *i.e.*, 480 DAS minimum volume of shoot 10.81 cc was found in TS-491. As observed in case of seedlings, in almost all the observations the clonal plants also showed consistently

**Table-12 : Genotypic response of different tea seed stocks and clones to microbial bio-inoculation on phosphatase activity of plants.**

| Phosphatase activity (( $\mu$ g p-nitrophenol released/g soil/hr) of soil on DAS/DAT |                                   |        |        |        |        |        |
|--------------------------------------------------------------------------------------|-----------------------------------|--------|--------|--------|--------|--------|
|                                                                                      | Treatment                         | 120    | 210    | 300    | 390    | 480    |
| Seed stocks                                                                          | T <sub>1</sub> (TS-462)           | 109.41 | 123.74 | 125.65 | 127.56 | 127.34 |
|                                                                                      | T <sub>2</sub> (TS-463)           | 108.14 | 118.71 | 126.40 | 134.09 | 139.73 |
|                                                                                      | T <sub>3</sub> (TS-491)           | 114.34 | 129.05 | 130.33 | 131.60 | 142.33 |
|                                                                                      | T <sub>4</sub> (TS-506)           | 111.41 | 120.81 | 128.47 | 136.13 | 134.09 |
|                                                                                      | SEm ( $\pm$ )                     | 8.360  | 15.368 | 8.615  | 5.633  | 7.397  |
|                                                                                      | CD at (0.05)                      | 25.065 | 46.072 | 25.828 | 16.887 | 22.177 |
|                                                                                      | CD at (0.01)                      | 34.534 | 63.477 | 35.586 | 23.267 | 30.555 |
| Clones                                                                               | T <sub>1</sub> (TV 26)            | 39.55  | 35.23  | 43.14  | 51.05  | 62.12  |
|                                                                                      | T <sub>2</sub> (TV 23)            | 44.36  | 53.60  | 58.96  | 64.33  | 62.67  |
|                                                                                      | T <sub>3</sub> (Teen Ali 17/1/54) | 40.76  | 53.43  | 53.51  | 53.60  | 59.24  |
|                                                                                      | T <sub>4</sub> (TV 9)             | 40.76  | 51.16  | 56.67  | 62.17  | 58.91  |
|                                                                                      | SEm ( $\pm$ )                     | 4.282  | 8.537  | 6.261  | 8.155  | 4.794  |
|                                                                                      | CD at (0.05)                      | 12.837 | 25.595 | 18.769 | 24.449 | 14.373 |
|                                                                                      | CD at (0.01)                      | 17.687 | 35.264 | 25.860 | 33.685 | 19.803 |

**Table-13 : Genotypic response of different tea seed stocks and clones to microbial bio-inoculation on dehydrogenase activity of plants.**

| Dehydrogenase activity ( $\mu$ g TPF g/soil/day) of soil on DAS/DAT |                                   |       |       |       |       |       |
|---------------------------------------------------------------------|-----------------------------------|-------|-------|-------|-------|-------|
|                                                                     | Treatment                         | 120   | 210   | 300   | 390   | 480   |
| Seed stocks                                                         | T <sub>1</sub> (TS-462)           | 14.08 | 21.12 | 20.07 | 19.06 | 15.25 |
|                                                                     | T <sub>2</sub> (TS-463)           | 12.51 | 18.76 | 17.82 | 16.93 | 13.54 |
|                                                                     | T <sub>3</sub> (TS-491)           | 13.31 | 19.96 | 18.96 | 18.01 | 14.41 |
|                                                                     | T <sub>4</sub> (TS-506)           | 12.63 | 18.76 | 17.82 | 16.93 | 13.54 |
|                                                                     | SEm ( $\pm$ )                     | 0.718 | 1.099 | 1.044 | 0.991 | 0.794 |
|                                                                     | CD at (0.05)                      | 2.153 | 3.293 | 3.129 | 2.972 | 2.380 |
|                                                                     | CD at (0.01)                      | 2.966 | 4.538 | 4.311 | 4.094 | 3.278 |
| Clones                                                              | T <sub>1</sub> (TV 26)            | 5.94  | 8.90  | 8.46  | 8.04  | 6.43  |
|                                                                     | T <sub>2</sub> (TV 23)            | 4.44  | 6.66  | 6.32  | 6.01  | 4.81  |
|                                                                     | T <sub>3</sub> (Teen Ali 17/1/54) | 4.40  | 6.60  | 6.27  | 5.95  | 4.76  |
|                                                                     | T <sub>4</sub> (TV 9)             | 4.63  | 6.94  | 6.59  | 6.26  | 5.01  |
|                                                                     | SEm ( $\pm$ )                     | 0.861 | 1.292 | 1.227 | 1.166 | 0.932 |
|                                                                     | CD at (0.05)                      | 2.581 | 3.872 | 3.678 | 3.494 | 2.795 |
|                                                                     | CD at (0.01)                      | 2.581 | 5.335 | 5.068 | 4.814 | 3.852 |

maximum volume for both root and shoot under treatment T<sub>3</sub> (Teen Ali 17/1/54) and minimum volume under treatment T<sub>1</sub> (TV 26). On initial observation (120 DAT) maximum volume of root 1.18 cc reported from clone TV 23, Whereas on 210, 300 and 390 DAT maximum root volume 2.05 cc, 2.81 cc, 3.58 cc was reported from clone Teen Ali 17/1/54. On final observation *i.e.*, 480 DAT maximum volume of root 5.29 cc was found in TV 9. While minimum root volume 0.86 cc, 1.60 cc, 2.33 cc, and 4.26 cc was reported from clone TV 26 on all observations except 390 DAT, where TV 9 found minimum 2.91 cc. In case of shoot, maximum 3.74 cc (TV 23) on 120 DAT, 6.47 cc, 8.91 cc, 11.35 cc (Teen Ali 17/1/54) on 210, 300 and 390 DAT and on final observation 480 DAT maximum shoot volume 16.74 cc was reported from clone TV 9. Where as, minimum volume of 2.73cc, 5.07 cc, 7.38 cc

and 13.48 cc was observed on 120, 210, 300 and 480 DAT in (TV 26). On 390 DAT minimum root volume of 9.22 cc was reported clone TV 9. Statistical analyses of data on volume of root and shoot for seed stocks and clones depicted that significant variations were observed on various observations on different ages of plants ranging from 120 to 480 DAS/DAT and various treatments T<sub>1</sub> to T<sub>4</sub>.

