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Management of Phytonematodes in Vegetable Crops through Seed Bio-Priming : A Review

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High-quality seed is the key to thriving agriculture. With its bias for technology and precision, modern agriculture demands that each seed readily germinate and produce vigorous seedlings, ensuring high yield and good quality. Uniformity of growth and synchrony in development are highly desirable characters for mechanized farming. Seed health is a significant component of seed quality. Seed health refers to the presence or absence of pathogenic micro-organisms with/within the seeds. The seed-borne microflora reduces the seed quality and is responsible for many dreadful diseases in the nursery and field for reducing grain value for use as food and feed. For better storability and to produce good crops in the following season, the seeds should be invigorated adequately by way of priming.

Priming is a method in which seeds remain assimilated either in water or osmotic solutions, solid matrix carrier, and a combination of water and biocontrol agents in specific proportions followed by drying before radical emergence. Seed priming is the method in which hydration of the seed is controlled over a level that allows pre-germinative metabolic activity to take place without the emergence of the radical. Two priming methods are available. First, Osmopriming utilizes aerated aqueous solutions of salts or polyethylene glycol (PEG), generating osmotic potential in the immediate solution. Another solid matrix priming (SMP) means using moist, porous solid materials, such as powdered coal or peat, making matrix potential. Combining SMP with *Trichoderma* spp. to control seedling diseases in nurseries has been used successfully on a broad range of plants (Harman *et al.* 1989).

Seed treatment with bio-control agents and priming agents may serve as an essential means of managing many soil and seed-borne diseases, the process often known as biopriming. These priming agents and bio-agents can protect the seeds from biotic and abiotic stresses like moisture stress. They can protect the seeds and the seedlings for extended periods (Taylor and Harman, 1990). Biological seed treatments for control of seed and seedling diseases offer the grower an alternative to chemical fungicides. When applied as seed

dressers, bio-control agents like *Trichoderma harzianum* and *Pseudomonas fluorescens* can colonize the rhizosphere, potentially benefiting the plant beyond the seedling emergence stage (Nancy *et al.* 1997). Seed priming is a quality enrichment method for rapid uniform germination of seeds and maximum plant stand in the field. This method is often used as a seed invigoration method for improving germination and vigor in low vigor lots. Therefore, it seems to convert the harmful effects of seed deterioration (Srinivasan *et al.*, 2009). During seed priming, seed moisture content increases up to 35-40% of its weight, enough to activate the biochemical events, advancing the seed germination process without radical emergence. The product of these changes persists following desiccation. It is available on reimbibitions of water during seed planting, enabling the completion of seed germination rapidly, leading to a uniform crop stand and synchronized flowering and fruiting.

Additionally, these physiological treatments induce tolerance to specific environmental stresses (Vanangamudi *et al.*, 2008). Various priming methods, *viz.* Osmo priming, hydro priming, solid matrix priming, and biopriming are used. Priming in pure water is termed hydro priming. Standard techniques include imbibing seeds on moistened blotters or soaking in water with or without aeration (Thornton Powell, 1992). Considering water is not limited, seeds germinate if they are viable and non-dormant. Therefore, the method must be arrested at a precise time to prevent the emergence of extremists. Hydro priming, Osmo priming, and solid matrix priming were used commercially in various horticultural crops to increase the speed and evenness of germination and improve field stand. Nevertheless, if seeds are contaminated with pathogens, fungal growth can be enhanced during priming, thus resulting in unacceptable effects on plants. Therefore, seed priming combined with low doses of fungicides or biocontrol agents has been used to improve the rate and uniformity in seed emergence and reduce damping-off and other soil-borne diseases.

Biopriming is a novel method of seed treatment that combines biological (inoculation of seed with beneficial

organisms to protect seeds) and physiological aspects of disease management. It is recently used as an alternative method for controlling many seeds and soil-borne pathogens using selected fungal antagonists.

Biological seed treatments provide an alternative to chemical control with added advantages of induced disease resistance, ecofriendly nature, and sustainable disease management. *Trichoderma viride*, *T. harzianum*, *Pseudomonas fluorescens*, *Purpureocillium lilacinum*, *Pochonia chlamydosporium*, etc., are primary biocontrol agents frequently used for biopriming treatments. Many researchers have studied the application of beneficial micro-organisms in the priming medium to control disease proliferation (Waren and Bennet, 2000).

Management of phytonematodes through seed bio-priming

Phytonematodes are well-thought-out important pathogens of almost all crops. They cause injury and damage to plants by feeding on the root hairs, epidermal cells, cortical and/or stealer cells (Khan, 2008). Many ectoparasitic nematodes like *Tylenchus*, *Hoplolaimus*, *Rotylenchus*, *Helicotylenchus*, *Tylenchorhynchus*, *Belonolaimus*, *Trichodorus* and *Longidorus* are feeding on the root surface. However, many other nematodes enter fully inside the host roots, such as root-knot nematodes (*Meloidogyne* spp.), cyst nematodes (*Heterodera* & *Globodera* spp.), root-lesion nematode (*Pratylenchus* spp.) and burrowing nematode (*Radopholus similis*), and these are called endoparasites nematodes. At the same time, some nematodes such as citrus nematode (*Tylenchulus semipenetrans*) and reniform nematode (*Rotylenchulus reniformis*) are semi-endoparasites as they partially enter the host tissue. The typical effect of nematode parasitism is weakening of the plant with stunting plant growth and mild yellowing of foliage that shows nutritional deficiency. As a result, instead of nematicide, farmers apply fertilizer, which proves ineffective and noneconomic.

Nonspecific symptoms of nematode infestation appear as patches of plants irregularly distributed in a field showing stunted growth, dull green, or pale yellow foliage (Luc *et al.*, 2005). The infected plants show daytime wilting despite adequate soil moisture while sunny days but recover at night. Moreover, roots so weakened and wounded by nematodes are easily pre-disposed and invaded by many pathogenic bacteria and fungi, leading to accelerated root decay. This secondary damage does not draw immediate attention. The incurable stage is soon reached, leading to severe

yield losses (Khan and Reddy, 1993) both quantitatively and qualitatively under subtropical and tropical conditions (Sasser, 1989). Phytonematodes may also act as a vector for bacteria, fungi, and viruses. For instance, *Anguina tritici* carries *Clavibacter tritici* and *Dilophospora alopecuri* to shoot meristem of wheat (Khan and Dasgupta, 1993). Nematode transmitted polyhedral viruses (NEPO), which are ringspot viruses, for example, tobacco ringspot virus, is transmitted by *Xiphinema* and *Longidorus* species. *Trichodorus* and *Paratrichodorus* species act as vectors for certain tobravirus such as tobacco rattle and pea early browning viruses (Taylor and Brown, 1997). Despite a significant impact on agriculture, nematodes have not been recognized as a major pest of crops, probably because the damage caused by nematodes is less evident than that caused by fungi or other pathogens. Nematodes may cause about 7-12% yield loss to various crops. The yield losses vary greatly depending on initial inoculum levels and susceptible host species. The severe infection may result in 80-90% yield decline in an individual field, and sometimes plants fail to yield economic value. However, nematodes do not always cause hidden damage. When fields are heavily infested, characteristic symptoms appear on roots or shoots. Specific symptoms include root-lesions, root-rot, root pruning, root-galls, cessation of root growth, etc. (Khan, 2008). For example, annual monetary loss due to nematodes has been estimated over \$ 6.0 billion in the USA alone (Agrios, 2005). In India, it is estimated to the tune of Rs.21,068.73 million only in 24 crops of AICRP on Nematodes (Jain *et al.*, 2007), but it can be Rs 12,000 to 13,000 million altogether.

Several methods for managing phytonematodes such as chemical control, organic amendments, resistant varieties, soil solarization, and biological control have been tried with different levels of success for protecting plants (Randhawa *et al.* 2001; Sakhuja and Jain 2001). There is general agreement that the toxic action of organophosphate and carbamate pesticides upon nematodes and insects is caused by their ability to inhibit acetyl cholinesterase (AChE) in various parts of the nervous system, thereby disrupt nervous transmission at that location (Corbett *et al.* 1984). Biological control of nematodes may be achieved with two kinds of micro-organisms. Classical parasites or predators (e.g., *Paecilomyces lilacinus*, *Dactylaria candida*, *Pasteuria penetrans*) have been used in nematode control since old times (Khan and Khan, 1995). Rhizosphere micro-organisms may provide defense upon pathogen attack (Weller 1988). The rhizoplane and rhizosphere are colonized or otherwise occupied by several micro-organisms. Plant growth-promoting

bacteria produce plant growth-promoting substances and antibiotics. They are capable of providing substantial protection against nematode diseases (Siddiqui and Mahmood 1999).

In recent years, interest has also been developed in using plant growth-promoting micro-organisms. They are most important and may prove efficient biocontrol agents of plant nematodes. They may suppress rhizospheric nematode populations by promoting host growth, inducing systemic resistance and/or producing nematotoxic metabolites (Kirkpatrick *et al.*, 1964), like, bulb forming (Brannen, 1995), phenazine (Toohey, 1965) and pyoleutorin (Howell and Stepinovic, 1980). Nematode management employing phosphate-solubilizing fungi or bacteria has the advantage over classical biocontrol agents as the former provides essential nutrients to plants in addition to their nematode inhibiting ability. *Aspergillus niger*, *Penicillium* spp., *Trichoderma*, *Bacillus subtilis*, *B. polymyxa*, *Pseudomonas fluorescens*, *P. stutzeri*, *P. striata*, nematophagous fungus *Arthrobotrys oligospora*, etc. are some of the promising phosphate-solubilizers inhabiting agricultural soils (Gaur, 1990, Rao, 1990; Rudresh *et al.*, 2005; Duponnois *et al.*, 2006; Pandey *et al.*, 2008) and possess the promising potential of nematode antagonism. In the following section, the role of bio-priming of these fungi and bacteria in nematode management is discussed. Many attempts or experiments of bio-priming had been made against plant diseases and insects-pest by different researchers, but very few were taken against nematodes.

Glasshouse, as well as micro-plot experiments conducted to find out the influence of different application methods of arbuscular mycorrhizal fungus (AMF) *Glomus mosseae* such as seed pelleting, revealed that AMF mixed with soil and as a layer under seed, AMF soil pelleting and direct application of spores against root-knot nematode (*Meloidogyne incognita*) on black gram (*Vigna mungo*) (Sankaranarayanan and Sundarababu, 2010). In both experiments, they found that the application of *G. mosseae* to black gram plants suppressed *M. incognita* soil population by up to 14–49% under pot culture and 35–46% reduction over nematode alone treatment. This reduction in the severity of disease caused by *M. incognita* in mycorrhizal plants might be due to the altered biochemical constituents in the host plant (Sikora and Schonbeck, 1975; Siddiqui *et al.*, 1999) or improved plant nutrition, especially phosphorus (Hussey and Roncadori, 1982) or alteration of compounds of root exudates or alteration of the physiological components of AMF root due to increased lignin levels in the exodermis of mycorrhizal plants (Dehne and Schonbeck, 1975). The presence of increased quantities of sugars, amino acids,

like phenylalanine and serine and phosphorus may each or collectively play a role in suppressing the development of *M. incognita* in mycorrhizal plants (Krishnaprasad, 1971).

An experiment under greenhouse conditions was carried out to test the nematocidal activity of some biopesticide agents (abamectin, azadirachtin 0.15% and azadirachtin 0.03%) and micro-organisms (*Bacillus subtilis*, *Pseudomonas fluorescens* and *Paecilomyces lilacinus*) against root-knot nematode on tomato plants, indicating that the most of the tested treatments reduced root galls and remarkably increased tomato plant growth characters significantly and egg masses on root system as well as juvenile's numbers in the soil. *P. lilacinus* was found the most effective treatment on both galls and egg masses, achieving 88.23 and 76.94% reduction, respectively. At the same time, *B. subtilis* recorded the highest increase in fresh root weight followed by *P. fluorescens* with the value of 125.75 and 86.57%, consecutively. Vice versa, *P. fluorescens* was the superior treatment to increase the dry root weight by 68.14%, followed by *B. subtilis*, which recorded 35.40% (Khalil *et al.* 2012). *P. lilacinus* strain UP1 was effective against *M. incognita*, which attacking tomato under screen house condition in pot experiments and significantly reduced the number of galls, nematodes and egg masses compared with Namacur (Oclarit *et al.* 2009). Also, Kavitha and co-workers in 2007 indicated that *P. fluorescens*, *B. subtilis* and *T. viride* significantly decreased the nematode population. Similarly, *P. fluorescens* decreased nematode penetration and galling by 54 and 70%, respectively (Sharma *et al.*, 2008). *P. lilacinus* caused substantial egg deformation in *M. incognita*. These deformed eggs never matured or hatched (Jatala *et al.*, 1985). In addition to killing juveniles and females of *M. incognita* and *Globodera pallida* in the laboratory test, this fungus infects eggs of *M. incognita*. It destroys the embryos within five days because of simple penetration of the egg cuticle by individual hypha aided by mechanical and/or enzymatic activities (Jatala, 1986). Also, *P. lilacinus* suppressed root-knot infections, which resulted in fewer galls developing in the root system. (Linderman 1992; Siddiqui *et al.* 2001; Prakob *et al.* 2007). The serine protease produced by *P. lilacinus* might play a role in penetration of the fungus through the eggshell of the nematodes (Bonants *et al.* 1995). On the other hand, early developed eggs were more susceptible than the eggs containing fully developed juveniles. As observed by transmission electron microscopy, fungal hypha penetrated the *M. javanica* female cuticle directly (Khan *et al.* 2006).

The pot house studies reveal that the effect of fungal and bacterial bio-agents, viz. *Trichoderma harzianum*, *T.*

viride and *Pseudomonas fluorescens* @ 5 g, 7.5 g and 10 g/kg seed against root-knot nematode, *M. incognita* infecting cowpea. Chemical check (carbosulfan 3% w/w) and untreated check were also maintained for comparison. They found that the maximum shoot, root length, shoot and root weights and a minimum number of galls/plant, egg masses/plant, eggs/egg mass, nematode population/100cc, and total nematode population were recorded with *T. harzianum* @ 10 g/kg seeds followed by *T. viride* @ 10 g/kg seeds and *P. fluorescens* @ 10 g/kg seeds and *T. harzianum* @ 10 g/kg seeds over control (Nama and Sharma, 2017).

The management of root-knot and root rot disease complex caused by the root-knot nematode *M. javanica* and the fungus *R. solani*, on soybean plants under greenhouse conditions used as the powder formulation of *T. harzianum* as seed treatment were reduced the number of galls, root galling, egg masses and disease severity (Mahdy *et al.*, 2006). Similarly, significantly increased the plant growth and reduced the final nematode population, treated with *T. harzianum* and *P. fluorescens* over streptomycin (Barua and Bora, 2008). The experiment's findings on the management of disease complex caused by *M. incognita* and *R. solani* with seed treatment of *T. harzianum* and *P. fluorescens* on okra indicated both the bio-agents to be significantly effective in reducing the damage and increasing the growth parameters (Bhagawati *et al.*, 2009).

Jonathan and his co-workers (2009) conducted two field experiments with tomato Hybrid 5005 at Kuttathottam and Theethipalayam villages of Coimbatore district to investigate the potential of two promising native isolates of plant growth-promoting rhizobacteria (PGPR) viz., *Pseudomonas fluorescens* (Pfbv22) and *Bacillus subtilis* (Bbv57) for the management of *M. incognita* and *R. reniformis* in tomato. The biocontrol agents were compared with the standard chemical viz., carbofuran. Consortium application of *P. fluorescens* (Pfbv22) and *B. subtilis* (Bbv57) as seed treatment each @ 5 g kg⁻¹ seeds and soil application (SA) @ 1.25 kg ha⁻¹ significantly reduced the nematode infestation and enhanced the plant growth and fruit yield.

The effect of different dose and application methods of *P. lilacinus* against *M. incognita* on okra at two different locations revealed shoot length, shoot weight and root length to be significantly increased in mixture treatments compared to individual treatments, principally combination of seedling treatment (10g/l water) + soil application treatment (5.0 kg/acre) documented maximum shoot length (60 and 90 DAS), shoot weight (90 DAS) and root length (90 DAS) and they were positively correlated with fruit yield of okra (Kannan and Veeravel,

2012). The seed treatment with *Paecilomyces lilacinus* gave better response in the root-knot index and fruit yield than the untreated control. The elective effect of *P. lilacinus* was attributed to the toxic and enzymatic principles such as acetic acid and proteolytic and chitinolytic enzymes released during fungal interaction with the nematode, which might cause killing or inhibiting *M. incognita* directly or indirectly promoting plant growth and ultimately enhancing yield component of okra (Mahapatra and Sahani, 2007). The increase in plant growth characters, yield, and egg mass infection except root weight reduced the nematode population in tomato (Shanmugapriya and Kumar, 2006b) and brinjal (Gomathi *et al.*, 2006). The experiments conducted on bio-efficacy of a bio-nematicide, IHR- *Paecilomyces lilacinus* (*Purpureocillium lavendulum* Luangsa-Ard) for the management of *M. incognita* on tomato at in two different agro-climatic regions i.e., Indian Institute of Horticultural Research, Bengaluru and C S Azad University of Agriculture and Technology, Kanpur, Uttar Pradesh, India. These trials were conducted using farmyard manure (FYM) enriched with *P. lilacinus* (1%) W.P. standardized optimum dose for the seed treatment with *P. lilacinus* (1%) W.P. seed treatment at the rate of 20g/kg seeds, nursery bed treatment @ of 50g *P. lilacinus*/m² and application of FYM (5 tons) enriched with 5kg of *P. lilacinus*/ha proved to be significantly effective in the management of *M. incognita* and significantly increased tomato yield (Rao *et al.*, 2012).

Different fungal and bacterial antagonists (*T. harzianum*, *T. viride*, *P. chlamydosporia*, *P. lilacinus* and *P. fluorescens*) used as seed coating treatments against root-knot nematode, *M. incognita*, infecting okra indicated that they found that the growth of okra plants was more significant and the root-knot nematode population was reduced after sixty days of sowing in all treatments compared to the untreated control (Kumar *et al.*, 2012).

Several authors have proved the efficacy of bacterial and fungal bioagents and nematicides used as a seed treatment in reducing *M. incognita* populations. The highest egg was parasitizing efficiency of *P. lilacinus* (80%) compared to other fungi (Goswami and Mittal, 2002). Few fungi (toxic) viz., *Aspergillus niger* Van Tieghem, *A. terreus* Thom., and egg parasitic viz., *C. oxysporum* Berk et Curtis, *P. lilacinus*, etc. have been reported to perform well in reducing the population of *M. incognita* (Mittal, 2006). In several reports, the combination of two fungal bioagents (*As-pergillus* spp., toxic, and *Paecilomyces* spp., egg parasitic) was found more effective than a single bioagent against *M. incognita*, resulting in better plant growth (Verma *et al.*, 2009). Both types of fungal bioagents (toxic and egg-parasitic), used in a talc-based formulation,

successfully managed diseases under field conditions (Goswami and Sharma, 1999; Kumar and Jain, 2010). Therefore, this formulation could be proposed as an ideal component of an integrated pest management package (Mittal, 2006; Verma, 2009).

The pot trial studies conducted on the management of root-knot nematode, *M. incognita*, infecting okra through the integration of fungal bio-agents (*T. viride*, *P. lilacinum*, *P. chlamydosporia*) and plant growth-promoting rhizobacteria (*P. fluorescens*) alone and in combinations as talc formulation pre-incubated with FYM, revealed that bio-agents significantly reduced the population of *M. incognita* and increased the growth parameters of okra as compared to the untreated check. However, among all the treatments, seed treatment with *T. viride* + *P. fluorescens* each @ 5g/kg seeds not only gave the better result as compared to other treatments but comparatively performed better over untreated control (Mahalik and Sahoo, 2017).

Conclusions

Any management practice has both advantages and disadvantages connected with its application. Chemical management practices are more popular among farmers as well as scientific communities for the management of phytonematodes. Environmental pollution and the development of resistance are significant problems accompanied by the use of chemical nematicides. Similarly, bio-control agents and plant growth-promoting micro-organisms as seed bio-priming have both merits and demerits. Although no environmental hazard is associated with biological control agents, specific reasons restrict their wide-scale application in sustainable agriculture.

Bio-control agents can easily and inexpensively be cultured and mass-produced, show rhizospheric competence, have a broad host range, and be used as a seed treatment. However, the limitation is that they require soil rich in organic matter contents and high temperature for better performance and applied in large amounts under field conditions (106/g soil). Furthermore, results vary with the species and density of nematodes. In addition, certain strains have shown pathogenicity of *Paecilomyces* spp. (Kerry, 1987; Stirling, 1991) and *Trichoderma* spp. (Guarro *et al.*, 1999) to human populations. Phosphate solubilizing bacteria such as *Pseudomonas* and *Bacillus* species are easily mass cultured on synthetic media and applied in soil or seeds. Their application may potentially reduce plant damage by suppressing nematode pathogenesis and stimulating plant growth. However, the inhibitory effects of

nematode are of shorter duration; probably, for this reason, they are not commercially used in nematode management.

The past four decades have seen a significant increase in the number of scientists working on the biological control of nematodes. Current experience suggests that integrating bio-control agents, plant growth-promoting microbes, nematicides, and other control measures would be a feasible and viable strategy for nematode management in developed and developing countries. The urgent need to reduce the dependence on nematicides requires considerable research and development to commercialize the successful use of bio-seed priming. The future of sustainable agriculture relies heavily on combining biotechnology with traditional agricultural practices involving crop rotation, trap crops, intercropping, etc. Identifying micro-organisms possessing considerable growth-promoting and pathogen suppressing potential for nematode management needs to be explored and tested under changing environmental conditions. To achieve these goals, extensive field trials are necessary to establish their biocontrol potential in the natural environment.

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Effect of Walnut (*Juglans regia* L.) Leaf Aqueous Extracts, on Seed Germination and Seedling Growth of Broccoli (*Brassica oleracea* var. Italica) in Horti-Silvi System of Uttarakhand Himalaya

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Abstract

Effect of different doses of aqueous extracts of walnut leaf was studied on germinating seeds and early seedling growth of broccoli (cv. F₁ Hybrid) recommended for mid hills under West Himalayan horti-silvi system. Six treatments with four replication comprised of distilled water control (0%), 10%, 20%, 30%, 40% and 50% concentration of leaf extracts were treated. The effect of aqueous extracts was found inhibitive, indicate a direct proportional relationship with concentration dependent manner on seed germination and subsequent seedling growth of broccoli. The broccoli varieties exhibited extent of phytotoxicity at 50% extracts application in comparison to untreated control. Invariably there was a decrease in first count, germination, seedling root and shoot length, seedling fresh weight, dry weight, vigour index I and II with increasing aqueous extracts concentration on germinating broccoli.

Key words : Walnut, leaf extracts, germination, growth, broccoli.

Introduction

Walnut (*Juglans regia* L.) is a large deciduous fruit tree with long fragrant leaves, distributed in the Himalayas between 1375-3350 m. asl, extending in the west to Afganistan and east to Bhutan (Bahuguna *et al.*, 2013). In the Himalayas, the walnut is one of the first species to lose its leaves, tree becoming leafless from September to October i.e. the right time of *rabi* crop sowing in hills (Dua *et al.*, 2007). Presence of trees in horti/agri-silvi system results in direct exposure of associated crop to continuous release of chemicals. These chemicals influence local environment, germination and growth of plants. The effects of these chemicals on other plants are known as allelopathy to be dependent on the concentration released into the soil / environment (Tharayil *et al.*, 2006; Tharayil *et al.*, 2008; Kaur *et al.*, 2009). Allelopathy involves a plant's secretion of biochemical materials into the environment to inhibit germination or growth of surrounding vegetation. Allelopathic effects of trees on agriculture crops are well documented. (Tripathi *et al.*, 1996; Kohli *et al.*, 2000). Allelochemical released by trees inhibit seed germination (Singh and Bawa, 1982), reduce plant growth through inhibitive cell division (Baker, 1996), reduce mineral uptake, increase or decrease respiration, inhibit protein and haemoglobin synthesis (Rice, 1974). Walnut are often found growing on landscape site and when certain other landscape plants are planted near or under this shade tree, they tend to retard germination, yellow, wilt and die. The chemical responsible for walnut allelopathy is juglone (Willis, 2000).

A colourless nontoxic reduced form called harmless hydro-juglone is abundant, especially in leaves, fruit hulls, stem and roots of walnut. When exposed to air or oxidizing substances, hydrojuglone is oxidized to its toxic form, juglone (Dana and Lerner, 1990; Bertin *et al.*, 2003). Rain washes juglone from the leaves and carries it into the soil. Thus neighbouring plants of the walnut are affected by absorbing juglone through their roots (Rietveld, 1983). In previous studies, effects of juglone and walnut leaf extracts on various plant species were investigated (Einhelling, 1986; Hejl *et al.*, 1993; Kocacaliskan; Terzi, 2001). Therefore, it is important to select tolerant varieties of cabbage and broccoli for planting in areas adjacent to walnut trees. To the best of our knowledge, no research has been reported on the effect of walnut leaf extracts on germinating cabbage and broccoli. It is hypothesized that in a walnut based horti-silvi inter cropping system, juglone released from walnut trees could be an inhibitor to the germination and subsequent seedling growth of cabbage and broccoli close to the walnut trees. Thus, the objective of this work was to test this hypothesis in a laboratory experiment.

Materials and Methods

Leaves of more than ten years old walnut trees were used in obtaining the extracts because walnut trees younger than seven years old do not contain sufficient juglone to cause toxicity (Pratavia *et al.*, 1983; Piedrahita, 1984). The leaves of walnut were collected in the second week of August, 2021, since the juglone content of walnut was found to be highest in the last week of July and the first

Table-1: Effect of walnut (*Juglans regia* L.) leaf aqueous extracts, on seed germination and seedling growth of Broccoli (*Brassica oleracea* var. *Italica*) in horti-silvi system of Uttarakhand Himalaya.

Treatment	First count (%)	Germination/ final count (%)	Root length (cm)	Shoot length (cm)	Seedling length (cm)	Seedling fresh weight (g)	Seedling dry weight (g)	Vigor index I	Vigor index II	Relative growth index (RGI)
0%	69.25	96.75	17.87	17.23	35.10	4.82	0.56	3395.93	54.18	71.58
10%	62.75	93.50	14.22	15.81	30.03	3.12	0.49	2807.81	45.82	67.11
20%	56.50	89.75	11.44	13.14	24.58	3.08	0.37	2206.06	33.21	62.95
30%	48.25	88.25	8.48	11.61	20.09	2.82	0.21	1772.94	18.53	54.67
40%	39.50	79.00	6.98	8.40	15.38	2.20	0.19	1215.02	15.01	50.00
50%	32.25	70.25	4.79	5.22	10.01	1.02	0.15	703.20	10.54	45.91
CD@5%	3.50	2.77	1.19	0.98	1.91	0.79	0.14	180.63	13.85	3.83
CV	4.98	1.88	6.97	5.19	5.76	8.74	11.29	5.96	10.79	4.82
Sem	1.16	0.93	0.39	0.36	0.69	0.22	0.04	59.87	4.59	1.08
gm	51.42	86.25	10.63	11.90	22.53	2.84	0.33	2016.83	29.55	58.70

CD-Critical Difference; CV-Critical Variance; Sem-Stander Mean Error

week of August (Tekintas *et al.*, 1988) and dried the leaves at 70°C in an oven for 48 hours. Later mechanically crushed the dried leaves and made fine powder then soaking in distilled water at room temperature for 48 hours and mechanically stirred for one hour at end. The extracts thus obtained were filtered through Whatman No. 1 filter paper and stored in refrigerator until required. 100 g of crushed leaf powder were soaked in 1000 ml of distilled water for preparing 100% concentration of stock solution. Treatment consisted of five concentration of aqueous leaf extract (10, 20, 30, 40 and 50 %) along with control on broccoli (cv. F₁ Hybrid) recommended for hills under west Himalayan horti-silvi system. 50 seeds of each treatment were placed separately in pre-sterilized petridishes with two fold filter paper at the bottom. The experiment was laid out in CRD with four replications. 10ml. distilled water each of control and five concentration of leaf leachate were added in each petridishes on first day and 5 ml later or as and when required. Seeds were surface sterilized with 0.1% mercuric chloride solution. Petridishes were sterilized in hot air oven at 160°C prior to start the experiment. The petridishes were placed in an incubator at a temperature of 20°C. The first count and seeds germinated were counted daily for 4 and 8 days respectively. Root length, shoot length and seedling fresh weights of ten randomly selected seedlings from each treatment were recorded after ten days of the start of experiment (Bahuguna, *et al.*, 2013). Seedling dry weight was measured after subjecting the samples in an air oven at 80°C for 24 hours and attained constant weight for three consecutive readings. Vigour index I was calculated as a product of germination and seedling length, however, vigour index II was worked out by multiplying germination per cent with seedling dry weight (Abdul-Baki and Anderson, 1973).

Results and Discussion

The effect of walnut leaf extracts on seed germination and seedling vigour characteristics are presented in table1. There was significant gradual decrease in the germination percentage at first and final count with the increase in walnut leaf extracts and higher value (69.25 and 96.75%) was observed for control, while application of 50% leaf extract resulted significantly lowest per cent germination (32.25 and 70.25%) respectively. The result also depicted that each treatments of leaf extract concentration were differed significantly to each other with respect to germination for both first and final count. Thus there was an inhibitory effect on germination with increase in leaf extract concentration. This is in conformity with the findings of Orcutt and Nilsen (2000). Reduction in root, shoot and seedling length across increasing concentration of walnut leaf extracts up to 50% was noticed. Each treatment of walnut leaf extract had significant influence on root, shoot and seedling length over control (0%). The maximum root, shoot and seedling length of 17.87, 17.23 and 35.10 cm was observed for control, while lowest value of 4.79, 5.22 and 10.01 cm was measured for 50% treatment respectively. The reduction in seedling growth may be attributed to inhibitive cell division due to walnut leaf extracts. In the present study, walnut leaf extracts containing juglone significantly prevented root, shoot and as well as seedling elongation. Kocacaliskan and Terzi (2001) demonstrated that both juglone and walnut leaf extracts inhibit germination and seedling growth of several plant species such as watermelon, tomato, garden crest and cucumber (Tekintas *et al.*, 1988), for tomato and bean (Neave and Dawson 1989), wheat and barley (Prasad *et al.*, 2013), wheat (Bahuguna *et al.*, 2013 and Prasad *et al.*, 2011), radish (Bahuguna *et al.*, 2013). An inhibitory effect was

noticed in the fresh and dry weight of seedling with the increase in leaf extract concentration from control to 50% and same trend was calculated in terms of vigour index I and II (Table 1). Least fresh weight (1.02 g) was observed for 50% concentration, while maximum seedling fresh weight of 4.82 g was observed from control treatment. The significantly maximum dry weight value of 0.56 g was recorded in untreated control, while significantly least (LSD <0.05) results (0.15 g) was observed at minimum concentration of leaf extracts (50%). Vigour index (Germination % $\times$ seedling length) and (Germination % $\times$ dry weight of seedling) is a real reflection of seedling vigour of seed/seed lot which were extremely reduced as the walnut aqueous leaf extracts concentration increased and statistically maximum value for vigour index I and II (3395.93 and 54.18) was computed for untreated control over all other treatments, while least value (703.20 and 10.54) was calculated also for 50% leaf extract concentration respectively. In several previous studies, it was determined that walnut leaf extracts decreased seed germination, seedling length along with seedling fresh and dry weight for various crops. Vigour index (I and II) is a multiple criteria of germination with seedling length and dry weight of seedling. Therefore, these indexes were markedly inhibited by the walnut leaf extract. This result is in close agreement with the findings of Kocacaliskan and Terzi (2001) in watermelon, tomato, garden cress and alfalfa, Prasad *et al.* (2011) in cauliflower.

Germination rate traits in terms of relative growth index (RGI) was significantly reduced by walnut leaf extracts containing juglone and maximum value (71.58) for RGI were calculated in control (0%) treatment, while least value (45.91) was recorded respectively in undiluted extracts, however, the value for each and every treatment differed significantly with respect to RGI. RGI express the power of germination i.e. germination spread over the time. These findings support the earlier work where retard germination rate and percentage were observed following walnut leaf extracts and juglone of various plant species (Rietveld, 1983). The delayed and unsynchronized germination might be attributed to interfere metabolic activities in the walnut leaf extracts subjected seeds (Terzi *et al.*, 2003).

Conclusions

As a conclusion, our results clearly revealed that aqueous leaf extracts of walnut had inhibitory effects on germinating broccoli. Although allelopathic effects of walnut leaf extracts have been examined previously, no studies related to the effect of walnut leaf extract have been reported for broccoli to date. However, broccoli seed

exhibited extent of tolerance and might be option in walnut intercropping under West Himalaya horti-silvi system as a rabi vegetable and cereal. Therefore, walnut leaf extracts phytotoxicity cannot be ruled out when examining the cause for observed reduction in seed germination and growth in broccoli under walnut intercropping horti-silvi system. A future study is necessary to get more detail information about walnut-broccoli allelopathic relationships by using more broccoli varieties.

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Effect of Floral Preservatives on the Vase Life of *Dendrobium* cv. Sonia-17

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Abstract

The current investigation entitled "Effect of floral preservatives on the vase life of *Dendrobium* cv. Sonia-17" was carried out to analyse the best floral preservative for *Dendrobium* cv. Sonia-17. The whole experiment was laid out in completely randomized design with 13 treatment and 3 replication. Treatment T₃ (Salicylic acid 200 ppm + 4 % Sucrose) significantly increases the vase life of *Dendrobium* cv. Sonia-17 as compared to all treatment combination and found significant in almost all the parameters in cut spikes of *Dendrobium*.

Key words : *Dendrobium*, vase life, floral preservative, parameters, cut spikes.

Introduction

Orchids are one of the largest blooming plant families, with 25,000 to 33,000 species and 600-800 genera. They come in a wide range of sizes, shapes, colors, attractiveness and they are highly valued for their ability to keep for up to 10 weeks. Orchid is ranked sixth in worldwide trade among the top ten cut flowers. *Cymbidium* is the most popular orchid, accounting for 3% of total cut flower production in floricultural crops. *Dendrobium* 'Sonia-17' is a popular variety of orchid grown in India. Which is fast growing, floriferous, with long vase life.

Different physiological processes such as ethylene production and respiration cause the degradation and reduce the post-harvest life of cut flowers of *Dendrobium*. Due to such reasons and improper handling 10 -30 % of post-harvest loss occurs in the cut flowers industry, by using such preservatives we can significantly reduce the post-harvest losses by improving the vase life of cut flowers, hence this experiment was conducted to improve the vase life of cut spikes of *Dendrobium*.

Material and Methods

Dendrobium 'Sonia-17' were taken from 'Tarra' Village orchid farm with standard production procedure, which is 21-23 km far from College of Agriculture Raipur. The flowers were harvested at commercial maturity and kept in water after harvest for maintaining freshness and turgidity of spikes, and then the cut end of spikes were tied up with moistened cotton in small plastic bags and then the spikes were kept in polythene bags taking sufficient care. 10 spikes were packed in one polythene and then packed into CFB boxes and brought to the laboratory. The whole experiment was laid out in completely randomized design

(CRD) with 13 treatments and 3 replication. The treatment used were T₀ Tap water (Control), T₁ Sucrose 4%, T₂ Glucose 5%, T₃ Salicylic Acid 200 ppm + Sucrose 4%, T₄ Salicylic Acid 300 ppm + Glucose 5%, T₅ Citric Acid 300 ppm + Sucrose 4%, T₆ Citric acid 400 ppm + Glucose 5%, T₇ Aluminium Sulfate [Al₂(SO₄)₃] 100 ppm + Sucrose 4%, T₈ Aluminium Sulfate [Al₂(SO₄)₃] 200 ppm + Glucose 5%, T₉ Aspirin 200ppm + Sucrose 4%, T₁₀ Aspirin 300 ppm + Glucose 5%, T₁₁ Lemon juice 35 ml + Sprite 45 ml + Laundry bleach 15 ml per liter, and T₁₂ Lemon juice 30 ml + Sugar 10 gm + Listerine 20 ml per liter and the observations were recorded on initial weight of spike, final weight of spike, weight loss (%), days to first petal dropping, days of first floret wilting, diameter of first floret (cm), percent of fully opened buds, percent of half opened buds, maximum number of opened buds per spike, unopened buds per spike, number of florets per spike, floret diameter (cm), longevity of first floret (days), longevity of flower, days of fading of last flower and vase life (days) of spikes.

Result and Discussion

Different preservative solution showed significant impact on physiological weight loss of cut spikes of *Dendrobium*. The lowest weight loss is observed in T₃ (salicylic acid 200 ppm + sucrose 4%) with 32.24% which was followed by T₆ (citric acid 400 ppm + glucose 5%) with 34.55 %.

The treatment effect revealed that the application of different preservative solution had significant effect on bud opening of cut *Dendrobium*. Highest percent of fully opened buds was observed in treatment T₃ (Salicylic acid 200 ppm + sucrose 4 %) with 95.99 % which was followed by treatment T₆ (Citric acid 400 ppm + glucose 5%) with 93.22 %.

The effect of different preservatives on the number

Table-1 : The effect of different preservative solutions on different parameters of *Dendrobium* Cv. Sonia-17.

Treatments	Physiological weight loss (%)	Percentage of fully open buds	No. of opened buds	No. of unopened buds	Diameter of 1 st floret (cm)	Diameter of Florets (cm)
T ₀	47.80	61.33	4.48	2.79	7.76	7.55
T ₁	40.58	71.26	5.51	2.22	8.29	8.21
T ₂	43.05	70.23	5.49	2.33	8.44	8.20
T ₃	32.24	95.99	8.00	0.33	9.28	8.75
T ₄	35.41	88.07	7.29	1.00	8.59	8.13
T ₅	37.24	87.65	6.28	0.88	8.50	8.11
T ₆	34.55	93.32	7.71	0.56	8.96	8.51
T ₇	36.89	85.18	6.46	1.14	8.41	8.23
T ₈	36.35	86.32	6.56	1.04	8.52	8.33
T ₉	35.75	82.80	6.60	1.38	8.58	8.36
T ₁₀	36.35	87.84	7.13	1.00	8.57	8.48
T ₁₁	41.22	84.38	6.23	1.15	8.31	8.34
T ₁₂	35.89	82.33	6.93	1.47	8.34	8.39
Mean	37.94	82.84	6.51	1.33	8.50	8.27
CD at 5%	4.67	4.57	0.63	0.14	0.69	0.54
SEm±	1.61	1.57	0.21	0.40	0.23	0.18

Table-2 : The effect of different preservative solutions on different parameters of *Dendrobium* Cv. Sonia-17.

Treatments	Days of 1 st floret wilting	Days of 1 st petal dropping	Days of fading of last flower	Longevity of 1 st floret (Days)	Longevity of flowers (Days)	Vase life (Days)
T ₀	2.67	2.78	18.00	7.73	16.33	14.78
T ₁	4.11	4.33	19.78	9.49	18.44	17.11
T ₂	4.00	4.22	21.11	9.45	19.11	17.89
T ₃	7.44	8.11	29.78	18.00	27.56	25.22
T ₄	6.67	6.89	28.56	16.73	26.78	24.67
T ₅	6.44	6.44	27.67	16.24	25.67	23.33
T ₆	7.00	7.11	29.00	17.67	27.11	24.56
T ₇	6.89	7.03	27.09	15.16	25.00	22.22
T ₈	6.67	6.67	27.33	15.89	25.44	21.33
T ₉	6.33	6.33	27.56	16.02	25.56	22.78
T ₁₀	6.56	6.78	28.44	16.89	26.56	24.00
T ₁₁	5.67	6.00	26.22	14.67	24.11	21.89
T ₁₂	6.00	6.11	25.56	14.44	24.00	20.78
Mean	5.88	6.06	25.85	14.49	23.97	21.58
CD at 5%	1.01	0.85	0.95	1.52	1.20	1.62
SEm±	0.34	0.29	0.32	0.52	0.41	0.56

of opened buds of *Dendrobium* cut spikes varied significantly. T₃ (Salicylic Acid 200 ppm + Sucrose 4%) had the most buds opened with 8.0 buds, followed closely by T₆ (Citric acid 400 ppm + Glucose 5%) with 7.71 buds.

Number of unopened bud were observed minimum from T₃ (Salicylic Acid 200 ppm + Sucrose 4%) with 0.33 buds followed by T₆ (Citric acid 400 ppm + Glucose 5%) 0.56 buds.

The effect of different preservatives on diameter of first floret of cut spikes of *Dendrobium* showed significant results. Maximum diameter of first floret was observed from T₃ (Salicylic Acid 200 ppm + Sucrose 4%) with 9.28 cm which was *at par* with T₆ (Citric acid 400 ppm + Glucose 5%) with 8.96 cm.

The effect of different preservatives on average

floret diameter of cut spikes of *Dendrobium* showed significant effect. Average floret diameter were observed maximum from T₃ (Salicylic Acid 200 ppm + Sucrose 4%) with 8.75 cm which was followed by T₆ (Citric acid 400 ppm + Glucose 5%) with 8.51 cm.

The effect of different preservatives on initial floret wilting of cut *Dendrobium* spikes showed significant outcomes. T₃ (Salicylic Acid 200 ppm + Sucrose 4%) exhibited delayed initial floret wilting with 7.44 days which was on par with T₆ (Citric acid 400 ppm + Glucose 5%) with 7.00 days.

The effect of different preservatives on first petal dropping of *Dendrobium* cut spikes showed significant effect. T₃ (Salicylic Acid 200 ppm + Sucrose 4%) showed delayed first petal dropping and it was on par with T₆

(Citric acid 400 ppm + Glucose 5%) with 8.11 and 7.11 days respectively.

The effect of different preservatives on the days of fading of the last bloom of cut *Dendrobium* spikes showed significant results in all treatment combinations. Maximum days of fading of last flower with 29.78 days observed from T₃ (Salicylic Acid 200 ppm + Sucrose 4 %) was on par with T₆ (Citric acid 400 ppm + Glucose 5 %) with 29.0 days.

Maximum longevity of first floret was observed from T₃ (Salicylic Acid 200 ppm + Sucrose 4%) with 18.00 days followed by T₆ (Citric acid 400 ppm + Glucose 5%) with 17.67 days.

Longevity of flower were observed maximum from T₃ (Salicylic Acid 200 ppm + Sucrose 4%) with 27.56 days which was followed by T₆ (Citric acid 400 ppm + Glucose 5%) with 27.11 days.

The effect of different preservatives vase life of cut spikes of *Dendrobium* showed significant results among all the treatment combinations except control. Maximum vase life in days was observed from T₃ (Salicylic Acid 200 ppm + Sucrose 4%) with 25.22 followed by T₄ (Salicylic Acid 300 ppm + Glucose 5%) with 24.67 days.

Reduced physiological weight loss is related to salicylic acid's effect in reducing tissue transpiration and evaporation, as well as slowing the respiration process, resulting in fresh weight loss avoidance in cut spikes (Serek *et al.* 1995) also reported by Ezhilmathi *et al.* (2007).

The amount of carbohydrate in the petal has been linked to flower opening (Van Doorn *et al.*, 1991). Bud opening is influenced by intact cell membrane (Toorre *et al.*, 1999), carbohydrate accumulation (Waithaka *et al.*, 2001) and water uptake (Mayank and Halevy, 1974). So higher water uptake, fresh weight and high petal sugar content with the vase solution treatment of Salicylic acid 200 ppm + 4 % sucrose resulted in a higher bud opening percentage in *Dendrobium* cut spikes.

Effect of salicylic acid as an anti-transpirant by inducing stomatal closure or preventing the conversion of amino cyclopropane-1- carboxylic acid to ethylene could explain the increased flower diameter (Leslie and Romani, 1986) with T₃ (200 ppm salicylic acid + 4 % sucrose). Increased water intake results in increase in cut flower fresh weight, ultimately increase in petal turgidity, which could lead to an increase in diameter (Bayat *et al.* 2017).

Salicylic acid and sucrose treatment was found to be effective in preserving the colour of cut flowers, also reported by Hariri *et al.* 2019.the increased vase life of

cut spikes was may be due to salicylic acid's role as antimicrobial substance and ethylene inhibitor (Bayat & Aminifard, 2017) which helped in delaying senescence. SA with activated antioxidant enzymes can delays the senescence of cut flowers and lowering lipid production per oxidation resulting delay in senescence (Jamshidi *et al.*, 2012) ultimately results in improved vase life.

Conclusions

The data from the present findings concluded that the treatment T₃ (salicylic acid 200 ppm + sucrose 4%) had a superior performance in almost all considerable aspects under study. The result revealed that the treatment T₃ (Salicylic acid 200 ppm + sucrose 4%) was found significant on almost all the parameters and showed maximum percentage of bud opening with maximum longevity and vase life.

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Management of Leaf Spot Disease in Turmeric by Using Bioinoculants, Liquid Organic Manure and Chemicals

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Abstract

Turmeric (*Curcuma longa* L.) is an important spice crop that is being grown in India since ancient times that belongs to the Zingiberaceae family. Among all the turmeric producing countries, India holds a dominant share in terms of export and production and is the largest turmeric producing country globally. A huge share of its produce is lost due to various fungal diseases. Leaf spot disease, caused by *Colletotrichum capsici*, is a major limiting factor that hampers the successful cultivation of turmeric in the country. Therefore, a field experiment was conducted in the crop season of the year 2020 for evaluation of the efficacy of bio inoculants, chemical fungicides and fermented liquid manure for the management of the leaf spot disease in turmeric. The experiment comprised of 8 treatments (T₁ to T₈), including an untreated control with three chemicals, two bioinoculants (alone and in combination) and one fermented liquid manure. In the present investigation, the plant height and number of leaves were found maximum in T₈ (*Trichoderma asperellum* + *Pseudomonas fluorescens*) with 87.500 cm and 7.867, respectively, followed by T₅ (Herbal *Kunapajala*) with 85.953 cm and 7.600. Difenconazole @ 0.1 % and Propiconazole @ 0.1 % were found most effective in reducing the disease severity (23.703 % and 24.592 %, respectively) with a yield of 12.601 t/ha and 11.850 t/ha, respectively. The cost-benefit ratio was found maximum (1:3.328) in T₂ (Propiconazole) followed by T₃ (Difenconazole) and T₈ (*Trichoderma asperellum* + *Pseudomonas fluorescens*) with 1:3.319 and 1.2.297, respectively. It is evident from the present study that the treatment *Trichoderma asperellum* + *Pseudomonas fluorescens* was found most effective with respect to plant growth parameters and was not far behind in reducing the disease incidence and severity against the leaf spot disease and thus, can be applied in order to avoid leaf spot disease and enhancing growth in turmeric crop to avoid the dependency on the synthetic fungicides.

Key words : Turmeric, leaf spot, *Trichoderma asperellum*, *Pseudomonas fluorescens*, herbal *Kunapajala*

Introduction

Turmeric (*Curcuma longa* L.) is a perennial rhizomatous spice crop that belongs to the Zingiberaceae family. It is one of the most important spice crops grown in India, cultivated primarily for its underground rhizome that yields a yellow powder (Chattopadhyay, 2004; Li *et al.*, 2011; Nongmaithem and Rebika, 2019). Turmeric has long antiquity for its use in India along and other Asian countries as condiment, dye, carminative, antiseptic, and antiparasitic (Ahmad *et al.*, 2020; Guji and Woga, 2019). India dominates the international turmeric market in terms of production, consumption and export. About 80 % of the whole turmeric production in the world is produced in India, with an average production of about 946.65 MT (NHB, 2018). In 2019, India exported turmeric worth approximately 194.35 billion US dollars (Shahbandeh, 2020).

A considerable share of turmeric production is lost

due to various fungal diseases such as leaf blotch, anthracnose, leaf spot, rhizome rot, etc. Among these diseases, leaf spot is the most important disease of turmeric, which results in significant qualitative and quantitative losses viz., up to 62.10 % in the major turmeric growing regions of the world (Hudge and Ghogul, 2010; Jagtap *et al.*, 2013; Kothikar and Koche, 2017). The pathogen responsible for leaf spot in turmeric is *Colletotrichum capsici* (Syd.) Butler and Bisby, a hemibiotic pathogen that causes significant losses due to the loss in the photosynthetic area of the turmeric leaves (Rao *et al.*, 2012; Kumar and Mishra, 2020). The disease usually appears in the field during August and September when there is high relative humidity in the atmosphere (Kadam *et al.*, 2014). The symptoms of leaf spot in turmeric appear on leaves as elliptical to oblong brown irregular spots of various sizes on the upper surface of leaves in turmeric plants (Rao, 1985). The spots measure from 2.5 cm to 4 cm in length and 1.5 to 2.5 cm in width.

Table-1: Details of the treatments used in the field experiment.

S. No.	Symbol	Treatment	Concentration
1.	T ₁	Control	-
2.	T ₂	Propiconazole	0.1 %
3.	T ₃	Difenoconazole	0.1 %
4.	T ₄	Copper oxychloride	0.3 %
5.	T ₅	Herbal <i>Kunapajala</i>	12.5 %
6.	T ₆	<i>Trichoderma asperellum</i>	1 %
7.	T ₇	<i>Pseudomonas fluorescens</i>	1 %
8.	T ₈	<i>Trichoderma asperellum</i> + <i>Pseudomonas fluorescens</i>	0.5 + 0.5 %

Table-2 : Disease rating scale for turmeric leaf spot given by Mayee and Datar (1986).

Scale (G)	Disease severity	Host response
0	No symptoms on plants	Highly Resistant (HR)
1	Small spots on leaves; less than 1 % area was infected	Resistant (R)
3	Medium spots on leaves; covering 1-10 % area of leaf	Moderately Resistant (MR)
5	Bigger coalescing spots, covering 11 % to 25 % area of leaf	Moderately Susceptible (MS)
7	Large coalescing spots, covering 26 % to 50 % area of leaf	Susceptible (S)
9	Spots covering more than 51 % to 75 % area of the leaf	Highly Susceptible (HS)

These spots coalesce later and eventually dry up, giving a blighted appearance (Guji and Woga, 2019).

The losses that occur in turmeric production due to the leaf spot disease can be mitigated using a variety of synthetic fungicides such as propiconazole, difenoconazole, copper oxychloride, etc. (Jagtap *et al.*, 2013; Rao and Kumar, 2013; Narasimhudu and Balasubramanian, 2002). However, these fungicides are not considered to support the sustainable development in modern times as the pathogens become resistant to fungicides. The chemical fungicides also have residual effects on the environment and human health (Ons *et al.*, 2020). Hence, it is beneficial to incorporate bioagents (*Trichoderma* spp., *Pseudomonas* spp., *Bacillus* spp., etc.) and other plant and animal origin products (Panchgavya, Herbal *Kunapajala*, etc.) in management strategies. Therefore, the present study was undertaken to evaluate and compare the efficacy of fungicides, bio inoculants and fermented liquid manure (Herbal *Kunapajala*) against the leaf spot disease in turmeric.

Materials and Methods

The present investigation was conducted at Vegetable Research Block and Laboratory of Plant Pathology Division, College of Forestry, Ranichauri, Tehri Garhwal, Uttarakhand during the crop season April- December, 2020. The field experiment was laid out in Randomized block design.

Evaluation of, fungicides, fermented liquid manure and bioinoculants against the leaf spot disease in turmeric under field conditions : A local variety of turmeric was selected and the rhizomes were sown in the experimental field at Vegetable Research Block in College of Forestry, Ranichauri. The field experiment was carried out in Randomized Complete Block Design with eight

treatments, and three replications. The rhizomes were sown in raised beds of size 2 × 1.8 m² at a spacing of 40 cm between the rows and 20 cm between the plants. The treatments comprised of three fungicides, Herbal *Kunapajala*, bio inoculants and one untreated control. The details of these treatments are shown in Table-1. The treatments were applied to the field in three applications at an interval of 30 days, starting from the first appearance of the disease. The view of the experimental field is shown in Fig-1. Observations for the growth parameters were taken at the physiological maturity of the crop, and for the disease, parameters were recorded at an interval of 30 days from August to November.