**Nature of buds :** Various observations recorded on nature of buds- growing and dormant per plant for all the plantlets raised from stocks and clones chosen have been presented in Table-9. It was observed that percentage of growing and dormant bud varied significantly depending on the genetic constituents of various seed socks in response to the growing media from 120 to 480 DAS. TS-462 produced maximum of 63.33% during 120 DAS *i.e.*, April, 2014. However on 210 DAS 93.33 %age of

growing buds were observed in case of TS-491 on 210 DAS (July, 2014) during the same period on the other hand maximum dormant buds 53.67 percent was produced by the seedlings of TS-462. During October 2014 *i.e.*, on 300 DAS TS-506 produced maximum number of growing bud (57.57%) and minimum 30.91% buds only growing type in case of TS-462. During January 2015 only 5.00% growing buds were observed in seed stock TS-491 while 95% of the buds were dormant on the same occasion maximum growing buds (35.67%) and corresponding 64.33 percent buds were observed to be dormant. On last observation during April, 2015 the response was observed to be the reverse as compared to January 2015 with a maximum of 96.00 % growing and 4.00% dormant buds in TS-491 closely followed by TS-462 (85.335), TS-463 (83.67%) and TS-506 (81.00%). From table-9 it's clearly indicated that for clones chosen, in similar passion to seed stocks the percentage of growing and dormant bud varied significantly depending on the genetic constituents of various clones in response to the growing media from 120 to 480 DAT. Initially all the clones chosen have 100% growing buds except on TV 23 (80.00%) during 120 DAT *i.e.*, April, 2014. However, on 210 DAT (July, 2014) 88.33 %ge of growing buds were observed in case of clone TV 9 during the same period on the other hand maximum dormant buds 50.00 percent was produced by the clones of TV 23. During October 2014 *i.e.*, on 300 DAT Teen Ali 17/1/54 produced maximum number of growing bud (55.40%) and minimum 27.05% buds only growing type in case of TV 26. During January 2015 only 3.33% growing buds were observed in clone TV 26 while 96.67% of the buds were dormant on the same occasion maximum growing buds (51.00%) and corresponding 49.00 percent buds were observed to be dormant in clone Teen Ali 17/1/54. On last observation during April, 2015 the response was observed to be the reverse as compared to January 2015 with a maximum of 96.00 % growing buds in all the clones chosen TV 23 (96.67%), TV 9 (96.76%) and Teen Ali 17/1/54 (96.00%) closely followed by TV 26 (85.335), and 3.33% dormant buds were observed in clones TV 23 and TV 9 followed by 4.00 and 12.38% in clones Teen Ali 17/1/54 and TV 26 respectively.

Statistical analyses of data on growing and dormant buds of seed stocks and clones chosen were not possible with any design. Hence we converted the data in to simple percentage and depicted that significant variations were observed on various observations on different ages of plants ranging from 120 to 480 DAS/DAT.

**Length, weight and volume of two leaves and a bud :** Various observations recorded on length, weight and volume of two leaf and a bud for all the seedlings of stocks and clones chosen have been presented in Table 10. It is

clear from Table 10 that in case of seedlings of stock TS-462 (T<sub>1</sub>) maximum length (3.82 g) and volume (1.17 cc) of two leaves and a bud was observed on 120 DAS. Where as maximum weight of 0.46 g incase of seedlings TS-506 on 120 DAS. Observations recorded on 210 DAS maximum length, weight and volume were (4.91 cm), (0.44 g) and (1.22 cc) respectively. similar pattern of observation were recorded on 300 and 390 DAS. On final observation 480 DAS, maximum length (4.11 cm) was recorded in seedlings of TS-462, where as maximum weight 0.028 g and volume (1.45 cc) respectively were recorded in the seedlings of TS-506. While minimum length of two leaves and bud was obtained in seedlings of stock TS-463 (3.30 cm, 2.75 and 3.35 cm) on 120, 210 and 300 DAS. Similarly minimum volume also obtained from same stock about (1.21 cc, 1.28 and 1.28 cc) on 300, 390 and 480 days after sowing. Where as minimum weight (0.20 g, 0.38 and 0.56 g) of two leaves and a bud found in stock TS-506. Over all it can be concluded that performance of stocks on length, weight and volume of two leaves and a bud parameter, seedlings of stock TS-506 performed better followed by TS-462, TS-491 and TS-463 respectively. From Table 10 it's clearly indicated that for clones chosen, on initial observation 120 days after transplanting clone TV 9 out performed than other clones about (4.22 cm, 0.24 g and 0.97 cc) of length, weight and volume of two leaves and a bud. On 300 and 390 DAT maximum weight and volume (0.41 g, 1.35 cc and 0.55 g, 1.49 cc) was obtained from clone TV 26. Similarly maximum length, weight and volume (4.60 cm, 0.25 g and 1.49 cc) reported from same clone on 480 DAT respectively. While minimum length, weight and volume (3.58 cm, 0.19 g, 0.93 cc and 3.32 cm, 0.22 g, 0.96 cc) of two leaves and a bud reported from clone Teen Ali 17/1/54 on 120 and 210 DAT. Over all it can be concluded that performance of clones chosen on length, weight and volume of two leaves and a bud parameter clone TV 26 performed better followed by TV 9, TV 23 and Teen Ali 17/1/54 respectively.

**Total leaf chlorophyll :** Various observations recorded on total chlorophyll content in leaves for all the planting materials chosen *i.e.*, four seed stocks and four clones to study the genotypic response to microbial bio inoculation from 120 to 480 DAS/DAT have been presented in Table 11. Among the seed stocks, the leaves of the seedlings of TS-462 and TS-506 showed consistently maximum and minimum chlorophyll content, respectively. Respective chlorophyll content in case of TS-462 ranged from 29.11 SPAD units on 120 DAS to 48.87 SPAD units on 480 DAS. Whereas, the seedlings of Stock TS-506 minimum chlorophyll content ranged from 21.80 SPAD units (on 120 DAS) to 42.53 SPAD units (on 480 DAS). Other two seed stocks *viz.*, TS- 463 and TS- 491 had moderate values in

all the observations without much variation. However, in case of clones, there were no consistent values over the age of the plants up to 480 DAT. On 120 DAT, TV-23 showed maximum of 30.01 SPAD units followed by Teen Ali 17/1/54 (27.04), TV 9 (25.18) and TV 26 with a minimum of 21.26 SPAD units respectively. On 210 DAT, maximum chlorophyll content (59.99 SPAD units) was recorded in clone Teen Ali 17/1/54 and minimum 46.51 was observed in clone TV 26. Observations recorded on 390 DAT for total chlorophyll showed non-significant variation among the clones chosen. So it can be said that among the clones chosen Teen Ali 17/1/54 performed better than others and generally clonal plants had higher total chlorophyll content than seedlings.

**Phosphatase activity of plant :** Various observations recorded on phosphatase activity of soil for all the seedlings of stocks and clones chosen have been presented in Table-12. It is clear from Table-12 that, on 120 and 210 DAS maximum phosphatase activity of soils 114.34, 129.05  $\mu\text{g/g/hr}$  in seed stock TS-491 and minimum of 108.14, 118.71  $\mu\text{g/g/hr}$  were observed in TS-463. Later on 300 and 480 DAS maximum activity of 130.33 and 142.33  $\mu\text{g/g/hr}$  was recorded in tea seedlings of Stock TS-491, with slight variation on 390 DAS, 136.13  $\mu\text{g/g/hr}$  was reported from stock TS-506. While, minimum 125.65, 127.56 and 127.34  $\mu\text{g/g/hr}$  phosphatase activity was observed in stock TS-462. The seedlings of Stock TS-491 produced consistently maximum phosphatase activity 114.34 to 142.33  $\mu\text{g/g/hr}$  on 120 to 480 DAS respectively.