Observations were made for plant height (cm), the number of leaves, yield, per cent disease incidence, per cent disease severity, per cent disease control, yield and economics of the treatments. The per cent disease incidence was recorded for the number of plants found infected in the field, and disease severity for the leaf spot disease was recorded by the scale (Table-2) and calculated by the formula given by Mayee and Datar (1986), and per cent efficacy of disease control (PEDC) was calculated by the formula given by Vincent (1927).

Per cent disease incidence

$$= \frac{\text{Total number of plants infected}}{\text{Total number of plants}} \times 100$$

Per cent disease severity

$$= \frac{\text{Sum of the numerical ratings}}{\text{Total number of leaves observed} \times \text{Maximum grade}} \times 100$$

$$\text{PEDC} = \frac{\text{Disease severity in control} - \text{Disease severity in treatment}}{\text{Total number of leaves observed} \times \text{Maximum grade}} \times 100$$

Table-3 : Effect of different treatments on plant height, number of leaves and yield of turmeric under field conditions.

S. No.	Symbol	Treatments	Concentration	Plant height (cm)	No. of leaves	Yield per plot (Kg/plot)
1.	T ₁	Control	-	69.453 ± 0.219	4.867 ± 0.067	2.733 ± 0.176
2.	T ₂	Propiconazole	0.1 %	78.527* ± 1.434	7.067* ± 0.067	4.267* ± 0.130
3.	T ₃	Difenoconazole	0.1 %	79.240* ± 0.783	7.133* ± 0.067	4.537* ± 0.188
4.	T ₄	Copper oxychloride	0.3 %	75.447* ± 0.762	6.667* ± 0.067	3.123* ± 0.062
5.	T ₅	Herbal <i>Kunapajala</i>	1 %	85.953* ± 0.672	7.600* ± 0.115	3.283* ± 0.169
6.	T ₆	<i>Trichoderma asperellum</i>	12.5 %	83.687* ± 0.548	7.400* ± 0.115	3.503* ± 0.163
7.	T ₇	<i>Pseudomonas fluorescens</i>	1 %	80.133* ± 0.508	7.267* ± 0.067	3.450* ± 0.104
8.	T ₈	<i>Trichoderma asperellum</i> + <i>Pseudomonas fluorescens</i>	0.5 + 0.5 %	87.500* ± 0.572	7.867* ± 0.067	3.950* ± 0.375
SE(d)				0.735	0.123	0.276
C.D. (0.05)				1.593	0.266	0.598

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

Table-4 : Effect of different treatments on per cent disease incidence, per cent disease severity and per cent efficacy of disease control (PEDC) after 120, 150, 180 and 210 DAS (Days after sowing).

S. No.	Symbol	Treatment	Conc.	Disease Incidence (%)	Disease Severity (%)	PEDC (%)
1.	T ₁	Control	-	55.555 ± 1.283 (48.172)	63.111 ± 1.602 (52.588)	-
2.	T ₂	Propiconazole	0.1 %	22.222* ± 1.283 (28.096)	24.592* ± 1.459 (29.697)	60.978 ± 2.530 (51.340)
3.	T ₃	Difenoconazole	0.1 %	21.481* ± 0.741 (27.594)	23.703* ± 0.392 (29.121)	62.405 ± 0.913 (52.164)
4.	T ₄	Copper oxychloride	0.3 %	32.592* ± 0.741 (34.796)	34.073* ± 1.413 (35.690)	45.824 ± 3.686 (42.570)
5.	T ₅	Herbal <i>Kunapajala</i>	12.5 %	33.333* ± 0.741 (35.242)	36.296* ± 0.646 (37.030)	42.465 ± 0.495 (40.649)
6.	T ₆	<i>Trichoderma asperellum</i>	1 %	25.185* ± 0.741 (30.105)	27.259* ± 0.784 (31.456)	56.690 ± 1.644 (48.829)
7.	T ₇	<i>Pseudomonas fluorescens</i>	1 %	29.629* ± 1.960 (32.962)	29.777* ± 1.026 (33.052)	52.774 ± 1.780 (46.574)
8.	T ₈	<i>Trichoderma asperellum</i> + <i>Pseudomonas fluorescens</i>	0.5 + 0.5%	23.703* ± 0.741 (29.117)	25.037* ± 0.534 (30.010)	60.255 ± 1.606 (50.904)
SE(d)				1.350	1.474	2.065
C.D. (0.05)				2.924	3.191	4.473

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

Values in parenthesis are angular transformed, Conc. = Concentration

Isolation and identification of the pathogen : The infected leaves of turmeric, showing the typical leaf spot symptoms, were collected from the untreated plots and were brought to the Plant Pathology Laboratory, College of Forestry, Ranichauri. Those leaf samples were then washed thoroughly with sterilized distilled water followed by air drying. The sample leaves were then cut into small pieces of about 4mm, having both the healthy and diseased portions. Those cut portions were then surface sterilized with double distilled water and sodium hypochlorite followed by air drying on the sterilized blotting paper. The inoculation of these cut portion onto the petri plates containing the PDA medium was done under aseptic conditions provided by a laminar airflow chamber. These plates were then incubated at 25±2 °C in a BOD incubator for about 7-10 days for the fungus to grow. The fungus was then observed under a compound microscope for its identification.

Pathogenicity test : The pathogenicity test was carried out on the healthy turmeric plants grown in earthen pots under the glasshouse conditions at 28±2 °C and 95 % relative humidity. A conidial suspension of the fungal culture was prepared with distilled water using a

haemocytometer (1×10^4 conidia ml⁻¹ of water). This suspension was then inoculated into the healthy turmeric leaves using an artificial inoculation method, viz. foliar inoculation. After inoculation these plants were covered with polythene bags for 48 hours to ensure high humidity for the conidial germination and infection. These leaves were then observed regularly for the appearance of the leaf spot symptoms. The organism associated with the infected leaves was then re-isolated on potato dextrose agar medium and examined under the compound microscope for the confirmation of the pathogen.

Results and Discussion

Evaluation of fungicides, fermented liquid manure and bioinoculants against the leaf spot disease in turmeric under field conditions

Plant growth parameters : The maximum plant height was observed in T₈ (*Trichoderma asperellum* + *Pseudomonas fluorescens*) with 87.500 cm. It was followed by T₅ (Herbal *Kunapajala*) with 85.953 cm, T₆ (*Trichoderma asperellum*) with 83.687cm and T₇ (*Pseudomonas fluorescens*) with 80.133 cm. The maximum number of leaves (7.867) were recorded in T₈

Table-5 : Estimation of C: B ratio of different treatments on turmeric crop growing under field conditions.

S. No.	Symbol	Treatment	Concentration	Gross Return/ha (Rs)	Cost of cultivation/ha (Rs)	Net returns (Rs)	Cost Benefit ratio
1.	T ₁	Control	-	436080	213300	222780	1:2.044
2.	T ₂	Propiconazole	0.1 %	756060	227130	528930	1:3.328
3.	T ₃	Difenoconazole	0.1 %	756060	227760	528300	1:3.319
4.	T ₄	Copper oxychloride	0.3 %	574980	226878	348102	1:2.534
5.	T ₅	Herbal <i>Kunapajala</i>	1 %	520500	226536	293964	1:2.297
6.	T ₆	<i>Trichoderma asperellum</i>	12.5 %	546200	226689	319511	1:2.575
7.	T ₇	<i>Pseudomonas fluorescens</i>	1 %	583860	226689	357171	1:2.409
8.	T ₈	<i>Trichoderma asperellum</i> + <i>Pseudomonas fluorescens</i>	0.5 + 0.5 %	658320	226689	431631	1:2.904



Fig-1 : The experimental field for the field evaluation of different treatments against the leaf spot disease in turmeric.

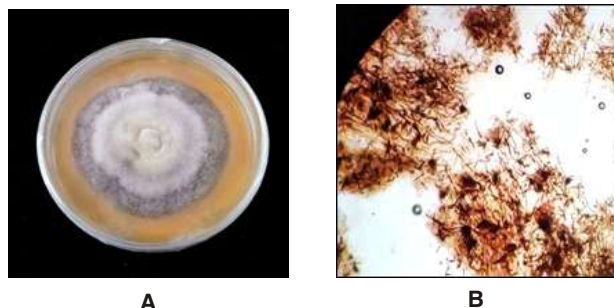


Fig. 2 :
 A. Mycelial colony of *Colletotrichum capsici*.
 B. Acervuli and conidia of *Colletotrichum capsici*.

(*Trichoderma asperellum* + *Pseudomonas fluorescens*). It was followed by T₅ (Herbal *Kunapajala*) with 7.600, T₆ (*Trichoderma asperellum*) with 7.400 and T₇ (*Pseudomonas fluorescens*) with 7.267 number of leaves.

The maximum rhizome yield (4.537 kg/plot) was obtained in T₃ (Difenoconazole) followed by T₂ (Propiconazole) with 4.267 kg/plot and T₈ (*Trichoderma asperellum* + *Pseudomonas fluorescens*) with 3.950 kg/plot. T₇ (*Trichoderma asperellum*) with 3.503 kg/plot, T₆ (*Pseudomonas fluorescens*) with 3.450 kg/plot and T₅ (Herbal *Kunapajala*) with 3.283 kg/plot also showed

significant efficacy in yield over control. All the treatments were found significant over control (Table-3).

Disease parameters : The present investigation was undertaken with a view to compare the effect of three fungicides (Propiconazole, Difenoconazole and Copper oxychloride) with three bioinoculants (*Trichoderma asperellum*, *Pseudomonas fluorescens*, and *Trichoderma asperellum* + *Pseudomonas fluorescens*) and Herbal *Kunapajala*. It is evident from Table-4 that all the treatments were significantly effective over Control in reducing the disease incidence and severity.

The minimum disease incidence (21.481 %) was recorded in T₃ (Difenoconazole) which was found statistically at par with treatment T₂ (Propiconazole) with 22.222 %. It was followed by T₈ (*Trichoderma asperellum* + *Pseudomonas fluorescens*) with 23.703%. The maximum disease incidence was recorded in T₁ (Control) with 55.555 % followed by T₅ (Herbal *Kunapajala*) with 33.333 %.

The lowest disease severity was observed in T₃ (Difenoconazole) with 23.703 % (5 G) which was found statistically at par with T₂ (Propiconazole) with 24.592 % (5G). It was followed by T₈ (*Trichoderma asperellum* + *Pseudomonas fluorescens*) with 25.037 % (5G), T₇ (*Trichoderma asperellum*) with 27.259 % (7G) and T₆ (*Pseudomonas fluorescens*) with 29.777 % (7 G). In Herbal *Kunapajala*, the per cent disease severity of 36.296 % (7G) was recorded whereas highest per cent disease severity with Highly Susceptible (HS) response was recorded in T₁ (Control) with 63.111 % disease severity and 9 G scale.

The per cent efficacy of disease control (PEDC) was found best in T₃ (Difenoconazole) with 62.405 %. It was followed by T₂ (Propiconazole) with 60.978 %, T₈ (*Trichoderma asperellum* + *Pseudomonas fluorescens*) with 60.255 % and T₇ (*Trichoderma asperellum*) with 56.690 % while the minimum PEDC was recorded in T₅ (Herbal *Kunapajala*) with 42.465 % and T₄ (Copper oxychloride) with 45.824 %.

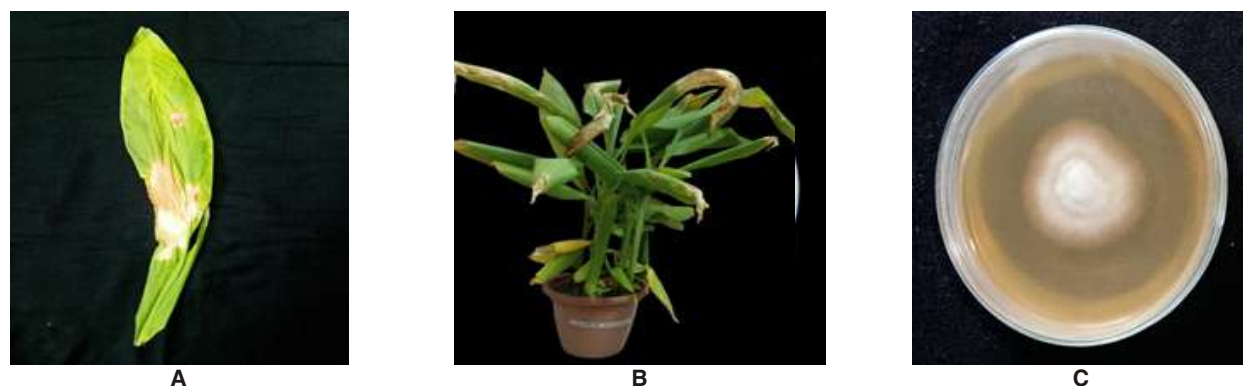


Fig-3 :

- A. Turmeric leaf showing the symptom of leaf spot disease.
 B. Turmeric plants on earthen pot infected with leaf spot disease.
 C. Colony growth of re-isolated pathogen.

Economics of treatments : Cost benefit ratio was worked out on the basis of mean yield obtained from the pooled analysis. All the treatments proved beneficial over control (Table-5). Among the treatments, propiconazole (1:3.328) followed by difenoconazole (1:3.319), *Trichoderma asperellum* + *Pseudomonas fluorescens* (1:2.904), *Trichoderma asperellum* (1:2.575), copper oxychloride (1:2.534), *Pseudomonas fluorescens* (1:2.409), and Herbal *Kunapajala* (1:2.29). showed higher cost benefit ratio when compared to Control (1. 2044).

Identification of the isolated pathogen : The pure culture obtained from the infected leaves was examined regularly for the colony characteristics, and the mycelium was observed under a compound microscope. The mycelial growth of the pathogen appeared to be white to grey in colour with a cottony texture and serrated margin on the PDA plates. The microscopic characteristics of the pathogen revealed that the conidia of the pathogen were fusiform with curved ends while the acervuli were rounded, having numerous setae attached to it, as shown in Fig-2. On the basis of observed characteristics, the isolated organism was identified as *Colletotrichum capsici*. The characters were found similar to those as described in the literature of Rangaswami (1972), Adhipathi *et al.* (2013), along with Rajamanickam and Sethuraman (2015).

Pathogenicity test : The pathogenicity test was carried out on earthen pots by artificial inoculation methods. The typical symptoms of leaf spot disease appeared after 6-8 days of inoculation. The disease appeared as brown spots with yellow halo on the leaves. The spots were irregular in shape which in later stages coalesced and covered the larger area on leaves. The spots were seen with brown dots (acervuli) on the leaves. The morphology and microscopic characters of the re-isolated pathogen were similar to the original pathogen i.e. *Colletotrichum capsici*. The mycelium colony on the PDA plate was white in

colour, having cottony texture. The conidia of the pathogen had curved ends. The acervuli had numerous setae attached to it which were similar as previously observed in Fig-2(B). The observations for the disease symptoms on turmeric plants and pathogen growth are shown in Fig-3.

The plant growth parameters were found best under the effect of bio inoculants and Herbal *Kunapajala* rather than the chemicals. The plant height and number of leaves were found best in *Trichoderma asperellum* + *Pseudomonas fluorescens* which is similar to the findings of Selvi *et al.* (2020). This may be because the bio inoculants, *Trichoderma asperellum* and *Pseudomonas fluorescens* are known to produce IAA (Indole-3-Acetic Acid), HCN (Hydrogen cyanide) production, inorganic phosphate solubilization and production of cellulose which result in better growth of the plants (Kumar *et al.*, 2016; Vinayarani *et al.*, 2019). On the other hand, fermented liquid manure, Herbal *Kunapajala* was also found effective for the plant growth parameters in turmeric. This may be due to the breakdown of larger molecules i.e., proteins, carbohydrates, and fats e.t.c. into their secondary metabolites which are absorbed by the plants at a faster rate (Nene, 2018) The beneficial effects of this liquid manure on soil and plant health can also be attributed due to the presence of organic carbon, beneficial microbes, and growth hormones (Ali *et al.*, 2012).

The disease parameters, i.e. per cent disease incidence, per cent disease severity and PEDC were found best under the effect of Difenoconazole, followed by Propiconazole and *Trichoderma asperellum* + *Pseudomonas fluorescens*. Similar results were observed by Gopinath *et al.*, (2006), Jagtap *et al.*, (2013). Propiconazole and Difenoconazole, belonging to triazole group of fungicides, inhibit one specific enzyme, C14-demethylase, which plays a role in sterol production

resulting in the inhibition of sterol biosynthesis pathway. Therefore, these fungicides result in abnormal fungal growth and eventually death (Mueller, 2006; Yang *et al.*, 2011). Furthermore, the Propiconazole treatment might also increase the activity of superoxide dismutase and photochemical activity (Zhang and Schmidt, 2000)

The benefit cost ratio was found to be highest under the effect of Propiconazole which are in conformity with Gorawar *et al.* (2006) and Mishra and Pandey (2015). Though Difenconazole was more effective for the per cent disease over control and yield per plot, the net returns were less due to the high cost of the fungicide.

Conclusions

It is evident from the present study that all the treatments were found significantly effective over the Control. Among the chemicals, difenoconazole was most found most effective in terms of disease parameters whereas for the growth parameters, *Trichoderma asperellum* + *Pseudomonas fluorescens* was found most effective followed by *Trichoderma asperellum* and *Herbal Kunapajala*. The results also revealed that the bioagents and *Herbal Kunapajala* was not far behind in reducing the disease incidence and severity against the leaf spot disease. It can be concluded that the treatment *Trichoderma asperellum* + *Pseudomonas fluorescens* was found most effective with respect to plant growth parameters followed by *Herbal Kunapajala* and as was not far behind in reducing the disease incidence and severity against the leaf spot disease and thus, can be applied in order to avoid leaf spot disease and enhancing growth in turmeric crop to avoid the dependency on the synthetic fungicides.

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Physical Characteristics of Soil as Influenced by Application of Organics and Chemical Fertilizer

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Abstract

A field experiment was conducted to study the effect of integrated nutrient management on physical properties of soil at Mandan Bharti Agriculture College, Agwanpur, Saharsa, Bihar. The experiment comprised 16 treatments combinations viz., N, P and K fertilizer application in conjunction with vermicompost, water hyacinth compost and vermicompost + water hyacinth compost. The experimental treatments were replicated three times. Vermicompost and water hyacinth compost improved the physical of soil like infiltration rate, soil penetration resistance and available water storage capacity of soil. The integration of organic manures and chemical fertilizer resulted in a positive influence on infiltration rate, soil penetration resistance and availability water storage capacity by increasing organic matter content in soil.

Key words : Organics, inorganic fertilizer, physical properties, wheat.

Introduction

Land degradation is observed in all agro-climatic regions on all continents. It is estimated that out of the 328 m ha of the total geographical area in India, 173.65 m ha are degraded, producing less than 20% of its potential capacity (Gol, 1990) and out of this 89.52 m ha suffer from one or the other form of physical constraints viz., shallow depth, soil hardening, slow and high permeability, sub-surface compacted layer, surfacing crusting, temporary water logging etc. (Painuli and Yadav, 1998).

Maintaining soil health is indispensable for sustaining the agricultural productivity at higher level. Soil health includes three groups of mutually interactive attributes i.e. soil physical, chemical and biological properties which must be restored at its optimum to sustain productivity. The adverse physical soil environment limits root growth and its activity and results in reduced nutrient absorption and growth of plants (Chaudhary and Sandhu, 1983). The nature and extent of physical constraints have however, not static. The current scenario calls for appreciating the fact that once degraded, it is difficult to restore the soil to its good physical condition. The important reasons for low and declining crop responses to fertilizer nutrients include continuous nutrient mining from the soil due to imbalance nutrient use, keeping to serious soil degradation (Dass *et al.*, 2014). Soil organic carbon plays an important role in soil fertility and productivity. It can be used for assessing soil quality. Agricultural practices such as addition of organic manure, FYM, green manuring improves the content of soil organic carbon while recommended dose of NPK fertilizers alone does not sustain productivity

under continuous intensive cropping system (Yaduwanshi, 2003). However, the combined application of organic manure and chemical fertilizer has been shown to improve soil organic carbon in comparison to addition of organic fertilizer alone (Mandal *et al.*, 2003). Water hyacinth are rich in nitrogen upto 3.2% of dry matter and have a C/N ratio around 15. It can be used as a substrate for compost. Water hyacinth due to its abundant growth and high concentration of nutrients ha a great potential as fertilizer (Bote *et al.*, 2020). Therefore, present study was carried out to study the effect of different organic sources of nutrient in conjunction with chemical fertilizer on physical parameters of a Typic Ustifluvents.

Materials and Methods

A field experiment was under taken during *rabi* season 2015-16 in light textured sandy loam soil of Mandan Bharti Agriculture College, Agwanpur, Saharsa in split plot design with four levels of NPK in main plot and four levels of organic sources in sub-plot treatment with four replications. The experimental site was located in between 25°52'50' North latitude and 86°48'62' East longitude in agro-climatic zone-II of Bihar having hot moist sub-humid climate. Wheat (*cv.* DBW-14) was grown as test crop during the reported period of 2015-16. Water hyacinth compost @ 10 t ha⁻¹, vermicompost alone or incombination with different levels of NPK fertilizer viz., 0, 50, 100 and 150 per cent of recommended dose were applied. Different doses of fertilizer in terms of N, P₂O₅ and K₂O were applied @120:60:40kg ha⁻¹, respectively. Nitrogen, phosphorus and potash were applied in the form of urea, SSP and MOP, respectively. Water hyacinth compost and vermicompost were applied before sowing

Table-1: Impact of organics and chemical fertilizers on infiltration rate (cm hr⁻¹) in soil.

Fertilizer Levels	Organic Sources				Mean
	No vermicompost and water hyacinth compost	Vermicompost	Water hyacinth compost	Vermicompost + water hyacinth compost	
No NPK	0.37	0.59	0.47	0.48	0.47
50% NPK	0.52	0.50	0.39	0.59	0.50
100% NPK	0.36	0.47	0.48	0.38	0.42
150% NPK	0.43	0.50	0.46	0.64	0.50
Mean	0.42	0.51	0.45	0.52	

Table-2 : Impact of organics and chemical fertilizers on soil penetration resistance (Mpa).

Fertilizer Levels	Organic Sources				Mean
	No vermicompost and water hyacinth compost	Vermicompost	Water hyacinth compost	Vermicompost + water hyacinth compost	
No NPK	1.18	1.15	1.09	0.85	1.06
50% NPK	1.16	1.13	1.08	0.92	1.07
100% NPK	1.14	1.11	1.11	0.88	1.06
150% NPK	1.18	1.17	1.16	1.08	1.14
Mean	1.16	1.14	1.11	0.93	

Table-3: Impact of organics and chemical fertilizers on available water storage capacity (cm m⁻¹).

Fertilizer Levels	Organic Sources				Mean
	No vermicompost and water hyacinth compost	Vermicompost	Water hyacinth compost	Vermicompost + water hyacinth compost	
No NPK	20.25	22.13	23.69	24.00	22.51
50% NPK	22.32	22.77	23.73	23.10	22.98
100% NPK	22.18	23.90	23.00	24.18	23.31
150% NPK	19.35	20.19	21.08	21.35	21.39
Mean	21.02	22.24	22.87	23.15	

of wheat. Agronomic and crop management practices followed were those recommended by Bihar Agricultural University, Sabour, Bhagalpur.

Infiltration characteristics of soil was determined in sites by double-ring infiltrometer using the Philip (1969) equation for limited condition.

$$IR = S/2 \quad t^{1/2} + A$$

Where

IR = Infiltration rate (ms⁻¹)

S = Sorptivity (ms^{-1/2})

A = Soil water

Soil penetration rate was determined using Penetrometer. Water holding capacity of the soil was determined by core samples using the following formula.

$$\text{Weight of water in soil (g)} = \frac{\text{Water holding capacity}}{\text{Weight of oven dry soil}} \times 100$$

Results and Discussion

The infiltration rate under different treatments was recorded after harvest of wheat (Table-1) which showed that cumulative infiltration varied from 0.37 (cm hr⁻³) to 0.64 (cm hr⁻³) under different treatment. The highest infiltration rate 0.64 (cm hr⁻³) was observed in the

treatment receiving 150% NPK + vermicompost + water hyacinth compost. Application of vermicompost, water hyacinth compost and combination of both increased the infiltration rate of water in the order vermicompost + water hyacinth compost 0.52 (cm hr⁻¹) > vermicompost (0.51 cm hr⁻¹) > water hyacinth compost (0.45 cm hr⁻¹) > no vermicompost, no water hyacinth compost. The infiltration rate was lowest (0.37 cm hr⁻¹) in the treatment having no organics and no chemical fertilizer. Thus it may be correlated that application of vermicompost, water hyacinth compost along with chemical fertilizers increased the infiltration rate of water as compared to chemical fertilizer alone, which may be attributed to improvement in bulk density and soil structure (Walia *et al.*, 2010). The application of organic manure generally improves the initial and steady infiltration rate due to increase in stability of soil aggregates (Saha *et al.*, 2010). Bhattacharyya *et al.* (2008) also reported incorporation of organic manure increase the infiltration rate and this may be due to increase in micro pores and macro pores in the soil resulting from better aggregation by cementing of soil organic carbon and favourable living soil organism. The effect of vermicompost, water hyacinth compost alone or in combination with NPK fertilizer on soil penetration rate is presented in table-2. As examine from the data, soil

penetration resistance varied from 0.85 Mpa to 1.18 Mpa under various treatment and maximum value (1.18 Mpa) was recorded in the control. Application of 150% of the recommended NPK as well as application of 100% of the recommended NPK offered more penetration resistance as compared to other treatments. Incorporation of vermicompost, water hyacinth compost along with inorganic fertilizer decrease the penetration resistance. The decrease in penetration resistance of soil may be attributed to improvement in the physical condition of soil on incorporation of vermicompost and water hyacinth compost which further decrease bulk density. These results are in agreement with the finding of Walia *et al.* (2010). Tiwari *et al.* (2000) reported similar increase in penetration resistance in a long term fertilizer experiment on a Typic Haplustepts soil. Reduction in bulk density and improvement in aggregation may explain the lower soil penetration resistance in organics treated plots (Saha *et al.*, 2010). Water infiltration by soil is known to be controlled primarily by (i) the no. of pores and pore size distribution of the soil (ii) the specific area of the soil. Furthermore as a result of decreased bulk density, the pore size distribution is altered and the relative number of small pores increase. The mean available water storage capacity of soil increased from 21.02 (cm m^{-1}) to 22.24, 22.87 and 23.15 (cm m^{-1}) with the application of vermicompost, water hyacinth compost and vermicompost + compost. The increasing order of effect was recorded as no manure 21.02 (cm m^{-1}) < vermicompost (22.24 cm m^{-1}) < water hyacinth compost (22.87 cm m^{-1}) < vermicompost + water hyacinth compost (23.15 cm m^{-1}). Highest available water storage capacity was recorded in 100% NPK + vermicompost + water hyacinth compost treatment. Organic manure application improves water retention properties of soil through its effect on pore size distribution and soil structure (Bandyopadhyay *et al.*, 2009). Hudson (1994) reported that soils high in organic matter content had greater available water holding capacity than the soils of similar texture with less organic matter. Aggelides and Londra (2000) also reported an improvement in structural component of soil due to the application of FYM with chemical fertilizer and microbial inoculants could be the possible reason of increase in available water storage capacity.

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Soil Fertility Assessment of Some Villages in Simri Bakhtiyarpur Block of Saharsa District in Bihar

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Abstract

Nutrient management plays in crucial role in achieving self-sufficiency in food grain production. High price index of chemical fertilizers coupled with mount pollution problem gave rise to interact in precision nutrient management tools. Site specific nutrient management increased and maintains the yield by optimizing the balance between supply and demand of nutrients. An assessment of soil fertility status is an essential requirement for making recommendation based on site specific nutrient management. In the light of their requirement the present study was under taken to assess the fertility status of Simri Bakhtiyarpur block of Saharsa district in Bihar. The study was carried out in four selected villages of the block. The results of the investigation revealed that mostly soils are near neutral in reaction and safe concerning electrical conductivity. The organic carbon varied from 0.390 - 0.552 per cent. The available macro nutrient content of the soil varied from soil 240 - 310, 23.98 - 37.15 and 138 - 187 kg ha⁻¹ N, P₂O₅ and K₂O, respectively. Similarly the available micronutrient content varied from 0.29 - 0.97, 1.23 - 2.32 and 20.25 - 71.66 ppm Zn, Cu and Fe, respectively. Low availability of nutrients and lower organic carbon content were identified to be the major soil related crop production constraints of the study area.

Key words : Soil testing, macro nutrients, micro nutrients

Introduction

Over the past few decades, chemical fertilizers have widely spread throughout the world with a focus that, the soil is an inert medium for plant roots, rather than as a living biosphere in which the crop is only one of the hundreds or thousands of interactions species (Dhanushkodi and Porkodi, 2018). However, it is new realized that in the field under intensive monoculture which receives heavy application of chemical fertilizers alone, there is a slow decline in productivity. Increasing productivity and production are essential to meet the food requirement of the burgeoning population. This is achieved through its unique balance of nutrients and clay minerals, which also increases microbial activity and build long term soil fertility soil fertility evaluation is a basic factor for the sustainable planning of a particular area (Khadka *et al.*, 2018). Determination of soil available nutrient status of an area using global positioning system (GPS) helps in formulating site-specific balanced fertilizer recommendations along with making critical decision on nutrient management. Site-specific nutrient management has been proposed as an approach to tailor fertilizers application to match the fixed specific needs of crops. This could be done by utilizing available information on indigenous nutrient supply, nutrients contribution, nutrient contribution from organic manure and crop residues pools and finally crop nutrient demand for targeted yield of crops. Soil organic carbon plays an important role in soil fertility and productivity. It can be used for assessing soil

quality. Large amount of soil organic carbon enhance water retention, present leaching of nutrients and maintaining soil fertility. Keeping this in consideration, an attempt has been made in the present investigation to determine the soil fertility status of Simri Bakhtiyarpur block in Saharsa district of Bihar. This kind of village level survey is highly necessary for taking region specific soil management decision.

Materials and Methods

Simri Bakhtiyarpur is a sub division and town in the Saharsa district of Bihar. There are 116 sub villages and 15 Nagar Panchayat in Simri Bakhtiyarpur. It is located about 20 km South from district headquarters. It is located in agro-climatic zone in between 25°43'0" north, 86°35'0" east at an elevation of 31 meter above mean sea level. The average annual temperature in Simri Bakhtiyarpur is 25.2 °C and receives annual rainfall of about 1100 mm. The Koshi river and its tributaries flood annually affecting about 21,000 kilometre square of fertile agriculture lands and affecting the rural economy. The area has been cultivated for a diverse range of crops such as maize, wheat, rice, gram, vegetables and mango. The soil samples were collected from four different villages of block namely Kusmi, Sonpura, Basatpur and Khoju Chak. Total eighty numbers of GPS based composite surface (0 – 15 cm) soil samples were collected from the study area which includes twenty samples from each villages from different land type. Soil sampling data including latitude, longitude and elevation above mean sea level was

Table-1 : Chemical properties of the study area.

Name of village	pH		Electrical Conductivity (dSm ⁻¹)		Organic Carbon (%)	
	Range	Mean	Range	Mean	Range	Mean
Kusmi	6.5 - 7.4	6.9	0.22 - 0.64	0.43	0.390 - 0.492	0.441
Sonpura	6.7 - 6.9	6.8	0.20 - 0.65	0.46	0.412 - 0.487	0.449
Basatpur	6.4 - 7.1	6.7	0.32 - 0.69	0.50	0.444 - 0.470	0.457
Khoju Chak	6.4 - 6.9	6.6	0.45 - 0.71	0.58	0.484 - 0.552	0.518

Table-2 : Macro nutrients availability of the study area.

Name of village	Available Nitrogen (kg ha ⁻¹)		Available P ₂ O ₅ (kg ha ⁻¹)		Available K ₂ O (kg ha)	
	Range	Mean	Range	Mean	Range	Mean
Kusmi	200 - 305	252	23.98 - 37.10	30.49	138 - 189	163
Sonpura	240 - 295	267	26.85 - 36.18	31.51	137 - 195	166
Basatpur	250 - 288	269	28.36 - 35.85	32.10	152 - 192	172
Khoju Chak	295 - 310	302	31.80 - 37.15	34.47	164 - 187	175

Table-3 : Micro nutrients availability of the study area.

Name of village	Available Zinc (Zn) (ppm)		Available Copper (Cu) (ppm)		Available Iron (Fe) (ppm)	
	Range	Mean	Range	Mean	Range	Mean
Kusmi	0.29 - 0.56	0.42	1.23 - 1.57	1.40	20.25 - 35.44	27.84
Sonpura	0.30 - 0.86	0.58	1.31 - 1.85	1.58	21.36 - 42.10	31.73
Basatpur	0.42 - 0.92	0.67	1.91 - 2.11	2.01	30.22 - 65.44	47.83
Khoju Chak	0.56 - 0.97	0.76	1.99 - 2.32	2.15	37.04 - 71.66	54.35

collected using a GPS instrument (Garmin make, model 76 MAPCSX). Soil samples were air dried, ground on a wooden plank with wooden roller and finally passed through 2 mm sieve before estimating organic carbon.

The soil samples were analyzed for organic carbon content (Walkley and Black, 1934), available N (Subbiah and Asija, 1956), available P (Olsen *et al.*, 1954), available K (Piper, 1966), DTPA extractable Zn, Cu and Fe (Lindsay and Norvell, 1978), pH (1:2 Soil: Water suspension), electrical conductivity (1:2 Soil: Water suspension) (Jackson, 1973).

Results and Discussion

Soil pH : Soil pH of Kusmi village were found very in between 6.5 to 7.4 with a mean value of 6.9; that of Sonpura village varied in between 6.7 to 6.9 with a mean value of 6.8 (Table-1). Similarly, pH of village Basatpur and Khoju Chak varied from 6.4 to 7.1 and 6.4 to 6.9 with a mean value of 6.7 and 6.6, respectively. Since most of the soil belongs to the near neutral category to neutral category, soil acidity or alkalinity not to be a major crop production constraints in the study area.

Electrical Conductivity : The data in the table showed that electrical conductivity of surface soil samples of the entire study area was found to be less than 1.0 dSm⁻¹. Hence, soil under the study area are safe for all types of crop production concerning the soluble salt content (Dash *et al.*, 2019).

Organic carbon : Soil organic carbon plays an important role in soil fertility and productivity. It is one of the most important constituent of the soil due to its capacity to effect plant growth as both as source of energy and a trigger for

nutrient availability through mineralization (Yadav *et al.*, 2017). Organic carbon varied in between 0.390 to 0.492, 0.412 to 0.487, 0.444 to 0.470 and 0.484 to 0.552 per cent in the soil of Kusmi, Sonpura, Basatpur and Khoju Chak, respectively (Table-1). The average soil organic content of the soil of the above four villages were determined to be 0.441, 0.449, 0.467 and 0.518 per cent, respectively. the average mean soil organic carbon content are inferred to be of low range, which did not enables the soils to go for a wide range of crops. Mishra *et al.*, 2013 also reported similar observation.

Available macro nutrients : Soil available nitrogen varies in between 200 - 305, 240 - 295, 250 - 288 and 295 - 310 kg ha⁻¹ with a mean value of 252, 267, 269 and 302 kg ha⁻¹ in the soil of village Kusmi, Sonpura, Basatpur and Khoju Chak, respectively (Table-2). Soils of the entire study area are found to be of low available nitrogen category. Hence, addition of sufficient quantity of organic matter and growing leguminous crops are advocated to enrich soil nitrogen. To meet crop demand, additional sources of nitrogenous fertilizers can be applied to achieve the targeted yields of various crops. Soil available phosphorus varies in between 23.98 to 37.10, with a mean value of 30.49 kg ha⁻¹, 26.85 to 36.18 with a mean value of 31.51 kg ha⁻¹, 28.36 to 35.85 with a mean value of 32.10 kg ha⁻¹ and 31.80 to 37.15 with a mean value of 34.47 kg ha⁻¹ in the soil of village Kusmi, Sonpura, Basatpur and Khoju Chak, respectively. Similar result was also reported by Barik *et al.*, (2017). The available potassium varies between 138 to 189 with a mean value of 163 kg ha⁻¹ in the soil of Kusmi village, 137 to 195 with a mean value of 166 kg ha⁻¹ in the soil of Sonpura village, 152 to 192 with a

mean value of 172 kg ha⁻¹ in the soil of Basatpur village and 164 to 187 with a mean value of 175 kg ha⁻¹ in the soil of Khoju Chak village. Soil showed medium to high range of soil potassium status.

Available macro nutrients : Available Zn content of Kusmi village varies in between 0.29 to 0.56 with a mean value of 0.42 ppm, 0.30 to 0.86 with a mean value of 0.58 ppm in Sonpura village, 0.42 to 0.92 with a mean value of 0.67 ppm in Basatpur village and 0.56 to 0.97 with a mean value of 0.76 ppm in the soil Khoju Chak village (Table 3). Similarly available Cu content varies in between 1.23 to 1.57 with a mean value of 1.40 ppm, 1.31 to 1.85 with a mean value of 1.58 ppm, 1.91 to 2.11 with a mean value of 2.01 ppm and 1.99 to 2.32 ppm with a mean value of 2.15 ppm in the soil of village Kusmi, Sonpura, Basatpur and Khoju Chak, respectively. The available Fe contents of the soils of Kusmi were found to be vary in between 20.25 to 35.44 with a mean value of 27.84 ppm in Sonpura village it varies in between 21.36 to 42.10 with a mean value of 31.73 ppm, 30.22 to 65.44 with a mean value of 47.83 ppm in the soils of Basatpur village and 37.04 to 71.66 with a mean value of 54.35 ppm in Khoju Chak village. Since most of the soils are low to medium category of soil micro nutrient availability, the addition of micronutrient fertilizers in integration with organic manures and bio fertilizers are recommended to enrich the micro nutrient availability to the crops.

Conclusions

From the above region specific small experiment, it was clear that the soils of Bakhtiyarpur block of Saharsa district in Bihar are near neutral to neutral in soil reaction, safe concerning soluble salt content, and soils are low organic carbon content. Concerning the soil fertility status, soils are low in status of soil, available nitrogen, phosphorus and that of medium to high for soil available potassium. Soil are low to medium category of the fertility status as per as the available micro nutrients are concerned. There it was concluded that besides, all the addition of sufficient organic matter is always

recommended to maintain soil health as a whole, for improving sustainable agricultural production.

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Constraints and Suggestions Perceived by the General and Executive Body of FPOs—A Study in Medak District of Telangana State

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Abstract

The urge for bringing small holders together is to offset the negative effects of increasing urbanization, decreasing land area under cultivation and the other reason being poor resource base of farmers making them unable to operate their farm with limited capital, while agriculture is becoming non-competitive. Therefore to protect the interests of small and marginal farmers the farmer producer organizations (FPOs) were formed. In the present study three FPOs were selected randomly in Medak district of Telangana state. Competition from other markets in capturing the buyers (100%) followed by lack of enough man power to provide services (93.33%) and no assured buy back and price (88.88%), in active directors (80.00%) were the constraints as perceived by officials and members respectively. The government has to provide financial support for the FPO (93.33%), permission to do business on commission basis (83.33%) and improving the credit and input provision to farmers (84.44%), creating storage facilities were the suggestions provided by officials and members respectively.

Introduction

Now and then for years, the only sector whose uncertainties are persisting with no proper consistent solution is agriculture and its business. As most of the farmers in India are small and marginal, coping to the restraining factors is difficult owing to factors like small landholdings, economically weak status, outbreak of pests and diseases, high cost of delivering produce to customers, high agency costs and no reasonable returns from produce. So the imminent need is to bring a new breath of fresh air for the problem and one such initiative brought is farmer producer organisations (FPOs). FPOs were established in order to bring up a better market by linking all the stakeholders of agribusiness owing to failure of cooperatives in marketing the agricultural produce. The key rationale required is hand holding support for rural farmers by promotion of FPCs that paves way for developing remunerative agriculture for the small farmers and to establish a better market potential in the era of competitiveness by leveraging the benefits of economies of scale.

Research Methodology

An *Ex-post-facto* research design was adopted for the study. The state of Telangana was chosen purposively for the study as the investigator hails from this state. Medak district was selected purposively as the district having highest number of FPOs under PRODUCE fund (source: NABARD). 3 FPOs were selected randomly from 3 different promoting institutes present in the Medak district.

From each of the selected FPO, thirty farmers and ten officials were selected by following random sampling procedure. The sample constituted to a total of 30 officials and 90 producer members.

The constraints and suggestions were identified by conducting an opinion survey of the officials and farmers and the findings were presented in table 1 and 2. As FPO structure comprises of executive body and general body, the problems faced by both were taken in to account.

Results and Discussion

Constraints as perceived by the officials of FPOs : It could be inferred from table-1. that cent percent respondents expressed that competition from other markets in capturing the buyers followed by lack of enough man power to provide services (93.33%), inadequate financial contribution by members (90.00%), insufficient voluntary action from members to lead (83.33%) were the major constraints as perceived by the officials of FPOs. In addition to the above, 76.67 per cent felt that inadequate assets to leverage credit from the banks, insufficient linkages for marketing of the produce (73.33%), lack of awareness on FPO business concept among the members (70.00%), dearth of adequate support from State Government for FPOs (66.67%), high soot charges in transportation of produce by trading companies (60%), do not get license in appropriate time or renewal of license (53.33%) and lack of capital to build godowns and storage structures (50%) were the other major constraints faced by them. The results were in

Table-1 : Constraints and suggestions as perceived by officials of FPOs.

(n = 30)

S. No.	Constraints	F	%	R	Suggestions	F	%	R
1.	Lack of enough man power to provide services	28	93.33	III	Trainings on business knowledge and skills to directors	21	70.00	V
2.	Absence of willing members to contribute for raising capital	27	90.00	II	Business done on commission basis	25	83.33	II
3.	Lack of awareness on FPO business concept among the members	21	70.00	VII	Government has to provide financial support for the efficiency of FPO	28	93.33	I
4.	Competition from other markets in capturing the buyers	30	100.00	I	Young members mobilization should be brought by extension personnel	18	60.00	VI
5.	Inadequate assets to leverage credit from the banks	23	76.67	V	Appointment of staff by government to turn FPOs in a business mode	24	80	III
6.	Insufficient linkages for marketing of the produce	22	73.33	VI	Lending loans without collateral security	23	76.67	IV
7.	Insufficient voluntary action from members to lead	25	83.33	IV	Increase in the salary of CEO	15	50.00	VII
8.	Do not get license in appropriate time or renewal of license	16	53.33	X				
9.	Dearth of adequate support from State Government for FPOs	20	66.67	VIII				
10.	High soot charges in transportation of produce by trading companies	18	60.00	IX				
11.	Lack of capital to build to godowns and storage structures	15	50.00	XI				

conformity with Navaneetham *et al.* (2017), Ragasa *et al.* (2014), Trebbin *et al.* (2012).

Suggestions expressed by the officials of FPOs : For effective performance of FPOs, the officials suggested that, the government has to provide financial support for the efficient FPO (93.33%), permission to do business on commission basis (83.33%), appointment of staff by government to turn FPOs in a business mode (80%), lending loans without collateral security (76.67%), trainings on business knowledge and skills to directors (70.00%) , young members mobilization by extension personnel (60%) and increase in the salary of CEO (50%).

Constraints perceived by members of FPOs : It could be inferred from table 2. that members of FPO expressed that no assured buy back and price (88.88%), in active directors (80.00%), insufficient credit availability with the FPO (68.88%) , high membership fee (50.00%), organisation is not taking whole members' produce (44.44%), poor maintenance of records (43.33%) were the major constraints faced by them.

Suggestions expressed by members of FPOs : Suggestions given by the members for the effective performance of FPOs were improving the credit and input provision to farmers (84.44%), creating storage facilities and buying the produce (68.88%), regular monitoring of group activities by directors (60.00%), village level small groups should be formed (44.44%), members should be encouraged to participate in BOD meetings (36.66%).

Strategy proposed for effective Performance of FPOs:

Based on the findings recorded in the study and suggestions offered by the respondents, the following interventions were proposed for effective functioning of FPOs.

Interventions suggested for Government

The concerned Ministries/ departments may be mandated to implement all "Farmer-centric Schemes" through the FPOs for efficient delivery of services and improved outcomes.

The existing scheme like Agriclincs/agribusiness centre, may be redesigned to create professionals for not only promoting FPOs but also acting as CEO of the FPOs in their local areas.

The system of issuing various licenses required for undertaking business activities by FPOs, may be simplified to make it a single window state-wide license.

Appropriate provision in the Food Grain Procurement policy of the Government of India requiring procurement of agricultural commodities directly through FPOs under MSP scheme.

Interventions suggested for Promoting institutions

As many NGOs' personnel lack in-depth knowledge of the products to be handled, going forward FPO activities require linking the farmers to consumers, Agriculture research organizations should act as promoting agencies for FPOs rather than those

Table-2 : Constraints and suggestions as perceived by members of FPOs. (n = 90)

S. No.	Constrains	F	%	R	Suggestions	F	%	R
1.	Poor maintenance of records	39	43.33	VI	Regular monitoring of group activities by directors.	54	60.00	III
2.	Inactive Directors	72	80.00	II	Village level small groups should be formed	40	44.44	IV
3.	Organisation is not taking whole members' produce	40	44.44	V	Improving the credit and input provision to farmers	76	84.44	I
4.	Insufficient credit availability with the FPO	62	68.88	III	Members should be encouraged to participate in BOD meetings	33	36.66	V
5.	No assured buy back and price	80	88.88	I	Creating storage facilities and buying the produce	62	68.88	II
6.	High membership fee	45	50.00	IV				

promoting institutions (PIs) providing different kinds of services.

While dealing with formation of FPOs, the promoting institutions should be selective in regrouping the existing community resources by identifying the local produce and mobilize only those interested in participating as producer members through a business model.

Private Institutions/ Agricultural departments may conduct special programmes on FPO promotion and agribusiness management, with focus on rural youths including women so as to create large pool of professionals in rural areas for managing FPO activities.

Interventions suggested at FPO level

Compulsory contribution (products/ services) by each member on regular basis, retaining 5% of transacted volume from each member for creating capital base to do various business activities.

FPOs should encourage product differentiation, such as in demand products to help members to receive more from a unit of output. Better performing farmers need to be rewarded.

As FPOs had insufficient working capital, members should pay a minimum amount in advance to FPOs for their requirements, which would help FPOs for purchasing of inputs in large quantities at wholesale.

There should be a mandatory requirement for every FPO to set aside a small percentage of money from

its annual funds as risk management fund. So that such fund is accessible by anyone in the FPO in the event of any crisis.

Conclusions

The study concluded that with critical issues sorted out to be marketing in capturing of buyers, no enough man power to cater for needs of the members, insufficient financial contribution from members to create working capital for running business activities as availing bank loan is a challenge. No assured buy back and price as promised by FPO while joining and directors inactiveness were the major constraints expressed by them. It can be observed that the constraints faced by them involve each other and can be solved by mutual help i.e members should realize its their company and contribute financially for their betterment and the leaders should actively involve in moving the FPOs in business mode. For this trainings should be conducted by the promoting institutions for shaping the members in to dynamic leaders for running a viable and profitable FPOs.

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Screening of Different Wheat Varieties for Susceptibility to Rice Weevil, *Sitophilus oryzae* Linnaeus

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Abstract

The ten wheat varieties were evaluated based on population growth, weight loss and germination loss during storage by the pest. Variety GW11 emerged out as resistant based on population growth and per cent loss in weight due to *Sitophilus oryzae* whereas, it was less susceptible based on per cent reduction in germination. LOK-1 variety was found to be resistant based on per cent reduction in germination whereas, it was less susceptible based on population growth and per cent loss in weight. Variety GW496 and HI1544 were found less susceptible and GADW3 was found highly susceptible based on all three parameters under study. GW366 and GW451 were found moderately susceptible based on population growth and per cent reduction in germination whereas, less susceptible and highly susceptible respectively based on weight loss. GW 322 and GW173 were less susceptible and GW1 was highly susceptible based on population growth and per cent loss in weight and these three were moderately susceptible, based on per cent reduction in germination.

Key words : *Sitophilus oryzae*, wheat varieties, varietal susceptibility, categorization.

Introduction

Wheat is the first most importance cereal crop consumed in the world and the second most produced food among the cereal crops after maize (Gilles *et al.*, 2001). Wheat contains nearly 70% carbohydrates, 12% protein, 1.7% fat, 2.7 % minerals, 2% fibers and 12% moisture content. It is a source of multiple nutrients and dietary fibers too. Among the various stored grain insect pests, rice weevil, *S. oryzae* (Curculionidae: Coleoptera) is a serious insect pest of various food grains under storage and it causing up to 50 per cent loss in weight (Koura and El-Halfwny, 1967). Infestation of this pest causes grain heating and mould development which also appears on the grains (Aslam and Suleman, 1999). A larva of *S. oryzae* consumes 14 mg grain/ day (Gioleblowska, 1968).). The rice weevil (*S. oryzae*) is considered a primary stored-grain insect pest in warm climate areas including India (Belloa *et al.*, 2000). It is an internal feeder in which the adults and the grub stages cause damage. Evaluation of relative susceptibility to the storage pests provides us information regarding wheat varieties which guides us to take up appropriate preventive and protective measures with special reference to highly susceptible varieties.

Materials and Methods

Laboratory studies were carried out on varietal susceptibility in the laboratory of Department of Entomology. B.A. College of Agriculture, Anand Agricultural University, Anand during 2020-2021. Ten varieties of wheat were evaluated for their susceptibility to *S. oryzae*.

Evaluation based on population growth of rice weevil,

S. oryzae : For each variety, three samples of wheat grain (50 g one sample for one repetition) was filled in plastic tube individually. Twenty adults of *S. oryzae* (5 to 10 days old) were released in each tube for egg laying which was covered with two-fold muslin cloth kept in position using rubber band. The adult introduced for oviposition were discarded from each tube after 7 days of exposure. The tube was covered with two-fold muslin cloth to facilitate aeration and prevent escape of adult. The observations on number of adults (live + dead) developed in each repetition were made after 6 months of storage. The data on number of adults developed after 6 months of storage were subjected to ANOVA after transforming them to logarithm.

Evaluation based on weight loss of grain against rice

weevil, *S. oryzae* : The hundred (100) grains were collected randomly after six month of storage from each sample and segregated into weevilled grain and germ eaten grain. The weevilled, germ eaten (Plate 3.3C and D) and 100 undamaged grains were weighed using mono pan electronic balance. Based on data, the per cent loss in weight was calculated by using the below mentioned formula given by Srivastava *et al.* (1973). The data on per cent loss in weight were subjected to ANOVA after arc sin transforming.

$$L = \frac{(W + G) - 100}{S(W_1 + G_1)}$$

Where,

L = Per cent loss in weight

Table-1 : Categorization of different varieties of wheat for their susceptibility against *S. oryzae*.

Category of resistance	Scale	Varieties
Based on population growth		
	$\bar{X} = 2.46$ SD = 0.10	
Resistant (R)	$2.35 > X_i$	GW11
Less susceptible (LS)	$2.35 > X_i > 2.46$	GW322, GW496, HI1544, GW173, LOK-1
Moderately susceptible (MS)	$2.46 > X_i > 2.56$	GW366, GW451
Highly susceptible (HS)	$X_i > 2.56$	GADW3, GW1
Based on weight loss (%)		
	$\bar{X} = 30.63$ SD = 8.53	
Resistant (R)	$22.13 > X_i$	GW11
Less susceptible (LS)	$22.13 > X_i > 30.66$	GW366, GW322, GW496, HI1544, LOK-1
Moderately susceptible (MS)	$30.66 > X_i > 39.19$	GW173
Highly susceptible (HS)	$X_i > 39.19$	GW451, GADW3, GW1
Based on germination reduction		
	$\bar{X} = 26.99$ SD = 5.11	
Resistant (R)	$21.87 > X_i$	LOK-1
Less susceptible (LS)	$21.87 > X_i > 26.99$	GW496, HI1544, GW11
Moderately susceptible (MS)	$26.99 > X_i > 32.10$	GW366, GW322, GW451, GW173, GW1
Highly susceptible (HS)	$X_i > 32.10$	GADW3

W = Percentage (by number) of weevilled grains

G = Percentage (by number) of germ eaten grains

S = Weight of 100 undamaged grains (g)

W_1 = Weight of weevilled grains (g)

G_1 = Weight of germ eaten grains (g)

Evaluation based on reduction in seed germination against rice weevil, *S. oryzae* : Three samples (one sample as one repetition) of wheat grain (100 seeds) drawn randomly from a bulk of treatment. The test was carried out on circular Whatman no.1 filter paper kept in Petri plates. The seeds were spread on germination paper at uniform distance in the Petri-plate. The Petri plate was covered with the lid carrying the moist filter paper and kept in a seed germinator maintained at $21 \pm 1^\circ\text{C}$ temperature and $95 \pm 2\%$ relative humidity. The little quantity of distilled water sprinkled on filter paper once a day to keep it moist. The number of germinated grains counted after 7 days of incubation. Based on germination count before adult release and six months after adult release the per cent germination was calculated repetition wise for each test. The data on per cent loss in germination was subjected to ANOVA after transforming to arc sin.