Whereas, on initial observations *i.e.*, on 120, 210 the seedlings of Stock TS-463 produced minimum phosphatase activity but later on 300, 390 and 480 DAS Stock TS-462 observed minimum. Overall it is concluded that there no much significant variation among the stocks chosen for experiment. The data revealed non significant differences among four stocks chosen in all observations. Similarly, in case of clones also the data revealed non significant differences among four clones chosen on all observations for phosphatase activity. However on 120, 210, 300 390 and 480 DAT, maximum 44.36, 53.60, 58.96, 64.33 and 62.67  $\mu\text{g/g/hr}$  phosphatase activity was reported from clone TV 23 where as minimum 39.55, 35.23, 43.14 and 51.05  $\mu\text{g/g/hr}$  activity was found in clone TV 26. On final observation *i.e.*, 480 DAT clone TV 9 reported minimum (58.91  $\mu\text{g/g/hr.}$ ) phosphatase activity. Perusal of the data revealed that response to bio inoculation was observed to be best in case of TS-491 as compared to other three seed stocks. Least response was observed in seedlings of stock TS-462. Tea clone TV23 out performed all other three clones namely TV 9, Teen Ali (17/1/54) and TV 26 in producing maximum phosphatase activity. Overall it is concluded that there is

not much significant variation in phosphatase activity among the treatments for all stocks and clones chosen.

**Dehydrogenase activity of plant :** Various observations recorded on dehydrogenase activity for all the seedlings of stocks and clones to microbial bio inoculation have been presented in Table 13. It is evident from the table that in seedlings of stock TS-462 maximum dehydrogenase activity observed ranging from 14.08 to 15.25  $\mu\text{g/g/day}$  on 120 to 480 days after sowing respectively. While minimum dehydrogenase activity 12.51 to 13.54  $\mu\text{g/g/day}$  was reported from treatment ( $T_2$ ) TS-463, similar readings were also found in seed stock TS-506. Whereas intermediate range of activity found in seed stock TS-491. Overall it can be said there is no significant variation observed between seed stocks chosen for study. The perusal of data given in Table 4.03.12 indicate that clone TV 26 showed maximum dehydrogenase activity ranging from 6.06 to 6.43  $\mu\text{g/g/day}$  on 120 to 480 DAT followed by TV 9 and TV 23 treatments. Where as, minimum dehydrogenase activity ranging from 4.40 to 4.76  $\mu\text{g/g/hr}$  on 120 to 480 days after transplanting respectively were reported from clone Teen Ali 17/1/54. In general, it is concluded that seed stock expressed more dehydrogenase activity than clone.

Data from the table on dehydrogenase activity depicted that non significant differences were observed for both seed stocks and clones chosen at all observations taken *i.e.*, 120, 210, 300, 390 and 480 days after transplanting respectively.

The present investigation on genotypic response of microbial bio inoculation to planting material showed significant variation among the seed stocks. Genotypic responses to microbial bio-inoculation were significant for all the four seed stocks and clones on height, girth at collar, fresh weight, volume of root and shoot, branches in both seedlings and clones of the plants produced up to 480 days. TV 23 produced maximum dry weight, while minimum was recorded in clone TV26 enhanced the production of up to 480 days. Response to bio inoculation was observed to be best in case of TS-462 and least response in case of TS-491. Tea clone Tinali out performed other three clones *viz.*, TV 9, TV 23 and TV 26 in producing more number of leaves per cutting as a response to addition of vermicompost and bio fertilizers with soil as potting mixture up to 480 days. Response to bio inoculation was observed to be best in case of TS-491 as compared to other three seed stocks. Least response was observed in seedlings of stock TS-462. Tea clone TV23 out performed all other three clones namely TV 9, Tinali and TV 26 in producing maximum phosphatase activity. Overall it is concluded that there is not much significant variation in phosphatase activity among the treatments for all stocks and clones chosen. TV 26

showed maximum dehydrogenase activity followed by TV 9 and TV 23. Whereas, minimum dehydrogenase activity was observed in Tinali. In general, seed stocks expressed more dehydrogenase activity than clone. Seedling tea bushes acquire much higher C and NPK nutrient stocks with age than clonal bushes. This may enable seedling plantations to depend less on limiting nutrient(s) supply under adverse conditions, *i.e.* drought. Additions of tea prunings in incubated soils caused immobilization of N and lowered the net N-mineralization compared to the forest soil, but the differences were relatively small and unlikely to cause degradation of the ageing tea plantations. The plantations are characterized by differences in age and genotypes of seedling or clonal cuttings (Kamau, 2008). The effect of plant genotype (seedlings or a clonal cultivar) on productivity was greater than the effect of age. The genotypes to a great extent determined the yield response to N. Thus, planting improved genotypes and implementing appropriate Nitrogen management strategies are key factors to avoid the risk on decline of productivity and profitability associated with ageing and bush degradation. Nitrogen management strategies should be based on the yielding potential of tea bushes in the target environment as defined by plant genotype and age of plantations (Kamau *et al.*, 2008). Correlation studies indicated that the physiological parameters seem to be major contributing factors towards dry matter partitioning in tea. *Jats* or seed stocks shows no significant variation in dry matter partitioning was found among cultivars. However, clones showed significant variation in dry matter partitioning, particularly maintenance of leaf and stem (Rajkumar and Thomas, 2005).

## Conclusions

As our country giving emphasis on organic cultivation and moving towards a sustainable agriculture for bright future, fulfilling the gaps such as organic planting material production in concern to commercial crops like tea is necessary. Comparative study of four clones viz., TV 26, TV 23, Teen Ali 17/1/54, TV 9 and four seed stocks viz., TS-462, TS-463, TS-491, TS-506 respective of planting material to microbial inoculation revealed that seedlings performed better than the clones. Among the seed stocks chosen TS-462 responded better than other seed stocks.

While, in case of clones Teen Ali 17/1/54 performed better in soil with organic manures added with microbial combinations. Which was resulted in plantlets with morphological, production and partitioning of dry matter, bio chemical related parameters.

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## Integrated Plant Nutrient Management System for Mustard (*Brassica juncea* L.) Crop under Soil Test Crop Recommendation in Prayagraj Region

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### Abstract

To study integrated plant nutrient management system for mustard crop under soil test crop recommendation nine treatments were tested in three replicated randomized block design. It was found that significantly better growth attributes, yield attributes and seed yield (11.53 q ha<sup>-1</sup>) was recorded in T<sub>8</sub> [STCR(40:15:15 kg ha<sup>-1</sup>) + 5 t FYM + 50% S] and minimum seed yield was recorded as 9.33 q ha<sup>-1</sup> in T<sub>0</sub> [Control]. The application of [STCR (40:15:15 kg ha<sup>-1</sup>) + 5 t FYM + 50% S] was also found significantly higher gross income (Rs 45417) and net profit (Rs 13077) while minimum gross income (Rs 28988) and net profit (Rs 4188) was found in T<sub>0</sub> [Control]. While cost benefit ratio was significantly higher (1.40) with application of [STCR (40:15:15 kg ha<sup>-1</sup>) + 5 t FYM + 50% S].

**Key Words :** FYM, gross income, mustard (*Brassica juncea* L.), STCR, yield attributes.

### Introduction

Oilseeds occupy a prestigious place in Indian agriculture due to their vital role in the sustainable economy of the country. Vegetable oil (edible) plays a significant role in human nutrition. As a high energy component of food, edible oil is important for meeting the calorific requirements of human beings. Indian mustard is one of the most important winter oil seed crops. The production of mustard is not fully exploited due to the lack of proper information on its nutritional requirements.