Evaluation based on categorization of varieties : The wheat varieties were grouped into four different categories of susceptibility to *S. oryzae* viz., resistance, less susceptible, moderately susceptible and highly susceptible based on three parameters viz., population growth, per cent loss in weight and reduction in germination. For this purpose, the methodology and scale adopted by Patel *et al.* (2002) was followed. The following scale was used categorizing different varieties. The transformed data were used for computation of X_i and

SD in each parameter. The scale used for categorization of different varieties is as under.

Category of resistance	Scale for resistance
Resistant	$X_i (\bar{X} - \text{SD})$
Less susceptible	$(\bar{X} - \text{SD}) X_i \bar{X}$
Moderately susceptible	$\bar{X} X_i (\bar{X} + \text{SD})$
Highly susceptible	$X_i (X + \text{SD})$

Results and Discussion

Categorization of varieties based on population growth : The GW11 was recorded less than 2.35 adults emerged therefore, grouped under resistant (R) category. The population growth was more than 2.35 but less than 2.46 adults in the varieties GW322, GW496, HI1544, GW173 and LOK-1 which were considered as less susceptible (LS). The variety GW366 and GW451 recorded adult emergence more than 2.46 but less than 2.56 which were considered as moderately susceptible (MS). The adult emergence recorded in variety GADW3 and GW1 were more than 2.56 which grouped as highly susceptible (HS) (Table-1).

Categorization of varieties based on weight loss : The Variety GW11 recorded less than 22.13 weight loss of grains and were categorized as resistant (R) to *S. oryzae*. Variety GW366, GW322, GW496, HI1544 and LOK-1 recorded more than 22.13 but, less than 30.66 weight loss. Thus, these were recognized as less susceptible (LS). While, variety GW173 recorded more than 30.66 but less than 39.19 weight loss which were labelled as moderately susceptible (MS). The wheat varieties GW451, GADW3 and GW1 were categorized into highly

susceptible (HS) group as it recorded more than 39.19 weight loss (Table-1).

Categorization of varieties based on germination reduction : Wheat variety LOK-1 recorded less than 21.87 per cent reduction in germination hence, categorized in to resistant (R) group against *S. oryzae*. GW496, HI1544 and GW11 were categorized under less susceptible (LS) group as it recorded more than 21.87 but, less than 26.99 per cent germination reduction. However, varieties GW366, GW322, GW451, GW173 and GW1 were emerged out as moderately susceptible to *S. oryzae* because per cent germination reduction was more than 26.99 but less than 32.10 per cent. Whereas, variety GADW3 highly susceptible in respect to germination reduction (Table-1).

The susceptibility of wheat varieties to *S. oryzae* was studied at different places (Chahal and Singh, 1974; Tiwari, 2016 and Arve *et al.* 2014) earlier. The earlier workers studied the susceptibility of different wheat varieties against *S. oryzae* in storage were apart from the varieties under present investigation and therefore, the present findings could not be compared except with Arve *et al.* (2014) and Tiwari (2016). Arve *et al.* (2014) reported per cent weight loss between 14.12 to 20.27. These differences might be attributed due to relatively shorter period of storage. GW496 and GW 173 were found less susceptible which was more or less similar to the present findings. Tiwari (2016) evaluated susceptibility of wheat varieties studied that LOK-1 variety was most susceptible while GW 322, GW173 were moderately susceptible with respect to adult emergence. These differences might be attributed due to difference in location (Jabalpur) of study and variations in prevailing temperatures and RH during the study period. The reactions of various wheat varieties against *S. oryzae* are outlined in Table-1.

Thus, GW11 emerged out as resistant (R) variety based on population growth and per cent loss in weight due to *S. oryzae* infestation whereas, it was less susceptible based on per cent loss in germination. LOK-1 variety was resistant (R) based on per cent loss in germination whereas, it was less susceptible based on population growth and per cent loss in weight. GW496 and HI1544 were found less susceptible and GADW3 was found highly susceptible based on all three parameters. GW366 and GW451 were found moderately susceptible based on population growth and per cent loss in

germination, whereas, less susceptible and highly susceptible respectively based on weight loss. GW 322 and GW173 were less susceptible and GW1 was highly susceptible based on population growth and per cent loss in weight and these three were moderately susceptible, if the parameter per cent loss in germination is to be considered.

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Influence of Integrated Nutrient Management on Physical Characteristics of a Typic Ustifluvents

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Abstract

To assess the effect of water hyacinth compost, vermicompost and inorganic fertilizers on some physical properties of soil, a field experiment was under taken during rabi 2015-16 in light textured sandy loam soil of Mandan Bharti Agriculture College, Agwanpur, Saharsa, Bihar in split plot design with four levels of NPK in main plot and four levels of organic sources in sub-plot treatment in three replications. The experimental site was located in between 25°52'50" North latitude and 86°48'62" East longitude in agro-climatic zone-II of Bihar having hot moist sub-humid climate. Wheat (cv. DBW-14) was grown as test crop during the reported period of 2015-16. Vermicompost, compost made from aquatic weed (water hyacinth compost) alone or in combination with different levels of NPK of recommended dose of fertilizers were applied. Bulk density decreased by all the treatment over control. All the treatment markedly increased the mean soil aggregates, total porosity and hydraulic conductivity. Organic manure contribute more to the improvement of bulk density, total porosity, soil aggregates and hydraulic conductivity.

Key words : Organics, chemical fertilizer, physical properties, wheat.

Introduction

Continuous application of fertilizers during early seventies helped in improving the soil fertility and also the replenishment of nutrient lost due to abiotic factor or consumed by plants and unshared an era of green revolution. After green revolution, the continuous trend of application of fertilizers in imbalanced way led to the emergence of problems of soil and water bodies. As a result, economic efficiency of fertilizer use as well as quality of crop product deteriorated. Organic nutrient management in agriculture as a way tends to be more promising and reliable to take on all the issues pertaining soil. use of chemical fertilizers and organic manure has both positive and negative effect on plant growth and the soil chemical fertilizers are inexpensive, have high nutrient content and are rapidly taken up by plants organic manure has a number of short coming including low nutrient content, slow decomposition. However, organic manure has multiple benefits due to balanced supply of nutrients, increased soil microbial activity, decomposition of harmful elements, soil structure improvement and increased soil water availability. Soil physical properties can be used as indices for making soil quality assessment and for determining the sustainability of farming system (Singh *et al.*, 2021). In the soil quality concept, soil physical attributes are given attention because they have close relationship with organic carbon and organic matter (Pandey *et al.*, 2021). Thus the soil management system that improves soil organic matter has direct bearing on soil physical properties and microbial biomass. Under such

situation, combined application of both organic and inorganic nutrient might be right proportion for these soil, primarily for improvement of soil physical environment. With the emerging concern on large quantity of agricultural waste being produced, its management becomes a key focus of sustainable agricultural development. One of the alternative options of utilization of these large quantities of nutrient rich agricultural waste is by converting then in to value added product like compost and recycle them back to field which have drawn the attention of scientists to reduce environmental pollution and increase efficiency of carbon and nutrient rich input for higher productivity. Soil aggregates was significantly increased by integrated nutrient management practices, whereas bulk density decrease with the same. Conjoint use of recommended dose of fertilizer and organic manure increased the porosity and hydraulic conductivity of the soil. So, replacement of a part of chemical fertilizer by organic manure through a simple technique of using minimum effective dose of sufficient and balanced quantities of organic and inorganic fertilizer in combination with specific microorganism called integrated nutrient management has a bright solution in this area.

Materials and Methods

A field experiment was under taken during *rabi* season 2015-16 in light textured sandy loam soil of Mandan Bharti Agriculture College, Agwanpur, Saharsa in split plot design with four levels of NPK in main plot and four levels of organic sources in sub-plot treatment with four

Table-1 : Influence of vermicompost, water hyacinth compost and chemical fertilizers on bulk density (g cm^{-3}) of soil.

Fertilizer Levels	Organic Sources				Mean
	No vermicompost and water hyacinth compost	Vermicompost	Water hyacinth compost	Vermicompost + water hyacinth compost	
No NPK	1.55	1.49	1.46	1.38	1.47
50% NPK	1.52	1.50	1.44	1.42	1.47
100% NPK	1.49	1.51	1.44	1.41	1.46
150% NPK	1.53	1.52	1.51	1.47	1.50
Mean	1.52	1.50	1.46	1.42	
	SE $m \pm$	CD (5%)			
Manure (M)	0.02	NS			
Fertilizer (N)	0.02	NS			
M x N	0.04	NS			

Table-2 : Influence of vermicompost, water hyacinth compost and chemical fertilizers on total porosity (%) of soil.

Fertilizer Levels	Organic Sources				Mean
	No vermicompost and water hyacinth compost	Vermicompost	Water hyacinth compost	Vermicompost + water hyacinth compost	
No NPK	42.16	44.47	47.39	49.24	45.82
150% NPK	43.08	45.41	46.38	49.03	45.97
100% NPK	43.10	45.26	47.22	49.03	46.65
150% NPK	43.15	43.76	44.74	45.45	44.27
Mean	43.37	44.72	46.43	48.18	
	SE $m \pm$	CD (5%)			
Manure (M)	0.56	1.97			
Fertilizer (N)	0.73	NS			
M x N	1.48	NS			

replications. The experimental site was located in between $25^{\circ}52'50''$ North latitude and $86^{\circ}48'62''$ East longitude in agro-climatic zone-II of Bihar having hot moist sub-humid climate. Wheat (cv. DBW-14) was grown as test crop during the reported period of 2015-16. Water hyacinth compost @ 10 t ha^{-1} , vermicompost alone or in combination with different levels of NPK fertilizer viz., 0, 50, 100 and 150 per cent of recommended dose were applied. Different doses of fertilizer in terms of N, P_2O_5 and K_2O were applied @ $120:60:40 \text{ kg ha}^{-1}$, respectively. Nitrogen, phosphorus and potash were applied in the form of urea, SSP and MOP, respectively. Water hyacinth compost and vermicompost were applied before sowing of wheat. Agronomic and crop management practices followed were those recommended by Bihar Agricultural University, Sabour, Bhagalpur.

Undisturbed soil samples were collected by using a core samples. Soil thus obtained with the help of core was transferred to a container, dried in an oven at 105°C to a constant weight and bulk density was calculated as

$$\text{Bulk density } (\text{g cm}^{-3}) = \frac{\text{Oven dry Weight of sample (g)}}{\text{Sample volume } (\text{cm}^{-1})}$$

Analysis for aggregates was done by wet sieving with the help of Yoder Wet sieving apparatus (Yoder, 1936). Saturated hydraulic conductivity was estimated using the core samples which was saturated with water

for 24 hours following the constant head method (Klute, 1965). Total porosity was measured following this formula

$$\text{Total porosity } (\%) = \frac{\frac{(\text{Weight of soil at saturation}) - (\text{Oven dry Weight of soil})}{\text{Volume of soil}}}{100} \times 100$$

Results and Discussion

The effect of vermicompost, water hyacinth compost alone or in combination with NPK fertilizers on bulk density of soil has been presented in table-1. The data revealed that bulk density decreased by all the treatments over control. It is clear that the organic manure contributed more to the improvement of bulk density i.e. decrease in bulk density then did the chemical fertilizers. The mean effect of the treatments was recorded in the order. Vermicompost + water hyacinth compost (1.42 g cm^{-3}) > water hyacinth compost (1.46 g cm^{-3}) > vermicompost (1.50 g cm^{-3}) > no vermicompost, no water hyacinth compost (1.52 g cm^{-3}). Parewa *et al.* (2018) reported that the bulk density of soil decreased significantly with incorporation of FYM @ 10 t ha^{-1} which may be due to increase in organic carbon content in soil. All the levels of fertilizers also decreased bulk density. The data also indicated that minimum bulk density (1.41 g cm^{-3}) was recorded in the treatment receiving 100% NPK + vermicompost + water hyacinth compost. Kafle *et al.* (2019) observed minimum bulk density in the treatments

Table-3: Influence of vermicompost, water hyacinth compost and chemical fertilizers on soil aggregates (%) of soil.

Fertilizer Levels	Organic Sources				Mean
	No vermicompost and water hyacinth compost	Vermicompost	Water hyacinth compost	Vermicompost + water hyacinth compost	
No NPK	36.36	38.91	44.33	47.57	41.79
50% NPK	39.72	40.58	42.62	40.87	40.94
100% NPK	37.55	40.48	41.22	44.81	41.01
150% NPK	36.75	39.26	37.46	38.61	38.02
Mean	37.59	39.80	41.40	42.96	
	SE m±	CD (5%)			
Manure (M)	0.46	1.59			
Fertilizer (N)	0.51	1.49			
M x N	1.03	2.96			

Table-4 : Influence of vermicompost, water hyacinth compost and chemical fertilizers on hydraulic conductivity (cm hr⁻¹) in soil.

Fertilizer Levels	Organic Sources				Mean
	No vermicompost and water hyacinth compost	Vermicompost	Water hyacinth compost	Vermicompost + water hyacinth compost	
No NPK	0.0207	0.0248	0.0309	0.0337	0.0275
50% NPK	0.0205	0.0257	0.0308	0.0285	0.0271
100% NPK	0.0245	0.0281	0.0305	0.0339	0.0292
150% NPK	0.0222	0.0233	0.0256	0.0273	0.0245
Mean	0.0227	0.0254	0.0294	0.0308	
	SE m±	CD (5%)			
Manure (M)	0.0002	0.005			
Fertilizer (N)	0.0006	0.0016			
M x N	0.0011	0.0032			

integrated with farm yard manure and chemical fertilizers. Das and Patel (2012) also reported that integrated nutrient management treatments generally decreased the bulk density of the soil as compared to these under treatments and the reason might be due to the higher soil organic in these treatments. The data (table-2) clearly indicate that all the treatments markedly increased the total porosity of soil. It is clear that 100% NPK contributed to the total porosity most favourable among 0%, 50%, 100% and 150% NPK levels. Effect of vermicompost, water hyacinth compost was recorded in the order of vermicompost + water hyacinth compost > water hyacinth compost > vermicompost > no vermicompost, no water hyacinth compost. 100 per cent NPK maximally decreased the bulk density (i.e. 1.46 g cm⁻³). Aziz *et al.* (2019) reported that bulk density increased with increases in a recommended dose of chemical fertilizer. The manure fertilizers and their interaction effect on bulk density of the soil was found statistically non-significant.

The maximum increase in total porosity was recorded in the treatment receiving 100% NPK + vermicompost + water hyacinth compost. Haynes and Naidu (1998) also reported that addition of organic manure into soil resulted in the improvement of soil total porosity. Harris and Meghara (2001) reported that soil

porosity was significantly greater in plots where NPK was applied in combination with FYM and bio fertilizers. Soil aggregates varied from 36.36 per cent to 47.57 per cent (table-3).

It increased from 41.79 to 40.94, 41.01 and 38.02 per cent under 50, 100 and 150 per cent NPK. Incorporation of vermicompost and water hyacinth compost also increased the soil aggregates over control. Highest soil aggregates (44.81 %) was recorded in the treatment receiving 100% NPK + vermicompost + water hyacinth compost. Soil aggregates as represented by mean weight diameter, aggregate stability and percentage of water stable aggregates was significantly increased by integrated nutrient management practices (Malik *et al.*, 2014). Positive effect of manure and straw application on aggregate stability has also been reported by Saha *et al.*, 2010. The data in the table-3 revealed that all the treatments significantly increased the hydraulic conductivity. The hydraulic conductivity varied from 0.0207 (cm hr⁻¹) to 0.0308 (cm hr⁻¹) under different treatments. It markedly increased over control under different NPK treatments. Incorporation of vermicompost and water hyacinth compost also increased the hydraulic conductivity and the order of effectiveness was vermicompost + water hyacinth compost > water hyacinth

compost > vermicompost > no manure. Improvement of hydraulic conductivity may be due to more organic matter content which increased biological activities, improved soil aggregation and optimum pore values as well as the effective conductivity of pores (Kaje *et al.*, 2018). Maximum hydraulic conductivity was recorded in the treatment receiving both organic manure and chemical fertilizer. Pant and Ram (2018) also reported beneficial effect of organic manure on hydraulic conductivity of soil compared with fertilizer NPK alone. Use of organic manure along with mineral fertilizer improved physical properties of soil through increased soil aggregation, improve aggregate stability, increased hydraulic conductivity for sustaining soil quality Nandapure *et al.* (2011).

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A Study on Soil Fertility Status of Some Villages in Banma Itahri Block under Agro-climatic Zone-II of Bihar

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Abstract

It is true that sustainable production of crop cannot be maintained by using only chemical fertilizers and similarly it is not possible to obtain higher crop yield by using organic manure alone. Proper identification and management of soil fertility status are prerequisite for boosting crop production and sustaining higher yield over a long term period. Sustaining the productivity at higher level to meet the increasing demand of food and fiber for the growing population from the limited and water resources is the key issue in Indian agriculture. Unless the soil fertility is maintained at its optimum level the genetic yield potential of crop cannot be realized even when all the other requirements are fulfilled. The present study was undertaken to assess the fertility status of Banma Itahri block of Saharsa district in Bihar. The study was undertaken in four selected villages of the block. The results of the investigation revealed that most of the soil are neutral in reaction and safe concerning electrical conductivity. The organic carbon content varied from 0.314 to 0.581 per cent. The available N, P_2O_5 and K_2O varied with a mean value of 252 to 320, 28.69 to 33.84 and 142 to 214 kg ha⁻¹, respectively. Similarly, the soil available micro nutrient content varied from 0.54 to 2.89, 1.23 to 3.09 and 7.94 to 67.13 ppm Zn, Cu and Fe, respectively. Lower availability of some nutrients and lower organic carbon content were identified to be the major soil related crop production constraints of the study area.

Key words : Fertility status, evaluation, agro-climatic zone, Saharsa

Introduction

Agriculture is facing several critical issue like fertilizer use efficiency, decreasing factor productivity, low organic carbon content stock, imbalance between nutrient removal and addition to soil (Bhatt *et al.*, 2019). Improvement and maintenance of soil fertility and sustaining crop production are of worldwide importance. Changes in fertility are caused by several factors including imbalanced fertilizer use and decline in organic matter content. Sustainable agriculture aims at meeting the needs of present generation without endangering the resource base for posterity. Unfortunately unsustainable productivity, yield decline, environmental pollution, decreasing soil organic carbon storage, decreasing factor productivity under high intensive agriculture in the post green revolution era has not been a matter of great concern today (Bandyopadhyay *et al.*, 2009). Maintain soil health / quality is indispensable for sustaining the agricultural productivity at higher level. Soil quality is defined as the capacity of soil to function within ecosystem and land use boundaries, to sustain biological productivity, maintain the environmental quality and promote plant, animal and human health. Soil quality includes three groups of mutually interrelated attributes i.e. soil physical, chemical and biological quality which must be restored at its optimum level to sustain productivity. The proper rate of plant nutrient is determined by knowing the nutrient requirement of the

crop and the nutrient supplying power of soil. Hence, the evaluation of soil fertility becomes important. Soil fertility evaluation is essential for balanced nutrition of the crops. Balance nutrients use refer to the application of essential plant nutrients in right amounts and proportions using correct method and time of application suited for specific soil-crop climatic situations. It help in maintenance and improving soil productivity. A proper evaluation of the fertility of a soil before planting of a crop helps in adopting appropriate measures to make up for the short coming and ensuring a good crop production. Hence, the present study was under taken to evaluate the fertility status of various villages of Banma Itahri block of Saharsa district in the agro-climatic zone-II of Bihar.

Materials and Methods

Description of the study area : Banma Itahri is a block in Saharsa district of Bihar state, India. It consist of 49 villages and seven Panchayat. It is situated about 40 kilometre away from the district headquarter, Saharsa. The total geographical area of village is 508.3 sqm. It is situated between 25°65'56" latitude and 86°57'97" longitude 42 meter mean sea level of agro-climatic zone-II of Bihar. The average annual temperature in Banma Itahri is 25.0 °C and receive annual rainfall of about 1100 mm. the Koshi river and its tributaries flood annually affecting the vest fertile agricultural land and affecting the rural economy. The area has been cultivated foe a diverse range of crops such as maize, wheat, rice and vegetables.

Table-1 : Chemical properties of the study area.

Name of village	pH		Electrical Conductivity (dSm ⁻¹)		Organic Carbon (%)	
	Range	Mean	Range	Mean	Range	Mean
Ghordaur	6.8 - 7.2	7.0	0.110 - 0.920	0.515	0.314 - 0.512	0.413
Sarbela	7.1 - 7.4	7.25	0.629 - 0.667	0.648	0.505 - 0.581	0.543
Kusmhi	7.0 - 7.5	7.25	0.612 - 0.670	0.641	0.510 - 0.578	0.544
Kasimpur	7.0 - 7.6	7.3	0.576 - 0.682	0.629	0.525 - 0.581	0.553

Table-2 : Macro-nutrients availability of the study area.

Name of village	Available Nitrogen (kg ha ⁻¹)		Available P ₂ O ₅ (kg ha ⁻¹)		Available K ₂ O (kg ha ⁻¹)	
	Range	Mean	Range	Mean	Range	Mean
Ghordaur	200 - 305	252	28.69 - 40.42	34.55	119 - 165	142
Sarbela	295 - 335	315	31.54 - 31.78	31.66	198 - 224	211
Kusmhi	300 - 325	312	31.36 - 32.90	32.13	198 - 231	214
Kasimpur	310 - 330	320	31.37 - 33.84	32.60	201 - 224	212

Table-3 : Micro-nutrients status of the study area.

Name of village	Available Zinc (Zn) (ppm)		Available Copper (Cu) (ppm)		Available Iron (Fe) (ppm)	
	Range	Mean	Range	Mean	Range	Mean
Ghordaur	0.54 - 2.72	1.63	1.23 - 4.82	3.02	14.41 - 67.13	40.77
Sarbela	0.62 - 1.01	0.81	8.54 - 11.76	10.15	11.46 - 16.34	13.90
Kusmhi	0.35 - 2.08	1.21	3.10 - 14.21	8.65	15.64 - 49.08	32.36
Kasimpur	0.13 - 2.89	1.51	1.15 - 3.09	2.12	7.94 - 11.46	9.7

The climate is hot humid and the soils are mostly sandy loam.

Soil sampling and analysis : Four villages of Banma Itahri block namely Ghordaur, Sarbela, Kusmhi and Kasimpur were included in the present investigation for studying the fertility status of soils. Total eighty numbers of composite surface (0 -15 cm) soil samples were collected from the study area which include twenty samples from each village from different land types. Composite soil samples were collected along with latitude and longitude of the plots with the help of GPS instrument (Garmin make model: 76MAPCSX). Soil samples were air dried, ground on a wooden plank with wooden roller and finally passed through 2 mm size sieve before estimating organic carbon. The soil samples were analyzed for organic carbon content (Walkley and Black, 1934), available N (Subbiah and Asija, 1956), available P (Olsen *et al.*, 1954), available K (Piper, 1966), DTPA extractable Zn, Cu and Fe (Lindsay and Norvell, 1978), pH (1:2:: Soil: Water suspension) electrical conductivity (1:2 :: Soil: Water suspension) (Jackson, 1973).

Results and Discussion

Soil pH : Soil pH of surface soil samples of Ghordaur village were found to vary in between 6.8 to 7.2 with a mean value of 7.0; that of soils of Sarbela a village varied between 7.1 to 7.4 with a mean value of 7.25; that of Kusmhi varied between 7.0 to 7.5 with a mean value 7.25; that of soils of Kasimpur village varied between 7.0 to 7.6 with a mean value of 7.30 (Table-1). The data clearly indicate that most of the soil samples are neutral category of soil reaction and pH appears not to be a major crop

production constraints in the study area. Similar findings have also been reported by Priyadarshini *et al.* (2017) and Dash *et al.* (2018).

Electrical Conductivity : Electrical conductivity of surface soil samples of the entire study area was found to be less than 1.0 dSm⁻¹ (Table-1). Hence, all the soils under the study area are safe for all types of crop production with respect to the soluble salt content.

Organic carbon : Soil organic carbon of surface soil sample of Ghordaur village varied in between 0.314 to 0.512 with a mean value of 0.413 per cent; that of Sarbela varied in between 0.505 to 0.578 with a mean value of 0.543; to that of Kusmhi village varied in between 0.510 to 0.578 with a mean value of 0.544 per cent and that of Kasimpur varied in between 0.525 to 0.581 with a mean value of 0.553 per cent (Table-1). In the entire study area organic carbon status was found to be low to medium which enables the soil for growing a wide range of crops. Similar findings was also reported by Mishra *et al.* (2013).

Available Nitrogen : Available soil nitrogen content of surface soil samples of Ghordaur village were found to vary in between 200 to 305 with a mean value of 252 kg ha⁻¹; that of soils of Sarbela varied between 295 to 335 with a mean value of 315 kg ha⁻¹; that of soils of Kusmhi village varied between 300 to 325 with a mean value of 312 kg ha⁻¹ and that of soils of Kasimpur village varied between 310 to 330 with a mean value of 320 kg ha⁻¹. The entire study area available soil nitrogen content varied between low to medium. Similar results were also reported by Behera *et al.* (2016).



Fig. : Map of Saharsa district.

Available Phosphorus : Available soil phosphorus content Ghordaur village were found to vary in between 28.69 to 40.42 with a mean value of 34.55 kg ha^{-1} ; that of Sarbela village varied between 31.54 to 31.78 with a mean value of 31.66 kg ha^{-1} , that of Kusmhi village varied between 31.36 to 32.90 with a mean value of 32.13 kg ha^{-1} ; and that of Kasimpur village varied between 31.37 to 33.84 with a mean value of 32.60 kg ha^{-1} . In the entire study area available phosphorus was found within the range of medium. Similar trends of available phosphorus was also reported by Barik *et al.* (2017).

Available Potassium : The available soil potassium content of Ghordaur village were found to vary in between 119 to 165 with a mean value of 142 kg ha^{-1} ; that of Sarbela village varied between 198 to 224 with a mean value of 211 kg ha^{-1} ; that of Kusmhi village varied between 198 to 231 with a mean value of 214 kg ha^{-1} ; that of Kasimpur village varied between 201 to 224 with a mean value of 212 kg ha^{-1} . In the entire study area available

potassium was found within the range of medium. Similar results was also reported by Mishra *et al.* (2013).

Available Zinc (Zn) : Available soil Zn content of Ghordaur village were found to be vary in between 0.54 to 2.72 with a mean value of 1.63 ppm; that of Sarbela vary in between 0.62 to 1.01 with a mean value of 0.81 ppm; that of Kusmhi village it vary in between 0.35 to 2.08 with a mean value of 1.21 ppm and that of Kasimpur village it varies between 0.13 to 2.89 with a mean value of 1.51 (Table-3). In the entire study area available Zn was found within the range of low to high.

Available Copper (Cu) : Available soil copper varied with a mean value of 3.02, 10.15, 8.65 and 2.12 ppm in the soils of Ghordaur, Sarbela, Kusmhi and Kasimpur village, respectively. In the entire study area available copper was found within the range of medium to high.

Available Iron (Fe) : The available soil iron (Fe) content of surface soil of the four villages under study are given in table-3. In Ghordaur village, the available iron content

were found to be vary in between 14.41 to 67.13 with a mean value of 40.77 ppm, that in Sarbela village it vary in between 11.46 to 16.34 with a mean value of 13.90 ppm. Similarly in Kusmhi village the available soil iron content were found to be vary between 15.64 to 49.08 with a mean value of 32.36 ppm and in that of Kasimpur village it vary in between 7.94 to 11.46 ppm with a mean value of 9.70 ppm. In the entire study area available Fe was found with in the range of high.

Conclusions

As per the experimentation carried out for the soil of Ghordaur, Sarbela, Kusmhi and Kasimpur village of Banma Itahri block of Saharsa district in agro-climatic zone-II. The results shows that soils were revealed in reaction with a safe concerning of electrical conductivity. Soil organic content was found to be within the range of low to medium. The results shows the deficiency and sufficiency of available plant nutrients in soils of representative villages. It will go a long way in balanced recommendation of fertilizer for various crops. This will also help to build up the database for evaluation, planning and monitoring of soil fertility status which can serve the farming community for higher profitability with a balanced recommendation of fertilizer in sustainable manner for present and future.

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Assessment of *In-Situ* Moisture Conservation Techniques under Rainfed Dry Lands on Farmer's Field in Black Gram (*Vigna mungo* L.)

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Abstract

Blackgram (*Vigna mungo* L.) is one of the most popular pulse crop all over India. But the productivity of this pulse crop is low due to poor management and adoption of traditional methods (broadcasting) of sowing. Improved methods of sowing is an important tool which has geared productivity in many counties the improved sowing techniques showed significant variations in plant height, branches per plant, pods per plant, and seeds per pod, test weight, seed yield, biological yield and harvest index. The present experiment was conducted on the different moisture conservation techniques i.e., T₁- Furrow Irrigated Raised Bed (FIRB), T₂- Summer Deep Ploughing (SDP) and T₃- farmers Practice (Plane seed bed) in rainfed dry lands. The results revealed that the use of FIRB system is beneficial for black gram cultivation under rainfed dry lands of Morena district in terms of growth, yield and economics of the crop. The *In-situ* moisture conservation technique FIRB is also mitigate the dry spell during the crop growth and increase the rain water use efficiency under rainfed dry lands.

Key words : *Furrow irrigated raised bed (FIRB), summer deep ploughing (SDP), rainfed dry lands, black gram, moisture conservation techniques (MCT).*

Introduction

Blackgram (*Vigna mungo* L.) is one of the most popular pulse crop all over India. Black gram is very nutritious as it contains high levels of protein (25 g), potassium (983 mg), calcium (138 mg), iron (7.57 mg), niacin (1.447 mg), thiamine (0.273 mg), and riboflavin (0.254 mg) per 100g (Mohiuddin *et al.* 2018). India accounts for 33% of the world area and 22% of the world production of pulses. Due to stagnant production, the net availability of pulses has come down from 60 gm in 1951 to 41.7 g/day/capita in 2016, as against Indian Council of Medical Research (ICMR) which recommends 65 g/day/capita (Sival *et al.* 2017). It is widely cultivated in all parts of pulse growing regions in India. It produces about 24.5 lakh tonnes annually from about 4.6 million hectares of area, with an average productivity of 533 Kg per hectare in 2020-21 (agricoop.nic.in). In Madhya Pradesh it is producing in 1647.20 thousand ha with average productivity of 531 kg/ha (Anonymous, 2021). But the productivity of this pulse crop is low due to poor management and adoption of traditional methods (broadcasting) of sowing. Improved methods of sowing is an important tool which has geared productivity in many counties the improved sowing techniques showed significant variations in plant height, branches per plant, pods per plant, and seeds per pod, test weight, seed yield, biological yield and harvest index. It was noted that 25-35% higher yield and net returns were recorded compared to traditional methods and gave higher productivity and profitability under changing

climatic conditions. Under high rainfall situation water stagnation usually causes yellowing and higher weed competition thereby reducing the yield of the black gram. Conventionally the crop is sown under flat bed conditions, however, under present investigation efforts were made to explore the feasibility of growing black gram under different planting method to resilience the crop with climatic variability's of region. Therefore, the present study was carried out to investigate the effect of planting methods on productivity of black gram on farmer's field at Morena district of Madhya Pradesh.

Research Methodology

Field experiment was conducted during *kharif* seasons of 2019 and 2020 at the 5 farmer's field under NICRA project at Morena district. The soil of the experimental fields was sandy loam in texture, normal in reaction (pH 6.5) and low in available nitrogen, phosphorus and medium availability of potassium, respectively. Total 03 treatments, viz.; T₁- Summer deep ploughing, T₂- Furrow Irrigated Raised Bed (FIRB) and T₃- Farmers practice (broadcasting) were used to conduct the experiment. Each farmer/location was taken as a replication for statistical analysis of experiment. Randomized block design was adapted to statistical analysis. Other agronomic practices were followed as per recommended. The black gram variety Pratap urd-1 was used for experiment with RDF 20:60:40::N:P:K at all the locations.

The rainfall during the experiment was recorded

Table-1 : Growth and yield attributes of black gram under various sowing methods during 2019-20 and 2020-21.

Treatment	Plant height at harvest (cm)	No. of branch/ plant at harvest	No. of pod/ plant at harvest	No. of seed/ pod at harvest	Pod length in cm	RWUE (Kg/ha/mm)
FIRB	41.05	4.84	37.93	6.95	4.20	1.90
SDP	37.45	3.99	31.84	6.50	3.92	1.76
FP	33.95	3.61	26.61	5.75	3.48	1.43
Sem	1.43	0.30	1.13	0.27	0.16	0.10
CD @ 5%	4.68	0.99	3.67	0.88	0.53	0.32

Table-2 : yield and Economics of black gram under various sowing methods during 2019-20 and 2020-21.

Treatment	Seed yield (q/ha)	Straw yield (q/ha)	Biological yield (q/ha)	Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net Return (Rs/ha)	B:C Ratio
FIRB	12.61	15.64	28.25	24200	80350	56150	3.32
SDP	11.68	13.90	25.58	24200	74253	50053	3.06
FP	9.50	10.92	20.42	23600	60252	36652	2.55
Sem	0.66	0.80	1.46	-	-	-	-
CD @ 5%	2.15	2.60	4.75	-	-	-	-

713.1 mm and 468.4 mm during *kharif* 2019 and 2020 respectively.

Results and Discussion

Results of experiment conducted at farmer's field were analyzed to assess the different *in-situ* moisture conservation practices in black gram crop at different locations of Morena district at farmer's field. The purpose of experiment was to improve the adoption of *in-situ* moisture conservation practices by the farmers. The moisture conservation practices were demonstrated to assess the climate resilience or to mitigate the rainfall abbreviation in dry lands of Morena district. The results were analyzed under different plant growth and yield attributes with rain water use efficiency in Black gram.

Plant height at harvest (cm) : The plant height of black gram was significantly affected by the *in-situ* moisture conservation practices. Furrow Irrigated raised bed system was found significantly higher (41.05 cm) over farmers practice (33.95 cm). However, summer deep ploughing (37.45 cm) was found at par to both other treatment used in experiment.

No. of branch per plant at harvest : The minimum number of branch per plant at harvest was found in farmers practice (3.61), which was statistically at par with summer deep ploughing (3.99) and significantly inferior to FIRB (4.84) system of planting.

Number of pod per plant at harvest : The maximum number of pod per plant at harvest was recorded under FIRB (37.93) system which was significantly higher over SDP (34.94) and FP (26.61). However, in concern to no. of pod per plant under SDP was also statistically superior over farmer's practice.

Number of seed pod at harvest : The minimum Number of seed pod at harvest was found in farmers practice

(6.95), which was statistically at par with summer deep ploughing (6.50) and significantly inferior to FIRB (5.75) system of planting.

Pod length (cm) : The minimum Pod length (cm) was found in farmers practice (3.48 cm), which was statistically at par with summer deep ploughing (3.92 cm) and significantly inferior to FIRB (3.48 cm) system of planting.

This might be due to increased availability of nutrients due to ridge sowing method which provided equal opportunity to the crop to grow and perpetuate. Also improvement in growth attributes could be improved in soil physical and chemical characteristics by reaction with soil minerals then improved water, air, soil characteristics and nutrient and mineral adsorption respectively. These findings were conformed to the earlier reports of Lone et al., (2010) and Ananthi and Mallika Vanangamudi (2014).

Biological Yield (kg/ha) : The biological yield was a major parameter to assess the efficacy of a technology. The maximum biological yield 28.25 q/ha was recorded under furrow irrigated raised bed which was statistically at par to summer deep ploughing 25.58 q/ha and both of these treatments were significantly superior over the farmers practice (20.42 q/ha). Singh *et al.* (2020) also revealed that the FIRB system of sowing gave maximum crop yield and showed significant increase on other growth and yield parameters in chick pea.

Straw yield (q/ha) : Under rainfed dry lands straw yield also of major concern because, livestock is mostly dependent on the straw of different available crops. The maximum straw yield 15.64 q/ha was recorded under furrow irrigated raised bed which was statistically at par to summer deep ploughing 13.90 q/ha and both of these treatments were significantly superior over the farmers practice (10.92 q/ha).

Seed yield (q/ha) : The seed yield or economic yield was also influence significantly through different *in-situ* moisture conservation techniques. The minimum was recorded under farmers practice (950 kg/ha) which was statistically at par to summer deep ploughing (1168 kg/ha) and significantly inferior to FIRB system (12.61 kg/ha).

The highest grain yield, straw and biological yield was obtained by the effective utilization of resources that increased the performance of crop. This result was conformity with the reports of Chaturvedi *et al.*, (2015).

Rain water use efficiency (kg/ha/mm) : The rain water use efficiency was calculated on the basis of mean rainfall received during both the year of experimentation and the per hectare productivity of crop. The maximum RWUE 1.90 kg/ha/mm was recorded under furrow irrigated raised bed which was statistically at par to summer deep ploughing 1.76 kg/ha/mm and both of these treatments were significantly superior over the farmers practice (1.43 kg/ha/mm).

Economics

The economics is the deciding factor to adoption of any technology, because the ultimate aim of technology to achieve the livelihood security for practicing farmers. To assess the economic efficacy of *in-situ* moisture conservation techniques, the cost of cultivation (Rs/ha), Gross return (Rs/ha), Net return (Rs/ha) and most importantly B:C ratio were calculated on prevailing input and output prices in market.

The maximum Gross return (80,350 Rs/ha), Net return (56,150 Rs/ha) and most importantly B:C ratio (3.32) was observed in the FIRB system of planting, which was followed by Summer deep ploughing (74,253 Rs/ha, 50,053Rs/ha and 3.06) respectively. However the minimum values are observed in farmers practice.

Conclusions

The present experiment was concluded on the different parameter of assessment, that the use of FIRB system is

beneficial for black gram cultivation under rainfed dry lands of Morena district in terms of growth, yield and economics of the crop. The In-situ moisture conservation technique FIRB is also mitigate the dry spell during the crop growth and increase the rain water use efficiency under rainfed dry lands.

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Efficacy of Growing Media and Indole-3-Butyric Acid on Survival and Success of Air Layering of Guava (*Psidium guajava* L.) Cv. L-49

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Abstract

Results of present experiment revealed that maximum success roots (75%), maximum callusing (15.83 mm), minimum days taken to roots emergence (28.93 days), maximum diameter (5.40 mm) of primary root, maximum fresh weight (1.47 gm) of roots and maximum dry weight (0.62 gm) of roots, maximum number (4.17) of new sprouts, length (10.33 cm) of new shoots, number (10.40) of leaves, maximum chlorophyll content in leaves (35.50 SPAD value) and maximum survival percentage (70.50%) were recorded in T₇ (sphagnum moss + IBA @ 5000 ppm), while maximum number of primary roots (27.30) and number of secondary roots (33.30) maximum leaf area (4.93cm²), maximum length of primary roots (10.37cm) and length of secondary roots (8.17cm) was recorded under T₉ (cocopeat + IBA @ 5000 ppm).

Key words : IBA, air-layering, rooting media, guava

Introduction

Guava (*Psidium guajava* L.) is one of the most important fruit crop of India. It is widely distributed throughout the tropical and sub tropical regions of the India. Guava is fourth most important fruit in area and production after mango, banana and citrus in India. It has been in cultivation in India since early 17th century and gradually become a crop of commercial significance. It is considered as “poor man’s apple” and ‘the apple of tropics’ (Hayes, 1957).

Air layering with the help of growth substances is a successful method of propagation, in which exogenous application of IBA accelerates the rate of rooting, increases final root percentage and number of roots (Leakey, 1990). Besides hormonal influences, the climatic and environmental factors of different season also affect rooting, root initiation and survival of guava air layer. The differences in rooting percentage, better root character and survival of guava air layer may also be attributed to the varying in weather conditions such as temperature, relative humidity and rainfall (Chandrappa and Gowda, 1998). The rooting media like sand, soil, peat moss, vermicompost, FYM, cocopeat and sphagnum moss are used to improve the scope of air layering in various fruit crops. Among different growth regulators, IBA, NAA in various concentrations and their mixtures have been found to be very effective in stimulation root initiation of layers of various fruit species (Sadhu *et al.*, 1972 and Ray and Chatterjee, 1996).

Materials and Methods

The present experiment was conducted at Instructional

cum Research Fruit Orchard, Department of Fruit Science College of Horticulture Mandsaur (M.P.) during the year 2018-19. There were one concentration of IBA (5000 ppm) and rooting media (soil, vermicompost, sphagnum moss, coirpith and cocopeat) used for preparation of air layering of guava. The experiment was laid out in randomized block design (RBD) with three replications consisted fifteen treatments i.e. T₁. soil, T₂. vermicompost, T₃. sphagnum moss, T₄. coir pith, T₅. cocopeat, T₆. vermicompost + IBA@5000 ppm, T₇. sphagnum moss + IBA@5000 ppm, T₈. coir pith + IBA@5000 ppm, T₉. cocopeat + IBA@5000 ppm, T₁₀. vermicompost + sphagnum moss + IBA @5000 ppm, T₁₁. sphagnum moss + coir pith + IBA @ 5000 ppm, T₁₂. vermicompost + cocopeat + IBA @5000 ppm, T₁₃. sphagnum moss + cocopeat + IBA @5000 ppm, T₁₄. coir pith + cocopeat + IBA @5000 ppm and T₁₅. vermicompost + coir pith + IBA @ 5000 ppm. Healthy branches of pencil thickness were selected for air-layering with the length of 45-60 cm approximately. In the present experiment growth regulators were prepared in talc powder base. Stock powder of IBA with 5000 ppm strength was prepared. After preparation, the powder was kept in broad mouthed bottles covered with paper to protect it from light. After selection of branches, a ring of bark about 2 cm wide was removed carefully from the selected shoot of guava just below the bud without injuring the under wood. Previously prepared powder containing growth regulators was applied evenly on all sides of the upper cut of the ring. The cut portion was covered with rooting media and with polythene wrappers according to treatment combinations.

Results and Discussion

Root parameters : The perusal of Table-1 showed that the treatment T₇ (sphagnum moss + IBA @ 5000 ppm) produced maximum success roots (75%), maximum callusing (15.83 mm) and minimum days (28.93 days) taken to roots emergence which was followed by T₉ (cocopeat + IBA @ 5000 ppm) (72%), (14.60 mm) & (29.13 days). This might be attributing to proper aeration and high water holding capacity which helped better root initiation. Mobilization and utilization of carbohydrate and nitrogen fraction in the presence of co-factor at wounding portion might have assisted in better root initiation, number and root length (Gregary and Samantarai 1950). The present findings in rooting and root characters were comparatively higher closely with those reported by Tyagi and Patel (2004), Singh *et al.* (2007), Rymbai and Reddy, (2010), Maurya *et al.* (2012) and Rymbai *et al.* 2012) and Parmar *et al.*(2018) in guava.

It is evident from table-1 that maximum number of primary roots (27.30), number of secondary roots (33.30), maximum length of primary roots (10.37cm) and length of secondary roots (8.17cm) was recorded in T₉ (cocopeat + IBA @ 5000 ppm) which was followed by T₇ (sphagnum moss + IBA @ 5000 ppm) (26.07),(22.22), (10.07cm) and (6.77cm), respectively. The maximum number of primary and secondary and increase in roots length might be due to hormonal effect leading to accumulation of internal substances and their downward movement as well as more cell division. The increase in number of roots may be due to the accumulation of rooting co-factors above the ringed portion as influenced of IBA. Contradictory results were obtained by Tyagi and Patel (2004), Patil *et al.* (2011), Maurya *et al.* (2012), Rymbai *et al.* (2012), Baghel *et al.* (2016) and Naik *et al.* (2017) in guava.

Data presented in Table1&2 showed that the maximum diameter (5.40 mm) of primary roots, maximum fresh weight (1.47 gm) of roots and maximum dry weight (0.62 gm) was recorded with sphagnum moss + IBA @ 5000 ppm (T₇) followed by T₉ (cocopeat + IBA @ 5000 ppm) (4.93 mm, 1.40 gm and 0.62, respectively). The reason behind this was increase in primary and secondary roots that might have helped for easy absorption of water, nutrients and helps for utilization of stored carbohydrates. The increase in root weight may be attributed to the fact that external application of auxin generally stimulate the movement of natural auxin and other materials in downward direction from the leaves and shoot tips which accumulate at the incision made. The contradictory results were obtained by Rymbai *et al.* (2012), Maurya *et al.* (2012), Baghel *et al.* (2016) in guava Naik *et al.* (2017), Naithani *et al.* (2018) in guava.

Growth parameters : Data presented in Table-2 showed that maximum number (4.17) of new sprouts, length (10.33 cm) of new shoots and number (10.40) of leaves was recorded in T₇ (sphagnum moss + IBA @ 5000 ppm) which was followed by (3.73), (10.03 cm) and (8.87) in T₉ (cocopeat + IBA @ 5000 ppm), respectively. This might be due to early initiation of roots, more number of roots and higher root length which absorbs more nutrient and water resulted in early leaf initiation and higher number of leaves. These results are in comparable with the results reported by Tyagi and Patel (2004) and Manga *et al.*(2017) in guava.

It is clear from data presented in Table 2 that maximum leaf area (4.93cm²) was recorded in T₉ (cocopeat + IBA @ 5000 ppm) which was followed by treatment T₇ (cocopeat + IBA @ 5000 ppm) (4.70 cm²). This might be due to the increased number of primary and secondary roots which might have helped for maximum absorption of nutrient and moisture. The increased total sugar will helps the growth of layer by increasing the leaf area of layers. Similar results were reported by those of Venkatesan *et al.* (2010) and Naik *et al.* (2017) in guava.

It is clear from Table 2 that treatment T₇ (sphagnum moss + IBA @ 5000 ppm) produced maximum chlorophyll content in leaves (35.50 SPAD value) which was followed by treatment T₉ (cocopeat + IBA @ 5000 ppm) chlorophyll content in leaves (33.17 SPAD value). The increased leaf area with increased concentrations of auxins might have activated the process of photosynthesis resulting in more chlorophyll content of leaves per air layering. Growth hormones have been shown to play an important role in regulating the amount and distribution of assimilates in plants (Galston and Davies, 1969). Similar results were reported by Kaur *et al.* (2002) in grapes.

Maximum survival percentage (70.50%) was recorded in T₇ (sphagnum moss + IBA @ 5000 ppm) followed by 69.67% in T₉ (cocopeat + IBA @ 5000 ppm). The increased in survival percentage might be due to the better water holding capacity of sphagnum moss for long time. The similar results were also obtained by Rymbai and Reddy (2010), Maurya *et al.* (2012) in guava and Patel *et al.* (2012) in pomegranate.

Conclusions

On the basis of one year experiment it is concluded that the sphagnum moss with IBA @ 5000 ppm was best treatment as regards to success & survival of air-layers of guava cv. Lucknow-49.

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Time Series Analysis of Climatic Trends of District Srinagar of North Western Himalayas of Kashmir Valley

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Abstract

The western Himalayan region is highly vulnerable to even minor climate changes because of its fragile ecology that might harm not only the valley's pristine ecosystems but also its socio economic sectors. Since the hydrology of this region is primarily governed by snow and glaciers, the Himalaya's local weather and climate are sensitive to and interconnected with global scale climate change. The analysis of long term weather data (1985-2020) revealed that maximum temperature has increased significantly to the tune of 1.8°C from 19°C to 20.8°C over the period of 1985-2020 at Shalimar with slope of 0.04 and the R² value of 0.19, which is coefficient of determination value that explains 19 % of variability in the annual maximum temperature. However, minimum temperature has not shown any significant impact (slope = -0.0034) and decreased to the tune of 0.45°C from last 41 years. Precipitation shows a decreasing trend with respect to time series analysis. However, it failed to show any significant effect (slope = -0.55).

Key words : Srinagar, climate, rainfall, temperature, weather, Himalayas

Materials and methods

Study area : Kashmir valley is located between the Greater Himalayas in the North and the Pir Panjal range in the south, generally between the latitude and longitude ranges of 32°22' to 34°43' N and 73°52' to 75°42' E, respectively. Shalimar is located between 34° 05' East and 74° 50' North at an altitude of 1588 m amsl. Trend analysis of a time series consists of the magnitude of trend and its statistical significance. Different workers have used different methodologies for trend detection. Trend analysis was carried out using Origin Pro (Hirsch *et al.*, 1982). In general, the magnitude of trend in a time series is determined either using regression analysis (parametric test) or using Sen's estimator method (non-parametric method). Both these methods assume a linear trend in the time series. Regression analysis is conducted with time as the independent variable and rainfall/temperature as the dependent variable. The regression analysis can be carried out directly on the time series or on the anomalies (i.e. deviation from mean). A linear equation, $y = mt + c$, defined by c (the intercept) and trend m (the slope), can be fitted by regression. The linear trend

value represented by the slope of the simple least-square regression line provided the rate of rise/fall in the variable. Sen's estimator has been widely used for determining the magnitude of trend in hydro-meteorological time series. In this method, the slopes (T_i) of all data pairs are first calculated by

$$T_i = \frac{x_j - x_k}{j - k} \quad \text{For } i=1, 2, \dots, N \quad \dots(1)$$

where x_j and x_k are data values at time j and k ($j > k$) respectively. The median of these N values of T_i is Sen's estimator of slope which is calculated as

$$\begin{aligned} T_{\frac{N+1}{2}} & \quad N \text{ is odd} \\ \frac{1}{2} (T_{\frac{N}{2}} + T_{\frac{N+1}{2}}) & \quad N \text{ is even} \end{aligned} \quad \dots(2)$$

A positive value of indicates an upward (increasing) trend and a negative value indicates a downward (decreasing) trend in the time series.

Results and Discussion

Temperature and rainfall analysis

Shalimar : The employed descriptive statistics for

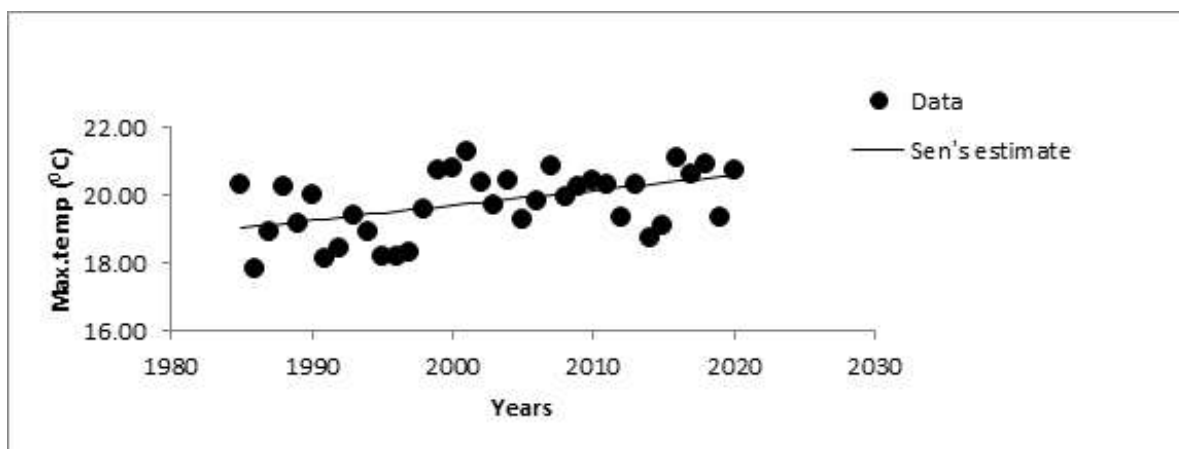


Figure 1 : Sen's slope of Maximum Temperature (1980-2020), Shalimar.