Sulphur plays a vital role in the development of seed and improving the quality by increasing oil content, protein content and several fatty acids. Sulphur helps in chlorophyll formation and also encourages vegetative growth. It also helps in the reduction-oxidation reactions in the respiration. Zinc is an important constituent of several enzymes which regulates various metabolic processes in the plants and also influences the formation of several growth hormones like IAA in plants. Zinc stimulates the pod setting, seed formation and oil synthesis in the seeds of mustard and it increases the biological seed and Stover yield of mustard. (Dubey *et al.*, 2013).

India is amongst the largest vegetable oil economic in the world. The present average per capita consumption of oils and fats has not been more than 11g day<sup>-1</sup> as against the nutritional standard of 30g/day for a balanced diet. Mustard is rich in minerals like calcium, manganese, copper, iron, selenium, zinc, vitamin A, B, C and proteins. 100g mustard seed contains 508 kcal energy, 28.09Mg carbohydrates, 26.08g proteins, 36.24g total fat and 12.2g dietary fibre. (Upadhyay *et al.*, 2016).

India occupies the third position in mustard

production in World after China and Canada. In India, during 2009-2010, the mustard crop had production of about 6.40 mt. from an area of 6.45 m ha with an average productivity of 1184 kg ha<sup>-1</sup>. However, in U.P it is grown in 0.82 m ha with production of 0.90 mt. The average productivity in U.P is 1141 kg ha<sup>-1</sup>. (Yadav *et al.*, 2017).

However, the work done so far mainly included the generation of soil test based fertilizer requirement only under the condition of the application of chemical fertilizers. The required information under conditions of joint application of organic and inorganic is scanty in vegetables and spices crops. (Raghuveer *et al.*, 2017).

### Materials and Methods

The investigation on "Integrated plant nutrient management system for mustard crop under soil test crop recommendation in Prayagraj Region" comprise of a field experiment which was carried out at the Soil Science and Agricultural Chemistry Research Farm, Sam Higginbottom University of Agriculture, Technology and Sciences, Prayagraj during Rabi season 2018-19. It is situated at 25°24'23" N latitude, 81°50'38" Longitude and at the altitude of 98 meter above the sea level. The area of Prayagraj district comes under subtropical belt in the South east of Uttar Pradesh, which experience extremely hot summer and fairly cold winter. The maximum temperature of the location reaches up to 46°C – 48°C and seldom falls as low as 4°C–5°C. The relative humidity ranged between 20 to 94 percent. The recommended dose of fertilizer for Mustard is 80:40:40 kg N: P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O per hectare. The farmers practise dose pf fertilizer foe mustard is 50:30:30 kg N: P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O per hectare and the soil test crop response dose of fertilizer for mustard is

40:15:15 kg N: P<sub>2</sub>O<sub>5</sub>:K<sub>2</sub>O per hectare. The crop was harvested plot wise at maturity stage when the pods turned black, 70 days after sowing. Harvesting was done manually with the sickles.

### Treatment Combination

| S.N. | Symbol         | Description              |
|------|----------------|--------------------------|
| 1.   | T <sub>0</sub> | [Control]                |
| 2.   | T <sub>1</sub> | [RDF + 5 t FYM]          |
| 3.   | T <sub>2</sub> | [STL + 5 t FYM]          |
| 4.   | T <sub>3</sub> | [FP + 5 t FYM]           |
| 5.   | T <sub>4</sub> | [STCR + 5 t FYM]         |
| 6.   | T <sub>5</sub> | [RDF + 5 t FYM + 50% S]  |
| 7.   | T <sub>6</sub> | [STL + 5 t FYM + 50% S]  |
| 8.   | T <sub>7</sub> | [FP + 5 t FYM + 50% S]   |
| 9.   | T <sub>8</sub> | [STCR + 5 t FYM + 50% S] |

RDF-Recommended dose of fertilizers (80:40:40 kg ha<sup>-1</sup>)

STL-Soil Test Levels (80:28:28 kg ha<sup>-1</sup>)

FP-Farmer's Practice (50:30:30 kg ha<sup>-1</sup>)

STCR-Soil Test Crop Response (40:15:15 kg ha<sup>-1</sup>)

**Table-1 : Effect of gross income, net profit and cost benefit (C:B) ratio influenced by Different Treatment Combination with Mustard crop.**

| S. No.         | Treatment Combination                                                             | Gross Income (ha <sup>-1</sup> ) | Net profit (ha <sup>-1</sup> ) | Cost benefit ratio (C:B) |
|----------------|-----------------------------------------------------------------------------------|----------------------------------|--------------------------------|--------------------------|
| T <sub>0</sub> | Control                                                                           | 28988.00                         | 4188                           | 1.17                     |
| T <sub>1</sub> | N <sub>80</sub> P <sub>40</sub> K <sub>40</sub> kg/ha + 5tFYM/ha                  | 37727.00                         | 4259                           | 1.13                     |
| T <sub>2</sub> | N <sub>80</sub> P <sub>28</sub> K <sub>28</sub> kg/ha + 5tFYM/ha                  | 38887.00                         | 6102                           | 1.19                     |
| T <sub>3</sub> | N <sub>50</sub> P <sub>30</sub> K <sub>30</sub> kg + 5tFYM/ha                     | 37476.00                         | 5099                           | 1.16                     |
| T <sub>4</sub> | N <sub>40</sub> P <sub>15</sub> K <sub>15</sub> Kg/ha + 5t FYM/ha                 | 43847.00                         | 12497                          | 1.39                     |
| T <sub>5</sub> | N <sub>80</sub> P <sub>40</sub> K <sub>40</sub> S <sub>10</sub> kg /ha + 5tFYM/ha | 38266.00                         | 3808                           | 1.11                     |
| T <sub>6</sub> | N <sub>80</sub> P <sub>28</sub> K <sub>28</sub> S <sub>10</sub> kg /ha + 5tFYM/ha | 37838.00                         | 4063                           | 1.12                     |
| T <sub>7</sub> | N <sub>50</sub> P <sub>30</sub> K <sub>30</sub> S <sub>10</sub> kg + 5t FYM       | 38383.00                         | 5016                           | 1.15                     |
| T <sub>8</sub> | N <sub>40</sub> P <sub>15</sub> K <sub>15</sub> S <sub>10</sub> kg + 5t FYM       | 45417.00                         | 13077                          | 1.40                     |