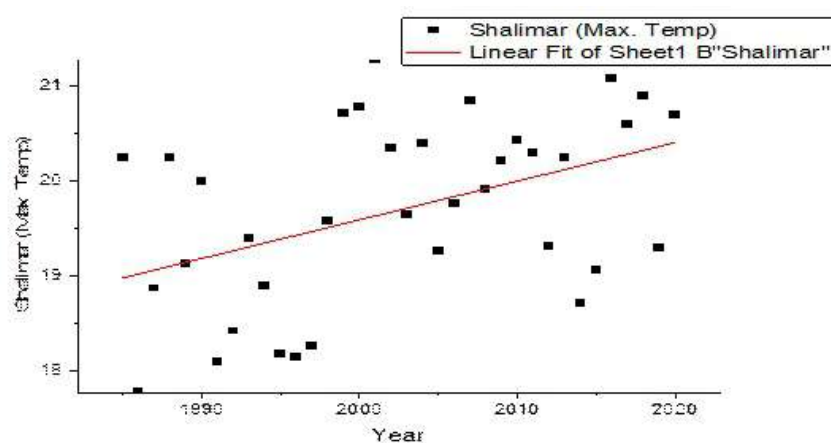


Figure 2 : Trend line of Maximum Temperature (1980-2020), Shalimar.

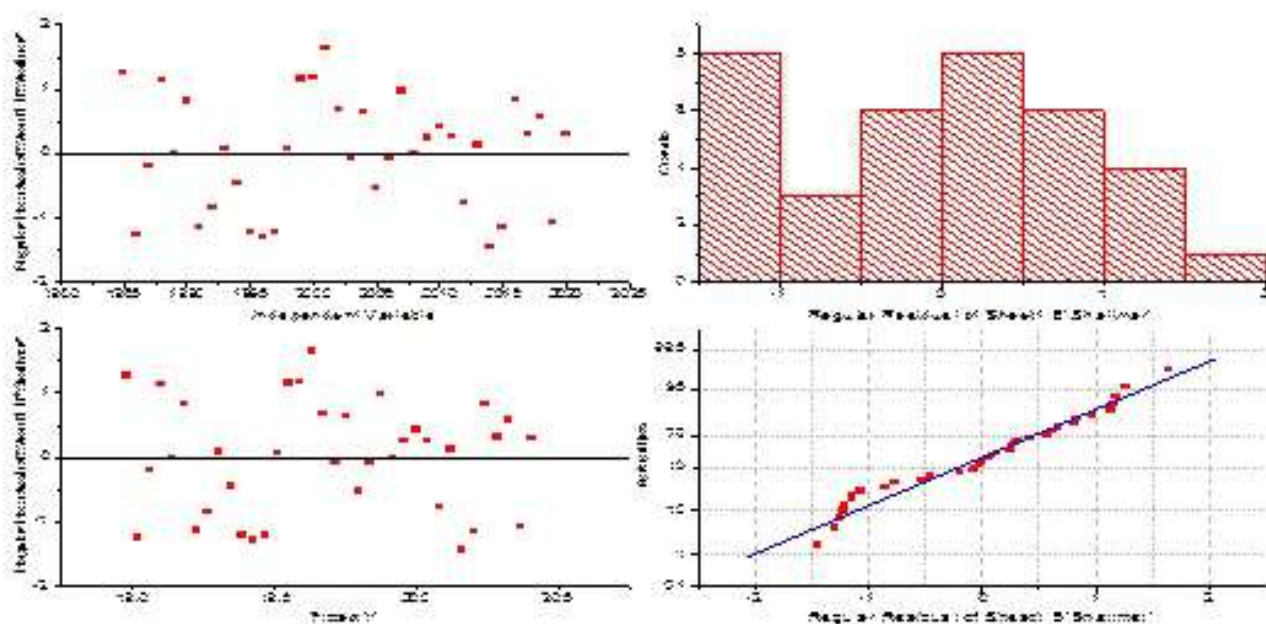


Figure 3 : Residual graph of Maximum Temperature (1980-2020), Shalimar.

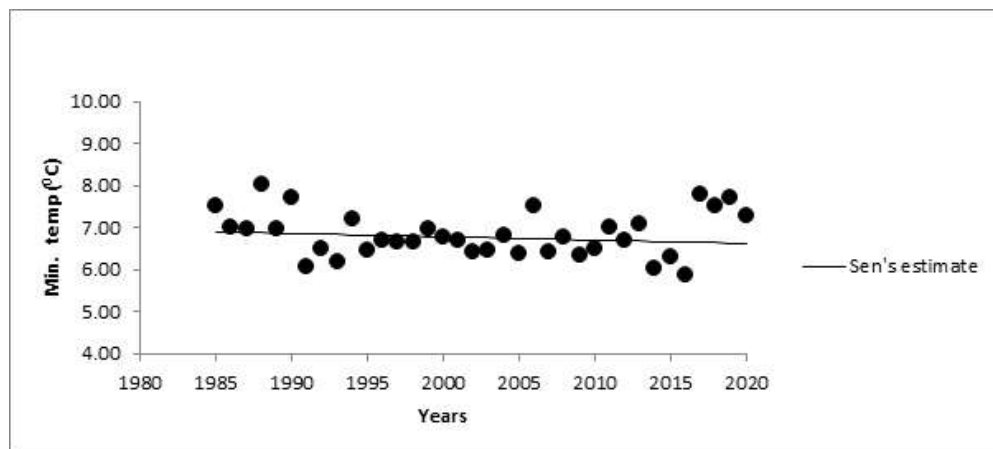


Figure 4 : Sen's slope of Minimum Temperature (1980-2020), Shalimar.

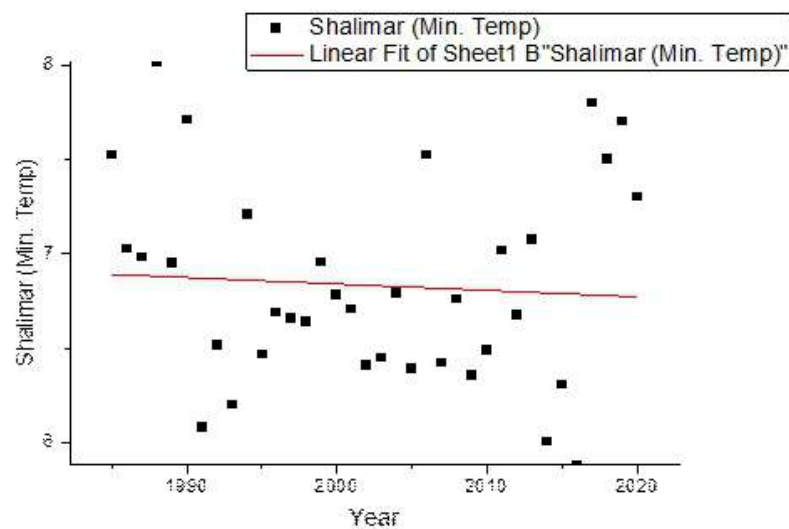


Figure 5 : Trend line of Minimum Temperature (1980-2020), Shalimar.

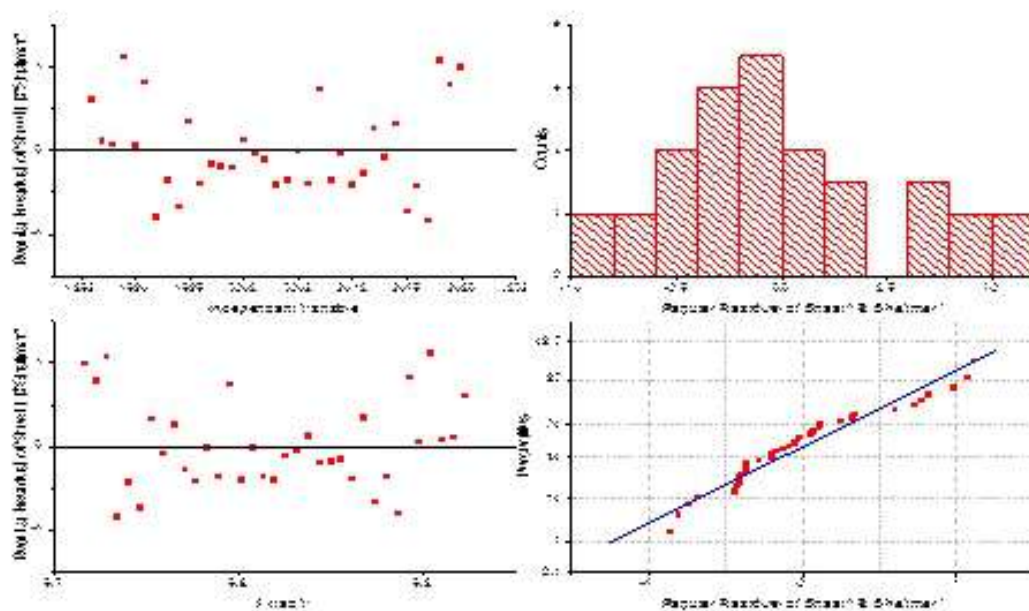


Figure 6 : Residual graph of Minimum Temperature (1980-2020), Shalimar.

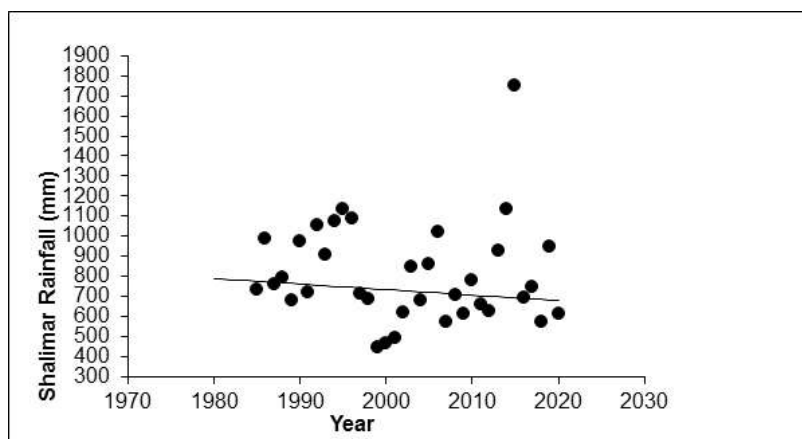


Figure 7 : Sen's slope of Rainfall (1980-2020), Shalimar.

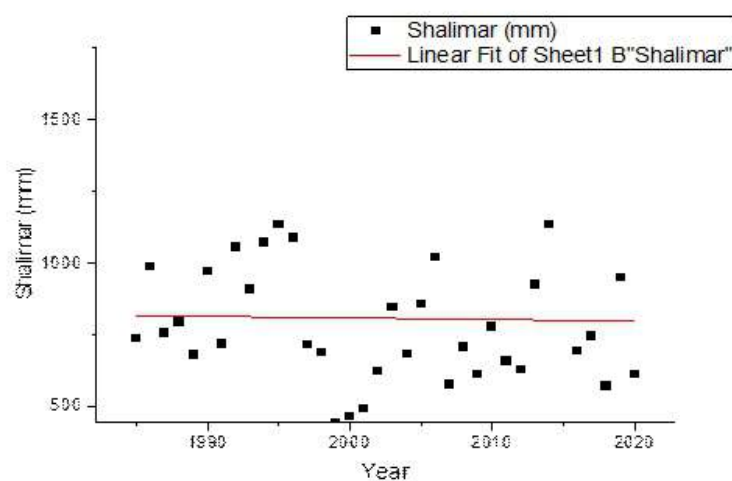


Figure 8 : Trend line of Rainfall (1980-2020), Shalimar.

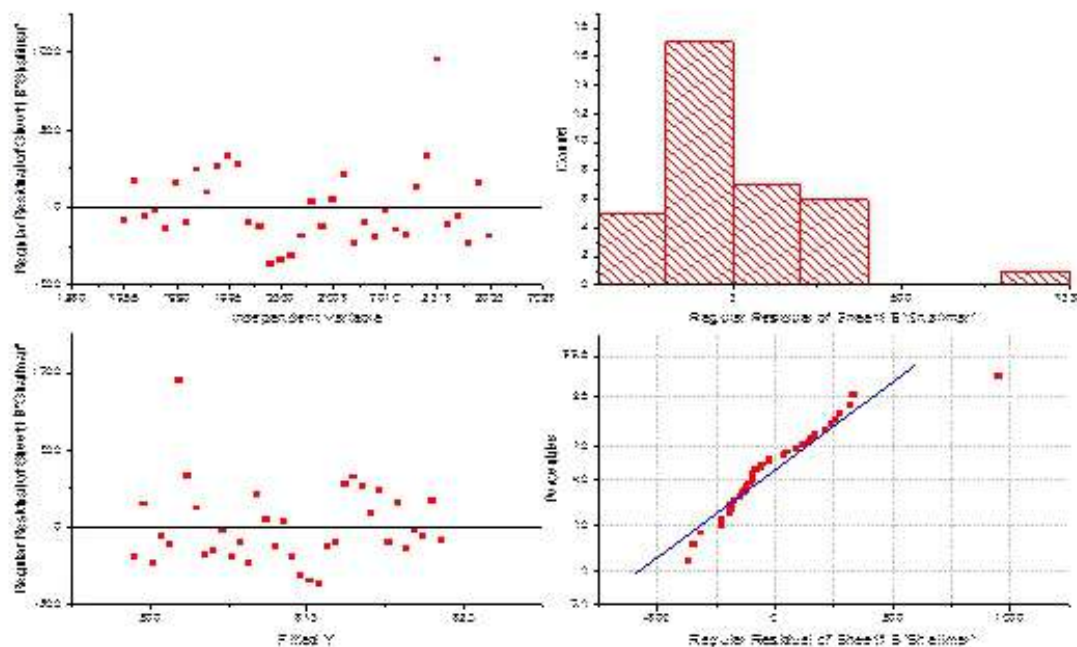


Figure 9 : Residual graph of Rainfall (1980-2020), Shalimar.

maximum and minimum temperature and rainfall of long term weather data (1985-2020) revealed that maximum temperature has increased significantly to the tune of 1.8°C from 19°C to 20.8°C over the period of 1985-2020 at Shalimar with slope of 0.04 and the R^2 value of 0.19, which is coefficient of determination value that explains 19 % of variability in the annual maximum temperature (Figure 1, 2 and 3). However, minimum temperature has not shown any significant impact (slope = -0.0034) and decreased to the tune of 0.45°C from last 41 years (Figure 4, 5 and 6). Precipitation shows a decreasing trend with respect to time series analysis. However, it failed to show any significant effect (slope = -0.55) (Figure 7, 8 and 9).

Conclusion

The present study has examined the trends of annual mean of three climate variables - minimum and

maximum temperature along with rainfall from 1980 to 2020. The results of mean maximum temperature indicated significantly increasing trends at Shalimar. These changes will affect both the hydrological processes and environmental systems which ultimately have the potential to affect the ecological balance of the Himalayan region. As Kashmir valley is having uneven topography due to which huge variation w.r.t. weather variables have been found. However, for minute study the future monthly analysis of all the three weather variables will be taken into account to get better understanding about climate change if any.

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Constraints and Remedial Measures in Dryland Agriculture

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Agriculture has been in practice in India since the vedic period. In 2013 India is ranked second in agricultural production contributing 7.68% of the total agricultural production of the world. Agriculture accounts for about one - 7th of the total exports of India. Agriculture contributed to about 45.48% of the total GDP during 1950-51. This value has been steadily declined and reached to about 15% during 2013-14 (Databook, 2014). These trends clearly show the shift of Indian economy from agrarian type of society to a society dominated by service sector. Despite this drift, agriculture sector still plays an important role in Indian Economy. With wide range of allied activities including dairy, fisheries, poultry, food storage and processing, Indian agro industry employs 54.6% of total workforce (Census 2011) despite shift of workforce from agriculture to manufacturing and services (Economic Survey, 2013).

Dry-Land Farming

Cultivation of crops in the areas with annual precipitation typically less than 50cm is called dryland farming. As per the estimates, 158.65 m ha of net agricultural area which is 53.4% of the total land area is arable. Out of this net cultivated area more than 50% is rainfed. The rain-fed agriculture accounts for more than 40% of total food grain production (www.data.worldbank.org). This data emphasizes the need to focus the attention towards research and development in dry-land farming to ensure food security and sustainable economic growth. Cultivation of pulses (91%), coarse cereals (91%), oil seeds (80%) and cotton (65%) predominates in these rain-fed region (Vision-2020: CRIDA).

Characteristics of dryland areas

Rainfall : The monsoon period is not one of continuous rains in any part of the country. Meghalaya that is uncommon in the behaviour of monsoon in the country. There are at least four variations in rainfall.

(i) The commencement of rains may be quite early or considerable delayed according to the dates of monsoon for central Maharashtra zone is 10th June but is started as early as 28th May 1925 and its onset was delayed upto 26th June 1954 according with the date of onset of monsoon in Rajasthan is between June 21 to 30 but is started as late as up to end of July 1987 to 1992.

(ii) There may be prolonged breaks in rainfall. These breaks in monsoon rains can be different duration. The breaks of 5 to 7 days may not be all serious concern but breaks of longer duration of 2 - 3 weeks created the situation of plant water stress leading to reduction in agricultural production. Another important point is the physiological properties of soil and available water holding capacity in the relation to the breaks and drought, some of the soils e.g. deep black soils have capacity to store more than 300 mm of water per meter depth where as the desert soil can ensure only 100 mm. The impact of drought is felt more quickly in the soil having less water holding capacity but in soils with high storage capacity 15 days dry break may not effect the crop where as the soils of less storage capacity show wilting symptoms in and dry break such breaks can not be predicated for a given season in advance. The drought caused due to this break is therefore of different magnitude and severity.

(iii) The rains may terminate considerably earlier or persists long than usual. The problem of withdrawal of monsoon is similar to onset of south-west monsoon. The date of withdrawal of south-west monsoon in Rajasthan is between September 19 – 20 its withdrawal was as early as 15th August in 1987 and 1989.

(iv) Un even distribution of rains

Due to comprehensive analysis relating to the fluctuation of rainfall and soil-water regimes of the different regions of the country. It was found that sub humid climatic regions are prone both floods and drought. The annual rainfall of India is about 1200 mm. which is slightly more than the global mean of 900 mm but its distribution is uneven. The regional variation is so large that the khari hills of north east get an annual rainfall greater than 6000 mm where as annual rainfall in Rajasthan desert is even less than 150 mm significant features of the distribution of rainfall is that a major part of rainfall received from S.W. monsoon from June to September. The continuation of this rainfall is quite high or whole of Gujarat and central parts of Rajasthan north of this region the per cent distribution by S.W. Monsoon reduced to 78% in Punjab about 80 – 85% in Haryana and North West Rajasthan there is small contribution (6 – 12%) by winter rainfall.

2. Temperature

Extreme variation in the temperature is the prime characteristic of dryland areas. During the winter season the north-east India experience very cold temperature which range from -9 to 14°C in the Ladakh region, in cold arid zone to 3 – 10°C in arid regions of Punjab, Haryana and Rajasthan frost often occur in north-west India Gujarat and Maharashtra experience minimum temperature of the range from 11 – 15°C while Karnataka and Andhra Pradesh record 16 to -18°C. The lowest temperature is recorded in January in North India and in December in South India, the temperature begins to rise from March onwards. Desert regions of North-west India record the highest day temperature. May and June are the hottest months and the mean annual temperature is about 48°C. On an individual days temperature of the order of 47 to 50°C are also recorded heat waves occurs the maximum temperature in southern part range around 39 – 40°C and May is the hottest month with the onset of monsoon the mean daily temperature fall sharply from 42°C in June to 33°C in July and 36°C in August to September.

3. Sunshine

Duration of hour of bright sunshine is an importance factor in dry areas sky remains generally clear favoring high insolation by day and rapid back radiation by night. The daily average sunshine hour are 7 to 9 in winter over India arid zone accept cold arid parts where the duration is less than 2.5 hours per day. During the summer season the arid zones record 9 to 10 hours per day and highest over Rajasthan, Gujarat, Maharashtra regions why in cold arid zone.

It is less than 8 hours with onset monsoon the hours of bright sunshine decreases sharply 4 to 5 per day in southern arid zone 4 to 7 hours in northern arid zone in the month of October. When south west monsoon is withdrawal over major part of the country the highest sunshine bright have 10 per day are recorded over western Rajasthan with decrease gradient south wards and are around 5 to 8 hours in southern arid zone on an annual basis the northern arid zones recorded slightly higher number sunshine hour per day more than (>8 hours) as compare to southern arid zone (7 to 8 per day hours).

4. Wind regime

In these areas wind regime as strong as on a Gujarat followed by Western Rajasthan. Where mean wind speed of >20 km/hour during April to July. Mean wind regime in western Punjab Haryana ranging from 2 – 10 km/hour. In southern arid zone stronger wind regime (>18 km/hour) prevail in Kurnul region of Andhra Pradesh and over

Raichur region Karnataka during June to August the wind regime in general remain low (4 to 10 km/hour) during October to April over major part of southern arid zone.

5. Potential Evapotranspiration (PET)

Potential Evapotranspiration varies from 1 to 2 cm during the January to 10 to 14 cm during May to August in cold arid zone. The annual PET in this regions varies from 75 to 80 cm (6 cm per year) in hot arid zone in north western India the annual PET increase from 130 in Punjab to 160 Haryana to over 200 cm in Rajasthan. During May – June the PET values at a maximum varying from 18 – 20 cm in Punjab to 22 – 23 in Haryana and 21 – 31 cm. in Rajasthan during winters the PET values range between 3 to 8 cm the annual PET values over southern arid zone R 180 – 185 cm because of the proximity to the equator and the maximum PE values vary ranging 22 cm during April – May while lowest during winter season between 10 to 13 cm.

6. Prolonged dry spells during the crop period

7. Low moisture retention capacity

8. Poor soil fertility condition

9. Socio-economic constraints particularly because of the pre-dominance of small and marginal farmers 54% of the holdings is less than one hectare.

10. Technological and developmental constraints

11. Limited infrastructure component and improper and untimely availability of credits and agricultural inputs.

Constraints associated with dryland farming areas

It is a dream desire to eliminate drought from this region. There are many problems that are associated with dryland farming systems. The problems may be grouped into four major factors: climatic, edaphic, technological and socio-economic.

Climatic

Scarcity of rain-water which is low and unpredictable with respect to intensity and distribution;

High ET (nearly 3650 mm annually compared to total annual precipitation ranging from 350 to 1400 mm);

Extreme thermic values (upto 49°C with the mean annual temperature exceeding 18°C at some places);

High solar incidence (450 to 500 Cal cm² day⁻¹);

High wind velocity with desiccating winds causing a high rate of ET and wind erosion;

Low relative humidity;

Extensive climatic hazards such as weather aberrations, drought, flood, frost, gale, cyclones and

burning winds due to dry, deserted and denuded situations.

Edaphic

Poor and marginal lands with soils low in fertility and productivity;

Uneven topography with high erodability;

Difficulty in workability particularly in vertisols;

Shallow or very deep in depth with extreme permeability;

Low moisture storage and release capacity particularly in Alfisols;

Presence of dissolved injurious salts in ground water;

Problem soils with respect to soil reaction (pH) and high concentration of soluble salts in the surface soils;

Water logging in level lands; flooding and breaking small field bunds resulting in poor conservation of soil and water;

Movement of sand and soil;

High surface crusting that leads to poor crop stand and high rate of evaporation and mechanical injury to roots.

Technological

Limited choice of crop varieties matching the short moist period suitable for cropping as about 60 per cent of the area has two to four-and-a-half wet months and about 19 per cent of the area has less than two wet months per year.

Difficulty in designing a suitable cropping system, crop mixture and crop geometry considering soil type and other flexible components such as the moisture availability index, and the duration of the monsoon;

Difficulty in evolving static and adaptable technologies fitting into the prevailing as well as anticipated rainfall conditions on a regional basis. The use of high input based technology is risky; Difficulty in seed production and multiplication specially in an on-far basis;

Farming is mainly human and animal power-based which is labour intensive and land saving but costly and time consuming resulting in difficulty in covering the entire arable area under the brief period of favorable weather during the season;

Limited use of fertilizers, poor response of biofertilisers and poor availability and the scope to improve it is very restricted;

Poor land capacity and the scope to improve it is very restricted;

Limited scope of use of residual moisture and nutrients;

Difficulty in conserving moisture for proper and timely utilization by crops;

Difficulty in reclaiming problems soils;

Lacking light and speedy implements with cheap sources of energy;

Profuse weed, pest, pathogen and parasite infestation;

Unpredicted heavy showers resulting in the accumulation of more than optimum moisture in the soil, impairing field operations including sowing interculture and harvesting in time;

Limited scope of land improvement;

Water harvesting and recycling is the high investment proposition at the initial level;

Water damage and loss of run off (up to 50 per cent of incident rainfall) causing loss of soil (greater than 10t/ha) and formation of gullies resulting in degradation and unsuitability for arable cropping.

Socio-economic

Peculiar ecological and socio-economic settings;

Frequent failure of crops and unstable production rendering farmers poorer;

Low cropping intensity; low farm income, malnutrition and poor quality of drinking water;

Small size of farm holdings and high population pressure on land (1.7 persons/ha);

Poor quality of produce fetching lower price;

Lack of marketing facilities and market incentives;

Low level of literacy and poor resource base of the farmers through they are economic minded and rational;

Unemployment for most of the period of the year;

Farmers are to depend on the favours of the monsoon or on financing institutions which are reluctant to provide assistance as there is a more risk in the recovery of the released amount from farming;

Farmers of these regions are deprived of innovations, initiative, inspiration, aspiration and appropriate incentives and appreciations and they wait, watch and worry over their future.

Management

The conservation of soil and water is very essential for sustainable production, environment preservation and

balanced ecosystem. Fifty percent of total geographical area (329mha) of our country needs soil and water conservation measures. About 5334 million tonnes of soil is lost annually along with 10 million tonnes of fertilizer and other essential elements and organic carbon. Loss of nutrients is almost equal to their total production in India. In India about 70% of the cultivated area falls under the category of dryland conservation measures for soil and water and efficient utilization of these resources is needed in these areas. The fact that rainfed agriculture supports 44% of India's human population and contributes 90 percent of coarse cereals and pulses, 80 percent of oils seeds and 65 percent of cotton and growing realization that further gains in productivity of crops and live stock will emanate from rainfed regions, leave no room for complacency in this regard.