## Results and Discussion

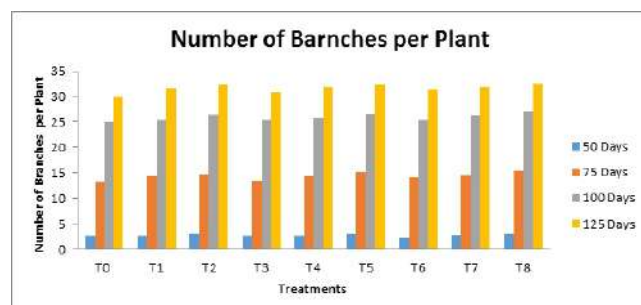
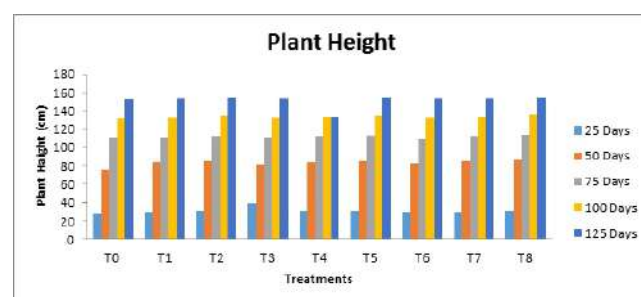
**Effect of different levels of fertilizer recommendation based on soil test values on Plant Height (cm) :** The data presented in figure clearly shows the response of plant height of Mustard recorded at 25 DAS, 50 DAS, 75 DAS, 100 DAS and 125 DAS as influenced by different levels of fertilizer recommendation based on soil test values. The maximum plant height was recorded as 31.00 cm, 86.13 cm, 114.27 cm, 134.38 cm and 154.53 cm in T<sub>8</sub> [STCR + @ 50 % FYM + @ 50 % S] at 25 DAS, 50 DAS, 75 DAS, 100 DAS and 125 DAS respectively and the minimum plant height was recorded as 28.53 cm, 75.60 cm, 110.33 cm, 132.00 cm and 152.20 cm in T<sub>0</sub> [control] at 25 DAS, 50 DAS, 75 DAS, 100 DAS and 125 DAS respectively. . Similar findings were reported by Bandani *et al.* (2014), Jat *et al.* (2012), Koushal and Singh (2011).

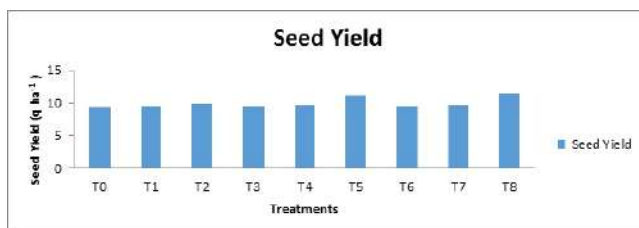
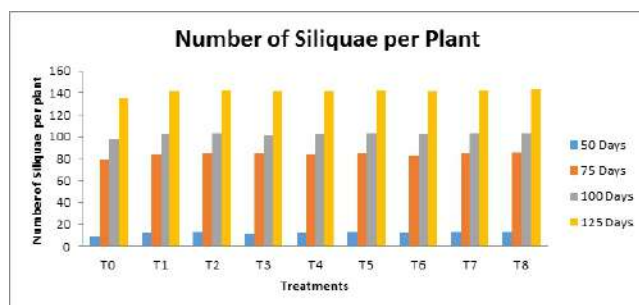
**Effect of different levels of fertilizer recommendation based on soil test values on Number of Branches per Plant :** The data presented figure clearly shows the response of number of branches per plant of Mustard recorded at 50 DAS, 75 DAS, 100 DAS and 125 DAS as influenced by different levels of fertilizer recommendation

based on soil test values. The maximum number of branches per plant was recorded as 2.27, 13.33, 25.07 and 30.80 in T<sub>8</sub> [STCR + @ 50 % FYM + @ 50 % S] at 50 DAS, 75 DAS, 100 DAS and 125 DAS respectively and the minimum number of branches per plant was recorded as 3.13, 15.40, 27.13 and 32.93 in T<sub>0</sub> [control] at 50 DAS, 75 DAS, 100 DAS and 125 DAS respectively. Similar findings were reported by Bandani *et al.* (2014), Jat *et al.* (2012), Koushal and Singh (2011).

**Effect of different levels of fertilizer recommendation based on soil test values on Number of Siliquae per Plant :** The data presented in figure clearly shows the response of number of siliquae per plant of Mustard recorded at 50 DAS, 75 DAS, 100 DAS and 125 DAS as influenced by different levels of fertilizer recommendation based on soil test values. The maximum number of siliquae per plant was recorded as 2.27, 13.33, 25.07 and

30.80 in T<sub>8</sub> [STCR + @ 50 % FYM + @ 50 % S] at 50 DAS, 75 DAS, 100 DAS and 125 DAS respectively and the





minimum number of siliquae per plant was recorded as 3.13, 15.40, 27.13 and 32.93 in T<sub>0</sub> [control] at 50 DAS, 75 DAS, 100 DAS and 125 DAS respectively. Similar findings were reported by Bandani *et al.* (2014), Jat *et al.* (2012), Koushal and Singh (2011).

**Effect of different levels of fertilizer recommendation based on soil test values on Seed Yield (q/ha) :** The data presented in figure clearly shows the response of Seed Yield of Mustard recorded as influenced by different levels of fertilizer recommendation based on soil test values. The maximum Seed Yield was recorded as 11.53 q ha<sup>-1</sup> in T<sub>8</sub> [STCR + @ 50 % FYM + @ 50 % S] and the minimum Seed Yield was recorded as 9.33 q ha<sup>-1</sup> in T<sub>0</sub> [control]. Similar findings were reported by Bandani *et al.* (2014), Jat *et al.* (2012), Koushal and Singh (2011).

## Conclusions

Among the treatments, STCR (T<sub>8</sub>) treatment, proved to be superior with respect to growth parameters *i.e.* plant height, number of branches per plant at all growth stages. Yield attributes *i.e.*, number of siliquae per plant, total seed yield shows highest in STCR (T<sub>8</sub>) over rest of the treatments. The gross return and net return were higher in STCR (T<sub>8</sub>) treatment over rest of the treatments. The B: C ratio was higher in modified STCR (T<sub>8</sub>).

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## Field Efficacy of Certain New Insecticides against Thrips in Mungbean

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### Abstract

A field experiment was conducted to evaluate the field bioefficacy of certain novel insecticides against thrips in greengram at RARS, Lam, Guntur, Andhra Pradesh. The new insecticides such as clothianidin 50 WDG @ 0.1 g/l, diafenthiuron 50 % WP @ 1.25 g/l, flonicamid 50 WP @ 0.3 g/l, spiromesifen 240% SC @ 1.25 ml/l, pyriproxyfen 10 EC @ 2.0 ml/l were found effective against thrips in greengram. However, the new insecticides were found on par with the most commonly used insecticides such as fipronil 5 SC @ 2.0 ml/l and thiamethoxam 25 WG @ 0.3 g/l against thrips in greengram. The per cent reduction in thrips population over untreated control was highest with clothianidin 50 WDG @ 0.1 g/l followed by diafenthiuron 50 % WP @ 1.25 g/l and flonicamid 50 WP @ 0.3 g/l.

**Key words :** Thrips, greengram, diafenthiuron, clothianidin, fipronil.

### Introduction

Mungbean (*Vigna radiata* (L.) Wilczek which is popularly known as greengram is an important legume crop widely grown in India and it occupies third place after chickpea with a total production of 2.51 m.t from an area of 4.58 m.ha with an average productivity of 548 kg/ha. Andhra Pradesh is one of the major greengram growing state in India with highest average productivity of 808 kg/ha (AICRP on MULLaRP, 2020). In Andhra Pradesh, it is grown through out the year, i.e as kharif crop, rabi crop both in uplands and rice fallows and also as summer crop. Mungbean contains about 51% carbohydrate, 26% protein, 4% mineral, 3% vitamins (Yadav *et al.*, 1994). Due to its more luxuriant vegetative growth, number of insects attack from seedling to harvesting stage which is detrimental factor for production and causing severe yield losses. Insect pests are responsible for 42% and 58% losses at pre-flowering and post-flowering stages, respectively of mung bean (Malik, 1992). Among the different biotic stresses, the sucking pests like aphid, *Aphis craccivora* Koch; jassid, *Empoasca kerri* Pruthi; whitefly, *Bemisia tabaci* Gennadius, thrips, *Thrips palmi* Karny and flower thrips, *Megalurothrips usitatus* Bagnall are known to cause significant damage to grain legume crops (Soundararajan *et al.*, 2013). During vegetative stage, thrips feed inside vegetative buds, rasp the top, unopened trifoliate leaves and suck plant juice oozing out of the plant part. In the initial blooming stage, male and female thrips randomly distributed within the flowers. Both larvae and adults feed on pollen and rasp other flower parts and suck the plant juice oozing out from the injured plant parts. As a result of this type of damage, flowers drop off and affects on pod formation. Thrips occur in every growing season and cause yield

losses through premature dropping of flowers. Thrips can cause at least 40 per cent yield loss in greengram, besides direct injury by feeding, thrips also act as vectors of different plant viruses that cause leaf curl and bud necrosis (Sreekanth *et al.*, 2003). Thrips populations are higher during the dry season, which favors rapid multiplication of thrips. So, it is necessary to control thrips in a safer and effective way at appropriate time to get higher yield of mungbean, hence some newer insecticides were evaluated against thrips in greengram.

### Materials and Methods

The field efficacy of certain new insecticides was evaluated at RARS, Lam Farm, Guntur for three consecutive seasons, i.e during Rabi 2018-19, 2019-20 and 2020-21. The most popularly grown variety in Andhra Pradesh, LGG 460 was selected as test variety and the seed was sown in plots each measuring 20 sq.m at 30 x 10 cm spacing. The crop was sown during second of November and harvested during first week of February during all the three seasons. A total of 8 insecticide treatments were evaluated along with one untreated control and each treatment was replicated thrice. The five new molecules belonging to different insecticidal groups were selected to evaluate their efficacy against thrips in greengram. The commonly used insecticides such as fipronil 5 SC @ 2.0 ml/l and thiamethoxam 25 WG @ 0.3 g/l were selected as standard insecticide checks along with seed treatment with imidacloprid 600 FS @ 5.0g/g seed and untreated control. The seed treatment with imidacloprid 600 FS @ 5.0 ml/kg seed was done commonly for all the treatments excluding untreated control. One spray was given at 30 DAS followed by second spray at 45 DAS using water volume of 500 liters per hectare. Observations were taken at one day before

spraying as pre treatment count, as well as at 3 and 7 days after each application from five randomly selected plants per plot. The thrips population was counted from three trifoliate leaves each one from top, middle and bottom canopies. The seed yield was recorded from net plot at the time of harvesting and then converted to hectare basis. The mean data thus obtained from two sprays during the three seasons regarding the pest incidence and yield was pooled and analyzed statistically by ANOVA after converting it to suitable transformed values.

The percentage reduction in the population of thrips over untreated check in different treatments was computed using the modified Abbot's formula (Fleming and Retnakaran, 1985) as given below.

## Results and Discussion

The field efficacy of certain novel insecticides against sucking pests was evaluated in mungbean. The pretreatment count of thrips ranged from 6.24 to 6.60 nos/3 leaves among the different treatments without any significant differences, indicating the uniform distribution of thrips among the experimental plots. The pooled efficacy of insecticides after 3 days revealed that all the new chemicals such as spiromesifen 240% SC @ 1.25 ml/lt, diafenthiuron 50 % WP @ 1.25 g/l, pyriproxyfen 10 EC @ 2.0 ml/l, flonicamid 50 WP @ 0.3 g/l and clothianidin 50 WDG @ 0.1 g/l were found effective against thrips which recorded less than 5.0 thrips/ 3 leaves without any significant differences among themselves. At 7 days after spraying also, similar trend was observed without significant differences among themselves. At 10 days after spraying also, all the newer insecticides proved their efficacy which recorded less than 2.0 thrips/3 leaves. The pooled mean of three observations showed that all the new insecticides were effective against thrips along with insecticidal checks, fipronil 5 SC @ 2.0 ml/l and thiamethoxam 25 WG @ 0.3 g/l which recorded less than 3.5 thrips/3 leaves without significant differences statistically. However, all the newer insecticides found significantly superior over untreated control and seed treatment alone which recorded more than 6.0 thrips/3 leaves. The seed treatment alone was found ineffective in reducing the thrips population at 45 DAS when compared to foliar sprays. The mean per cent reduction over control at 10 days after spraying showed that all the newer insecticides were able to reduce more than 70 per cent of thrips population over the untreated control. The highest reduction in thrips population was recorded with clothianidin 50 WDG @ 0.1 g/l (77.43 %), a neonicotinoid insecticide which acts as nicotinic acetylcholine receptor agonists followed by flonicamid 50 WP @ 0.3 g/l (76.82 %) and diafenthiuron 50% WP @ 1.25g/l (76.19 %). The seed treatment alone was able to reduce only 6.10 %

thrips population over untreated control. The seed yield ranged from 771 to 1033 kg/ha among the treatments without significant differences among the newer insecticides. However, all the treatments were found significantly superior over the untreated control which recorded the lowest yield of 771 kg/ha except seed treatment alone (Table-1).

The results obtained from the present study revealed that new chemicals such as spiromesifen 240% SC @ 1.25 ml/lt, diafenthiuron 50 % WP @ 1.25 g/l, pyriproxyfen 10 EC @ 2.0 ml/l, flonicamid 50 WP @ 0.3 g/l, clothianidin 50 WDG @ 0.1 g/l and thiamethoxam 25 WG @ 0.3 g/l were found effective against thrips in greengram. The results are in concurrence with several other research workers who reported the efficacy of selected insecticides earlier in wide range of crops. Clothianidin 48SC @ 0.4 ml/lt was the most effective insecticide against all the thrips species with the highest reduction of population on top trifoliate leaves and terminal shoots at vegetative stage as well as at reproductive stage of mungbean (Yasmin *et al.*, 2020). Better performance of clothianidin 50 WDG against thrips was reported earlier in cotton (Patil *et al.*, 2007), in Indian bean (Chaudhari *et al.*, 2015), in blackgram (Parmar *et al.*, 2015) and in greengram (Sasmal and Kumar, 2016) which are in corroboration with the present results. Chaudhari *et al.* (2015) observed that flonicamid 50WG @ 0.015% showed comparatively higher reduction in the incidence of thrips, hoppers and whiteflies in Indian bean. Swathi *et al.* (2018) reported that flonicamid 50 WG @ 0.0325% was very effective against the population of thrips and whiteflies in rice fallow blackgram. Diafenthiuron 50 WP @ 312g a.i./ha was most effective treatment in reducing population of whitefly, jassid and flower thrips in greengram (Kharel *et al.*, 2016). The higher efficacy of diafenthiuron was reported by Gopalaswamy *et al.*, 2012 in blackgram, Mandal (2015) in greengram, Parmar *et al.* (2015) in blackgram and Ranjit and Krishnamoorthy (2016) in cardamom which are in conformity with present results. Varghese and Mathew (2013) reported that spiromesifen at 20 g a.i. ha<sup>-1</sup> was found to be effective against chilli thrips reduced the leaf curling symptom and safest insecticide against natural enemies. Spiromesifen 240 SC @ 150g a.i./ha was found effective as compared to standard checks thiamethoxam 25 WG @ 25g a.i./ha and triazophos 40 EC @ 500g a.i./ha against sucking pests in greengram (Kharel *et al.*, 2016). The superior efficacy of thiamethoxam was reported against thrips population earlier in mungbean (Mishra and Mukherjee (2015); Ahirwar *et al.*, 2016; Sasmal and Kumar, 2016) in accordance with present results. Kumar and Singh (2016) recorded maximum reduction in the population of thrips from the plots treated with Pyriproxyfen (56.98%) followed by thiamethoxam (48.52%) in cotton. However, the insecticidal checks were

Table-1 : The mean efficacy of different insecticides against thrips in mungbean (Pooled data of 2018-19, 2019-20 and 2020-21).

| Tr. No.        | Treatment details                                | Thrips/ 3 leaves |                             |                             |                              |                              | % ROC at 10 DAS | Yield (kg/ha) |
|----------------|--------------------------------------------------|------------------|-----------------------------|-----------------------------|------------------------------|------------------------------|-----------------|---------------|
|                |                                                  | PTC              | 3 DAS                       | 7 DAS                       | 10 DAS                       | Pooled mean                  |                 |               |
| T <sub>1</sub> | ST with imidacloprid 600 FS @ 5.0 g/kg           | 6.24<br>(2.69)   | 5.40<br>(2.53) <sup>b</sup> | 6.20<br>(2.68) <sup>b</sup> | 6.71<br>(2.78) <sup>c</sup>  | 6.11<br>(2.67) <sup>c</sup>  | 6.10            | 882 b         |
| T <sub>2</sub> | T <sub>1</sub> + Spiromesifen 240 SC @ 1.25 ml/l | 6.25<br>(2.69)   | 4.67<br>(2.38) <sup>a</sup> | 2.98<br>(1.99) <sup>a</sup> | 1.96<br>(1.72) <sup>ab</sup> | 3.20<br>(2.05) <sup>ab</sup> | 72.66           | 1024 a        |
| T <sub>3</sub> | T <sub>1</sub> + Diafenthiuron 50% WP @ 1.25g/l  | 6.60<br>(2.76)   | 4.58<br>(2.36) <sup>a</sup> | 3.02<br>(2.01) <sup>a</sup> | 1.80<br>(1.67) <sup>ab</sup> | 3.12<br>(2.03) <sup>a</sup>  | 76.19           | 1031 a        |
| T <sub>4</sub> | T <sub>1</sub> + Pyriproxyfen 10 EC @ 2.0 ml/l   | 6.56<br>(2.75)   | 4.87<br>(2.42) <sup>a</sup> | 3.07<br>(2.02) <sup>a</sup> | 1.87<br>(1.69) <sup>ab</sup> | 3.27<br>(2.07) <sup>ab</sup> | 75.14           | 960 a         |
| T <sub>5</sub> | T <sub>1</sub> + Flonicamid 50 WP @ 0.3 g/l      | 6.45<br>(2.73)   | 4.53<br>(2.35) <sup>a</sup> | 2.73<br>(1.93) <sup>a</sup> | 1.71<br>(1.65) <sup>a</sup>  | 2.99<br>(2.00) <sup>a</sup>  | 76.82           | 1033 a        |
| T <sub>6</sub> | T <sub>1</sub> + Clothianidin 50 WDG @ 0.1 g/l   | 6.53<br>(2.74)   | 4.62<br>(2.37) <sup>a</sup> | 3.00<br>(2.00) <sup>a</sup> | 1.69<br>(1.64) <sup>a</sup>  | 3.11<br>(2.03) <sup>a</sup>  | 77.43           | 969 a         |
| T <sub>7</sub> | T <sub>1</sub> + Thiamethoxam 25 WG @ 0.3 g/l    | 6.47<br>(2.73)   | 4.69<br>(2.39) <sup>a</sup> | 3.07<br>(2.02) <sup>a</sup> | 2.13<br>(1.77) <sup>ab</sup> | 3.30<br>(2.07) <sup>ab</sup> | 71.20           | 952 a         |
| T <sub>8</sub> | T <sub>1</sub> + Fipronil 5 SC @ 2.0 ml/l        | 6.49<br>(2.74)   | 4.93<br>(2.44) <sup>a</sup> | 3.27<br>(2.07) <sup>a</sup> | 2.38<br>(1.84) <sup>b</sup>  | 3.53<br>(2.13) <sup>b</sup>  | 68.00           | 928 a         |
| T <sub>9</sub> | Control                                          | 6.42<br>(2.72)   | 6.11<br>(2.68) <sup>c</sup> | 6.80<br>(2.79) <sup>b</sup> | 7.36<br>(2.89) <sup>c</sup>  | 6.76<br>(2.79) <sup>d</sup>  | -               | 771 c         |
|                | F Test                                           | NS               | Sig                         | Sig                         | Sig                          | Sig                          |                 | Sig           |
|                | C.D. at 5%                                       | -                | 0.13                        | 0.14                        | 0.17                         | 0.08                         |                 | 108.5         |
|                | SE(m) ±                                          | 0.04             | 0.04                        | 0.05                        | 0.06                         | 0.03                         |                 | 63.7          |
|                | C.V. %                                           | 2.98             | 3.16                        | 3.71                        | 4.82                         | 2.74                         |                 | 9.5           |

\*Figures in parenthesis are square root ( $\sqrt{x+1}$ ) transformed values; ROC-Reduction over control  
DAS : Days after spray; NS-Non-significant; Sig-Significant

slightly less effective against thrips when compared to newer insecticides. However, the efficacy of fipronil 5 SC was well documented in cotton (Saner *et al.*, 2013), in pomegranate (Dongarjal, *et al.*, 2018), in chilli (Jadhav *et al.*, 2004) and in onion (Singh *et al.*, 2013) against thrips population. In contrast to the present study, Singh *et al.*, (2019) reported that fipronil was highly effective against sucking pests when compared to spiromesifen and fenprothrin in greengram.

## Conclusion

The new chemicals such as clothianidin 50 WDG @ 0.1 g/l, diafenthiuron 50 % WP @ 1.25 g/l, flonicamid 50 WP @ 0.3 g/l, spiromesifen 240% SC @ 1.25 ml/l, pyriproxyfen 10 EC @ 2.0 ml/l were found on par with the most commonly used insecticides such as fipronil 5 SC @ 2.0 ml/l and thiamethoxam 25 WG @ 0.3 g/l against thrips in greengram.

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## Attitude of Urban Housewives Towards Terrace Gardening

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### Abstract

As the greener cover of urban areas are eaten away by the skyscrapers and concrete paths, the idea of urban greening and terrace cultivation should take a foothold. If it is taken up by the women, we can encompass gender empowerment along with natural conservation and good agricultural practices. Here, we are trying to analyse the attitude of urban housewives towards terrace gardening. The findings of the present study, which is conducted at Pune city, clearly depicts that there is a moderate level of positive attitude towards terrace gardening (53.55 per cent). While analysing the factors affecting the attitude, it is evident that the variables such that age, area of cultivation, experience, information sources utilisation, and innovativeness is correlated with attitude towards terrace gardening at one per cent level of significance, while, time spent on gardening activities and frequency of harvest were correlated with attitude towards terrace gardening at five per cent level of significance. The variables such that education, family size, annual income, health consciousness, and vegetable consumption pattern doesn't show any effect on the attitude towards terrace gardening as they were non-significant.

**Key words :** Attitude; Terrace gardening; Factors affecting terrace gardening; Urban greening

### Introduction

Urban agglomerations and their resource uses are becoming the dominant feature of the human presence on earth, profoundly changing humanity's relationship to its host planet and its ecosystems. There was lack of space for cultivation of crops. When this situation arrived, it became a necessity to utilize the available spaces for cultivation. Hence there was an urgent need for terrace gardens (Panneerselvam *et al*, 2014). A terrace garden is a garden which is established on a terrace, roof, or patio, usually in a house where there is limited gardening space. Today around 15 per cent of the world's food is grown in urban areas.

In India, since available land for cultivation is shrinking, mainly in urban areas, there is a need of some alternative measures like terrace gardening. It not only provides benefits such as space and time utilization, but also provides organic food devoid of chemicals, enhanced health, better disposal of household wastes, reduction of family expenditure on buying vegetables and a fresh hygienic and eco-friendly atmosphere at house premises (Agnes *et al*, 2010; Poornima and Suryawanshi, 2020).

Agriculture and women have close association. Agriculture without women can't be imagined (Lohse, 2011). The data shows that slightly less than half of the population of our country is women. In Pune scenario (As per Govt. of India Census, 2011), there are 31 lakhs

people are there in the city. Out of these 15 lakhs are females (48.67 per cent). Out of the 12 lakhs people in the city who are engaged in work or any business activity, only 3 lakhs are females (27.61 per cent among working population and 10.63 per cent among total population). Even though the situation of urban women is quite satisfactory compared to that of rural women, they too need more encouragement to get engaged in some employment or work. There is good scope for empowerment of urban housewives in Pune city through the creation of employment opportunities and income through proper utilization of their time and the space available in the house premises and terraces for cultivation of vegetables (Azaduzzaman, 2011).

In Maharashtra state, Pune is second largest city. The practice of terrace gardening is getting widely accepted in this area. But it is observed that most of the people are not aware of this practice of terrace gardening and importance of consumption of organic food. Here, in this study, an attempt has been made to analyse the attitude of urban house wives towards terrace gardening.

### Research Methodology

The study was undertaken in Pune city which consists of Pune Municipal Corporation and Pimpri-Chinchwad Municipal Corporation. As women are enthusiastic towards terrace gardening and there is a need for strengthen the gender and giving a space in farming related activities, the respondents selected for the study

were housewives in the region. Through random sampling ninety housewives are selected; out of which sixty-two from Pune Municipal Corporation and twenty-eight from Pimpri-Chinchwad Municipal Corporation. The data was collected using pre-ried and structured interview schedule. The collected data was accurately analysed using suitable statistical tests such as mean, frequency, percentage, standard deviation, and Karl Pearson's correlation analysis.

## Results and Discussion

**Attitude of housewives towards terrace gardening :** Attitude indicates the degree of favourable or unfavourable feeling towards a practice, person, or an object. In this study, attitude measurement is done with a questionnaire comprising statements covering various facets of terrace gardening which can assess their level of favourableness towards the practice. The statements encompassed the extent of time management, family expenditure reduction through gardening, maintenance, waste management, difficulty in doing gardening, environment protection, water management, mental well being *etc.* Table 1 indicates that more than half of the farmers (53.55 per cent) showed a moderate degree of positive attitude towards terrace gardening. Around one fourth (25.55 per cent) of the farmers showed least favourable attitude towards terrace gardening. Only 17 farmers (18.88 per cent) were having high degree of favourableness towards the practice.

**Table-1 : Distribution of respondents based on the attitude towards terrace gardening.**

| Sl.No. | Attitude              | Frequency | Percentage |
|--------|-----------------------|-----------|------------|
| 1.     | Least favourable      | 23        | 25.55      |
| 2.     | Moderately favourable | 50        | 53.55      |
| 3.     | Highly favourable     | 17        | 18.88      |

**Correlation coefficient between profile of the farmers and attitude towards terrace gardening :** The correlation coefficients (r-value) between the profile characteristics of the farmers and the attitude towards terrace gardening were worked out to understand the nature of relationship existing in between the variables. The variables such that age, education, area of cultivation, experience in farming, family size, annual income, information source utilisation, innovativeness, health consciousness, time spent on gardening, vegetable and fruit consumption pattern, and harvesting were taken in to account. Table 2. shows the results of correlation analysis.

It can be observed from the table that age is positively and significantly correlated ( $r = 0.279$ ) with attitude at 0.01 significance level. That means as age increases the attitude towards terrace gardening tends to be more. The probable reason is because the

respondents are more involved in gardening after their retired life. It is also obvious that experience is also positively correlated with attitude ( $r = +0.309$  at 0.01 significance level). Those housewives who are more experienced tends to take terrace garden as a passion.

| Variables                                           | Correlation coefficient (r) |
|-----------------------------------------------------|-----------------------------|
| Age                                                 | 0.279**                     |
| Education                                           | 0.113                       |
| Area of cultivation                                 | 0.309**                     |
| Experience in farming                               | 0.331**                     |
| Family size                                         | 0.021                       |
| Annual income                                       | 0.105                       |
| Information sources utilisation                     | 0.276**                     |
| Innovativeness                                      | 0.330**                     |
| Health consciousness                                | 0.030                       |
| Time spent on gardening                             | 0.394*                      |
| Vegetable consumption pattern                       | 0.054                       |
| Harvesting frequency                                | 0.277*                      |
| **Significant at one per cent level of significance |                             |
| *Significant at five per cent level of significance |                             |

From the result it is evident that as the area available for cultivation is more, the housewives have a tendency to develop a positive attitude towards terrace gardening. The correlation coefficient value is found to be 0.309 at one per cent level of significance. Similarly, the information source utilisation also plays a key role in deciding the attitude of terrace gardeners as the knowledge gathered have a useful effect on the farming activities. The result points out that the utilisation of sources of information is positively correlated ( $r = 0.276$ ) with attitude at 0.01 level of significance.

The housewives involved in roof gardening were found to be more innovative and they try out and adopt new practices in their gardens ( $r = 0.330$ ). It is obvious from the table that, the gardeners who spends more time with the crops inclines to become an ardent gardener ( $r = 0.394$  at five per cent level of significance). Likewise, a correlation coefficient of 0.277 tells that, as the yield from the garden increases, the favourable attitude towards doing gardening activities will also increases.

The variables such that education, family size, annual income, health consciousness, and vegetable consumption pattern doesn't show any effect on the attitude towards terrace gardening.

## Conclusion

The findings indicate that farmers have medium level attitude towards terrace gardening. The variables such that age, area of cultivation, experience, information sources utilisation, and innovativeness is correlated with attitude towards terrace gardening at one per cent level of significance, while, time spent on gardening activities and frequency of harvest were correlated with attitude towards

terrace gardening at five per cent level of significance. The variables such that education, family size, annual income, health consciousness, and vegetable consumption pattern doesn't show any effect on the attitude towards terrace gardening as they were non-significant. As there is only a few farmers showing the highly favourable attitude, it is the need of the hour to encourage, create awareness and impart knowledge on terrace cultivation among urban population.

## References

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