In these areas, rainfall frequently occurs with high intensity that produces higher runoff due to non adoption of soil and water conservation (SWC) measures and poor permeability of the soil. As a result crop grown during rainy season often suffer from moisture stress due to inadequate moisture storage in the profile. Secondly soil erosion problems such as sheet, rill and even gully erosion are common in the region.

It has been reported that the black soils of peninsular region of India, under cultivated fallow gives runoff of about 23.4 percent of rainfall and results in a soil loss of 8.94 t ha⁻¹ at 1.0 percent slope (Verma et al., 1986). They further reported that the rate of siltation reduced by 83 percent within a span of five years due to adoption of Agronomic measure of SWC. These studies clearly showed that soil erosion and runoff are the major cause land degradation in the region that needs appropriate SWC measure so that crop productivity could be maintained.

Tillage

In dryland, tillage is required, (i) for moisture conservation (ii) to break the hardpan and help root penetration (iii) to control weeds, (iv) provide better aeration and (v) to provide a good seed bed.

Tillage alters the soil physical characters like porosity, bulk density, surface roughness and harness of pans. Different types of tillage implements influence these characteristics in their own way and thus affect runoff and erosion. Tillage operations, such as ploughing, disking harrowing, planting, cultivating and others are done very carefully so that least loss of soil may take place. Off season tillage is necessary to get a weed free seedbed having good tilth and better moisture conservation. Another, perhaps more important objective is to keep the surface soil loose so that higher rate of infiltration is

maintained and runoff reduced. Cultivation of soil with various implements provided as more pore space for storage and increases the amount of water stored. Surface roughness and micro depressions play a great role in high retention of water in soil profile. Profile modification by very deep plough (40-60m depth) with mould board plough in soils with sandy surface but clayey sub surface resulted in better storage at the surface layers. Sub-soiling improved soil moisture regimes, reduced runoff and soil erosion and increased yield of barley and soybean by 20 to 30 percent.

Contour Cultivation

Farmers generally cultivate their fields along the slope that not only accelerate soil erosion but also adversely affect crops yield. It is therefore, very essential to perform all tillage operations and sowing of crops on contour or across the general slope.

Experiments Conducted at Kanpur showed that yield increase with pearl millet, maize and sorghum with contour cultivation range between 7.5 to 25 per cent. Besides, it reduces runoff by 10 percent and nutrient loss by 40 percent compared to plots with cultivation along slope (Reddy, and Reddi, 2002). The results of the experiments conducted at CSWCRTI, Research center, Kota indicate that contour cultivation of sorghum and sorghum and pigeon pea (1:1) intercropping not only reduced runoff and soil loss (but also produced higher yields (Verma et al., 1990).

Graded bunds

Bunds of varying kind for different purposes and situations have been found effective to check erosion losses from black clay soils. Graded bunds are constructed to control soil erosion on lands having slope in the range of 1 to 6 per cent and the area receiving more than 600 mm of annual rainfall, however, these are also beneficial for deep black soil with rainfall less than 600 mm. These are constructed across the slope on a grade of 0.1 to 0.2 percent spaced at suitable vertical intervals; so as to divide total catchments area into small parts and runoff water from each part is carried away along these bunds without causing any erosion. Graded bunds reduced the runoff from 20 to 4.8% and soil loss from 24 to 4.12 t/ha per year (Singh, 1997).

Broad Bed and Furrow System (BBF)

The BBF system is one of the most efficient land management practices evolved by ICRISAT for in-situ moisture conservation in deep black soils. The BBF provide considerable protection against soil erosion throughout the year as they form permanent land feature. Results at ICRISAT indicate that the optimum slope for the bed and furrow system is 0.3 to 0.6% on alfisols (red soils)

and 0.4 to 0.8% on vertisols (black cotton soils). The beds function as mini bunds at a grade and help in reducing the velocity of surface runoff and increase in infiltration opportunity time. The excess water is removed through the furrows.

The system involves creation of 90-150cm wide, 15-20 cm high raised beds with 0.3 to 0.5 percent grades. The beds are stable for 2 to 4 years and conveniently adopted to planting of upland crops in rows spaced at 30, 45, 75 or 150 cm. The system tends to conserve soil, rain water in-situ and improves crop yield and sustainability.

Crop rotation is generally defined as a more or less regularly recurrent succession of different crops on a single piece of land. The crops used are commonly a cultivated crops a small grain and a grass, legumes, or legume-grass mixture. Of these, the cultivated crop exposes the soil to the maximum erosion; the small grain allows less erosion and the grass or legume-grass crop effectively controls erosion during the period of its life. The principles to be followed in a soil-saving rotation are to reduce the time the land is occupied by a cultivated crop as much as the economic situation of the farm will permit, increase as much as possible the time it is covered by legume or a grass, and reduce soil tillage. It is evident that the soil loss from corn following clover in the rotation is less than where corn is grown continuously; also, that the soil loss during the entire rotation occurs mainly while the field is in a cultivated crop.

Soil loss from conventionally tilled continuous cotton average over 70t/ha annually as compared to previously measured annual soil loss of 19 and 16t/ha forms soybeans and maize respectively. Pasture has negligible runoff and sediment losses. Inclusion of Lucerne in crops rotation reduced soil loss even in soil with 13 percent slope. Soil loss with Lucerne hay was 13.6t/ha compared with 364t/ha with arable crops over a four year period. Growing a crop that produces the maximum cover reduces runoff and soil loss.

Crops are rotated in order the soil productivity may be preserved and crops yields maintained. Not only does crop rotation serve to reduce soil and water loss, but it also maintains crops yields. Hence, this practice is a profitable one for the farmer to adopt regardless of its value in saving soil and moisture.

Intercropping

Intercropping of short growing legumes in wider inter row spaces of crops provide sufficient cover on the ground there by reducing erosion hazards from the sloping cultivated fields. Intercropping on contour not only, reduced the runoff (2 to 3%) and soil loss (5 to 8%) but also resulted in higher yield (48%) (Singh, 1997).

Growing cover crops

Soils bare of vegetation are often prone to erosion. It is also observed that soils low in organic matter content are more easily eroded. Any crop producing dense canopy and foliage to cover the land surface is called as cover crop. Cover crops reduce runoff, add organic matter content to the soil for an improved soil particle binding capacity, protects newly constructed bund/ mechanical structures- and increase water absorbing capacity and the infiltration of water into the soil. Straight or erect growing crops grown in wide rows with cultivation like cotton, corn, sorghum etc. are highly conducive to soil loss therefore, they must be grown alongwith suitable cover crops like greengram, blackgram, cowpea, groundnut etc. These crops was found satisfactory at 1 per cent slope for reducing soil erosion as these crops covered the land properly within a short span of 30-35 day after sowing (Verma et al., 1986).

Nutrient management

Crop production on eroded soil under dryland conditions is limited not only due to inadequate moisture, but also due to poor fertility status of the soil. Fertilizer application doubled the yield of several crops on eroded soil. Response to fertilizer application is more with soil conservation practices and placement of fertilizers. Drilling of seeds and placement of fertilizer in most subsurface in the same furrow stimulated root growth and extracted more moisture from the deeper layers of soil. Better utilization on soil water as well as nutrients by the crop via better root growth increased grain yield (Hossain, and Maniruzzaman, 1992). Siddiqi, 1987 also observed that water holding capacity of alkali soil increased from 42.2 to 53.5 per cent due to addition of organic matter.

Green manuring

Green manuring is the practice of turning under plant material to improve the soil. While any thick crop will provide seasonal cover, special crops are grown for green manuring. Sesbania, sunhemp, red clover, sweet clover and alfalfa make excellent green manuring crops when finally turned under, but they are rarely seeded for this particular purpose sunhemp has been widely tried as a covercum-green manure crop in summer/Kharif season to conserve soil, moisture, improve physical conditions and fertility status of soils a part from controlling a weed growth. The effect of green manuring with sunnhemp on runoff, soil loss, fertility improvement, moisture conservation, weed control and crop yield has been reported (Sharda et al., 1999b; Sharda et al., 1999a). They found that sunnhemp as a green manure crop reduced runoff by 18.6 percent conserved about 8 per cent higher moisture in the upper soil layers, reduced soil

loosely 33.1 per cent and enhanced yield of wheat crop by 28 per cent as compared to fallow-wheat system.

Mulching

Mulches are used for various reasons, but water conservation and erosion control are undoubtedly the most important for agriculture in dryland (semi arid and arid) regions. While the effectiveness of mulches for water conservation is variable, mulches when properly managed definitely aid wind and water erosion control. The material include crop residues, leaves, clipping, bark, manure, paper, plastic films, petroleum products, gravel and coal.

Mulching with plant materials reduces soil loss up to 43 time compared to bare soil and 17 times compared to cropped soil without mulches. By increasing the amount of mulch, sediment present in runoff water can be reduced as it covers more soil surface and protects it from rain drop impact. A minimum ground cover with residue should be 30 percent to keep runoff and soil within acceptable limits. Mulches are also applied in narrow slots (vertical mulching) instead of spreading on the soil surface. Crop residues are pressed into harrow continuous slots of 5 to 10 cm width and 20 to 25cm depth. The residue is filled up to 5 cm above the ground level. These slots with residues form a ridge across the slope. They increase infiltration and this reduces runoff.

Use of chemicals

Breakdown of aggregates by the falling raindrops is the main cause of detachment of soil particles. Soils with stable aggregates resist break down and thus resist erosion. Aggregate stability can be increased by spraying chemicals like polyvinyl alcohol at 480 kg/ha, the rate, however, depend on the type of soil. Soil treated with bitumin increase water stable aggregates and infiltration capacity of the soil. However, practical method of increasing stability of aggregates is by application of organic matter, farmyard manures crop residues, green manure etc.

Weed control

Weeds (including volunteer crop plants) compete with crops for water, nutrients and light under all cropping conditions. However, under dryland conditions, competition for water generally considered the most important. Consequently, effective weed control before and after crop planting is essential if crops are to produce at their potential under the prevailing environmental conditions. Weed control before planting increases the potential for higher soil water contents at planting, thus providing additional water for the subsequent crop. Weed control during the crops growing season reduces direct competition for water.

Other agronomic practices

Several other agronomic practices helps in soil and water conservation either by increasing infiltration or by providing more opportune time for infiltration or by improving soil physical properties or by decreasing detachment of soil particles. Application of manure and fertilizer provides early crop cover due to quick growth. Dead furrows (with closed ends) formed at 3.6m interval after emergence of the crop sown across the slope, reduce the length of the run of rain water, hold water and increase opportune time for infiltration.

Planting geometry refers to the special arrangement of the plants or colonies in the field. These arrangements for a given population can be adjusted either by changing the inter row or intra row distances. The need for suitable geometry under dryland condition is mainly for better utilization of available water. Rectangular planting is found to be more advantageous than square planting for crops raised under conserved moisture situations. When plants are spaced closely with in row and increasing the distance between rows, the soil moisture supply is not exhausted as rapidly as in narrow rows.

It is difficult to predict the season especially under kharif rainfall situations. Therefore, it may be advisable to start the season with permissible optimum spacing and optimum population and later on thin out the alternate or third row to provide for wider spacing or by removing the unhealthy seedlings within a row itself if the season is not favourable.

Vegetative control of Gullies

Gullies tend to form wherever runoff is concentrated in unprotected depression channel ways. Once started, they increase in which rain the land. Where gullies have developed to considerable size, special methods must be used to control their growth and where possible, to reclaim the gullied area for agricultural use. For this purpose, vegetation is most economical and satisfactory, although in some instances, especially in large gullies, the use of close-growing plants may need to be supplemented with mechanical measures. Even in small gullies, brush, straw, log, loose rock, or sod dams may be helpful in checking runoff and collecting silt favourable to plant growth while the protective vegetation is becoming established. Gullies often utilized for vegetated water ways. Water must first be diverted, however, the sides smoothed by plowing, and suitable grass or grass legume mixtures seeded. Studies conducted at CSWCRT1, Research centre, Kota reveal that loose boulders and brush wood check dams performed satisfactorily in subsidiary gullies which do not carry much. runoff, whereas, loose boulders check dams are suitable for main gullies as they help in silt deposition

which facilitate stabilization of gully beds (Verma et al., 1986).

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Integrated Approach for Weed Management in Tuberose (*Polianthes tuberosa* L.) cv. Prajwal

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Abstract

Weed management is the important aspect in tuberose cultivation. A study was conducted during 2017 - 2018, 2018-2019 at farmer's field Chinnapudur, Dharmapuri (dit) to know the integrated weed management in tuberose. The result revealed that pre-emergence application of pendimethalin at 3 days after planting *fb* hand hoeing + pendimethalin at the rate of 1.5 kg ha⁻¹ on 30, 90, 150, 210 days after planting significantly reduced the weed growth and recorded higher spike weight (29.22 and 30.43 g), florets per spike (56.16 and 53.12, flower yield (13.30 and 13.23 t ha⁻¹) was registered in both years. Control plot caused the reduction in flower yield of tuberose. Thus the adoption of proper weed management provided the suitable environment for tuberose cultivation.

Key words : Integrated, weed management, pre-emergence, tuberose.

Introduction

Flowers have been grown since ancient times and form an integral part of our heritage and culture since ancient time. Floriculture is the art of growing of flower crops. In India floriculture is one of the important commercial trades in agriculture. Lot of significance has been given to this sector due to employment, aesthetic needs and foreign exchange. Traditional agriculture with regular cultivation of cereals and pulses facing lot of problems in cultivation. Now a day commercial floriculture is gaining more importance. More particularly they are being used as raw materials for perfumes, confectioneries and medicinal industries. Among the different flower crops tuberose is one of the important flower crop grown in tropical regions. It is bulbous crop belongs to the family of amaryllidaceae and origin of Mexico. The flower blooms all over the year. Florets remain fresh long time and stand for distance transportation. Tuberose has the great economic potential for cut flower and perfume industry (Panwar *et al.*, 2010).

Growth of flower is affected by different factors like pest, disease and weed infestation. Due to these factors the yield of the flower is drastically reduced. Among these factor weed infestation is the major problem in tuberose cultivation since it is used for both the flower and bulb production. In general weeds can be removed manually but it is time consuming and increased cost of cultivation. Under this condition alternate way to control the weed is chemical weed control integration with hand weeding to provide season long weed control. Herbicides include pre and post emergence to control the weeds. Use of pre-

emergence herbicides offered the alternate way to control the weeds during the early growth stages. The selection of post-emergence herbicides is limited in tuberose cultivation. Therefore suitable method should be followed to control the weeds. Integrated use of pre and post emergence herbicides during crop period would pave the way for reducing weed competition and increase the flower yield. So, keeping these all this in concern the study was conducted with different pre and post emergence herbicides integrated with hand weeding.

Materials and Methods

A field experiment was carried out during kharif season during 2017-2018, 2018-2019 at farmer's field Chinnapudur, Dharmapuri (dit) to know the effect of chemical weed management in tuberose. The experiment was laid out in randomized block design and replicated thrice. The treatments comprised of ten different weed management practices viz., T₁-Pendimethalin @ 1.0 kg ha⁻¹ on 3 DAP *fb* Paraquat 1.0 kg ha⁻¹ on 30 & 150 DAP + quizalofop-ethyl 50g ha⁻¹ on 90 and 210 DAP, T₂ - Pendimethalin @ 1.0 kg ha⁻¹ on 3 DAP *fb* hand hoeing + pendimethalin @ 1.5 kg ha⁻¹ on 30, 90, 150, 210 DAP, T₃ - Pendimethalin @ 1.0 kg ha⁻¹ on 3 DAP *fb* hand hoeing + alachlor @ 1.5 kg ha⁻¹ on 30 and 150 DAP *fb* hand hoeing + Pendimethalin @ 1.5 kg ha⁻¹ on 90 and 210 DAP. T₄ - Pendimethalin @ 1.0 kg ha⁻¹ on 3 DAP *fb* hand hoeing + pendimethalin @ 1.5 kg ha⁻¹ on 30 DAP *fb* Paraquat 1.0 kg ha⁻¹ 120 DAP *fb* quizalofop-ethyl 50g ha⁻¹ on 210 DAP, T₅ Pendimethalin @ 1.0 kg ha⁻¹ on 3 DAP *fb* hand hoeing + pendimethalin @ 1.5 kg ha⁻¹ on 30, 120, 210 DAP, T₆ -

Table-1 : Effect of weed control treatments on total weed density (No. m⁻²) during 2017-2018.

Tr. No.	Treatments	Total weed density (No. m ⁻²)	Total weed dry weight (kg ha ⁻¹)	Weed control efficiency (%)	Weed Index (%)
T ₁	Pendimethalin @ 1.0 kg ha ⁻¹ on 3 DAP fb paraquat @ 1.0 kg ha ⁻¹ on 30 & 150 DAP + quizalofop-ethyl @ 50g ha ⁻¹ on 90 and 210 DAP	64.47 (4.60)	453.13 (12.06)	77.27	36.04
T ₂	Pendimethalin @ 1.0 kg ha ⁻¹ on 3 DAP fb hand hoeing + pendimethalin @ 1.5 kg ha ⁻¹ on 30, 90, 150, 210 DAP	29.64 (3.25)	240.82 (8.98)	89.55	7.44
T ₃	Pendimethalin @ 1.0 kg ha ⁻¹ on 3 DAP fb hand hoeing + alachlor @ 1.5 kg ha ⁻¹ on 30 and 150 DAP fb hand hoeing + pendimethalin @ 1.5 kg ha ⁻¹ on 90 and 210 DAP	34.52 (3.43)	261.22 (9.35)	87.83	13.5
T ₄	Pendimethalin @ 1.0 kg ha ⁻¹ on 3 DAP fb hand hoeing + pendimethalin @ 1.5 kg ha ⁻¹ on 30 DAP fb paraquat @ 1.0 kg ha ⁻¹ on 120 DAP fb quizalofop-ethyl @ 50g ha ⁻¹ on 210 DAP	62.04 (4.52)	420.41 (11.62)	78.13	36.32
T ₅	Pendimethalin @ 1.0 kg ha ⁻¹ on 3 DAP fb hand hoeing + pendimethalin @ 1.5 kg ha ⁻¹ on 30, 120, 210 DAP	53.59 (4.24)	314.51 (10.23)	81.1	21.5
T ₆	Pendimethalin @ 1.0 kg ha ⁻¹ on 3 DAP fb hand hoeing + pendimethalin @ 1.5 kg ha ⁻¹ on 30 DAP fb hand hoeing + alachlor @ 1.5 kg ha ⁻¹ on 120 DAP fb hand hoeing + pendimethalin @ 1.5 kg ha ⁻¹ on 210 DAP	59.00 (4.45)	353.74 (10.82)	73.32	31.66
T ₇	Atrazine @ 1.0 kg ha ⁻¹ on 3 DAP	123.04 (6.15)	452.47 (12.25)	56.62	47.25
T ₈	Hand weeding at 30,90,150 and 210 DAP	116.50 (5.77)	437.03 (11.18)	58.93	27.41
T ₉	Weed free check	0.0 (0.71)	0.0 (0.71)	100	0
T ₁₀	Unweeded check	283.68 (9.44)	1090.79 (18.91)	0	57.68
	SEd	0.54	0.94	-	-
	CD (P = 0.05)	1.12	1.95	-	-

Pendimethalin @ 1.0 kg ha⁻¹ on 3 DAP fb Hand hoeing + Pendimethalin @ 1.5 kg ha⁻¹ on 30 DAP fb Hand hoeing + Alachlor @ 1.5 kg ha⁻¹ on 120 DAP fb hand hoeing + Pendimethalin @ 1.5 kg ha⁻¹ on 210 DAP, T₇ - Atrazine @ 1 kg ha⁻¹ on 3 DAP, T₈ - Hand weeding at 30, 90, 150 and 210 DAP, T₉ - Weed free check, T₁₀ - Control. The soil type of the experimental field is sandy clay loam in texture, neutral in pH 7.30 and 7.03 low Ec (0.44, 0.48 dSm⁻¹), low organic carbon (0.27, 0.23 per cent) medium in available N (234.26, 223.8) and in available P (15.80, 14.62) and K content (282.52, 273.41) recorded in both the years. Need based plant protection measures were given as per the crop protection guide. The growth attributes were recorded from five selected plants in each plot. Observations on weeds were recorded with the help of a quadrat (0.5 m x 0.5 m) placed randomly at two places (outside the net plot area) in each treatment. The data on weeds were subjected to square root transformation ("X+2") to normalize their distribution.

Results and Discussion

Effect of weed management practices on weed parameters : In the experimental field, different types of

weeds like broad leaved weeds (*Commelina benghalensis*, *Convolvulus arvensis*, *Cleome viscosa*, *Trianthema portulacastrum* and *Phyllanthus niruri*), sedges (*Cyperus rotundus*) and grass (*Dactyloctenium aegyptium*, *Cynodon dactylon*) were dominated throughout the growing period. Similarly in tuberose different kinds of weeds like *Cyperus rotundus*, *Trianthema portulacastrum* and *Dactyloctenium aegyptium* was reported by Rameshkumar *et al* (2011). Weed population and weed dry matter was recorded at different interval 30, 90, 150 and 210 DAP recorded in both the years (Table 1 & 2) chemical weed management significantly reduced the weed population and dry weight of weeds compared to the other weed control treatments. These might be due to effective control of weeds by the different herbicide combinations. Similar results were recorded in chrysanthemum reported by Tripathy *et al* (2015).

Among the different weed control treatments pre emergence application of pendimethalin @ 1.0 kg ha⁻¹ on 3 DAP fb hand hoeing + pendimethalin @ 1.5 kg ha⁻¹ on 30, 90, 150, 210 DAP (T₂) recorded reduced weed

Table-2 : Effect of weed control treatments on total weed density (No. m⁻²) during 2018-2019.

T. No.	Treatments	Total weed density (No. m ⁻²)	Total weed dry weight (kg ha ⁻¹)	Weed control efficiency (%)	Weed Index (%)
T ₁	Pendimethalin @ 1.0 kg ha ⁻¹ on 3 DAP fb paraquat @ 1.0 kg ha ⁻¹ on 30 & 150 DAP + quizalofop-ethyl @ 50g ha ⁻¹ on 90 and 210 DAP	72.98 (4.84)	429.60 (11.90)	72.44	36.76
T ₂	Pendimethalin @ 1.0 kg ha ⁻¹ on 3 DAP fb hand hoeing + pendimethalin @ 1.5 kg ha ⁻¹ on 30, 90, 150, 210 DAP	31.44 (3.30)	231.34 (8.84)	87.62	9.25
T ₃	Pendimethalin @ 1.0 kg ha ⁻¹ on 3 DAP fb hand hoeing + alachlor @ 1.5 kg ha ⁻¹ on 30 and 150 DAP fb hand hoeing + pendimethalin @ 1.5 kg ha ⁻¹ on 90 and 210 DAP	34.58 (3.43)	244.25 (9.04)	86.39	12.13
T ₄	Pendimethalin @ 1.0 kg ha ⁻¹ on 3 DAP fb hand hoeing + pendimethalin @ 1.5 kg ha ⁻¹ on 30 DAP fb paraquat @ 1.0 kg ha ⁻¹ on 120 DAP fb quizalofop-ethyl @ 50g ha ⁻¹ on 210 DAP	67.78 (4.76)	358.85 (11.04)	71.59	34.84
T ₅	Pendimethalin @ 1.0 kg ha ⁻¹ on 3 DAP fb hand hoeing + pendimethalin @ 1.5 kg ha ⁻¹ on 30, 120, 210 DAP	56.28 (4.35)	305.51 (10.04)	77.85	16.8
T ₆	Pendimethalin @ 1.0 kg ha ⁻¹ on 3 DAP fb hand hoeing + pendimethalin @ 1.5 kg ha ⁻¹ on 30 DAP fb hand hoeing + alachlor @ 1.5 kg ha ⁻¹ on 120 DAP fb hand hoeing + pendimethalin @ 1.5 kg ha ⁻¹ on 210 DAP	62.72 (4.58)	357.01 (10.86)	70.82	35.73
T ₇	Atrazine @ 1.0 kg ha ⁻¹ on 3 DAP.	132.65 (6.20)	418.77 (11.89)	47.8	45.74
T ₈	Hand weeding at 30,90,150 and 210 DAP	129.89 (5.89)	386.33 (10.99)	48.88	21.39
T ₉	Weed free check	0.0 (0.71)	0.0 (0.71)	100	0
T ₁₀	Unweeded check	254.12 (9.20)	1044.12 (18.49)	0	51.16
	SEd	0.56	0.82	-	-
	CD (P = 0.05)	1.17	1.70	-	-

population and dry weight in both the years. The next best treatment was application of pendimethalin @ 1.0 kg ha⁻¹ on 3 DAP fb hand hoeing + alachlor @ 1.5 kg ha⁻¹ on 30 and 150 DAP fb hand hoeing + pendimethalin @ 1.5 kg ha⁻¹ on 90 and 210 DAP (T₃) registered reduced weed density in both the years. The highest weed density were recorded in unweeded check (T₁₀). These might be due the presence of weeds throughout the crop growth. Similar results were recorded in Kishan Swaroop *et al.* (2017) in gladiolus.

Effect on vegetative parameters : Weed management practices have the favourable effect on vegetative parameters like plant height, no leaves plant⁻¹, days required for emergence of rachis, length of spike and rachis length in irrigated tuberose. In present investigation all the weed control treatments resulted considerable effect on vegetative parameters compared to the unweeded check (T₁₀). The maximum plant height was recorded in weed free check (T₉). These might be due to the absence of weeds throughout the season and there is no competition of space, light, nutrients. Similar results were recorded in chrysanthemum as reported by

(Badhesha 2003). Among the different weed control treatments pre emergence application of pendimethalin @ 1.0 kg ha⁻¹ on 3 DAP fb hand hoeing + pendimethalin @ 1.5 kg ha⁻¹ on 30, 90, 150, 210 DAP (T₂) recorded plant height, no leaves plant⁻¹, days required for emergence of rachis, length of spike and rachis length (Table 3 & 4). Use of chemicals not only reduced the weed density but also enhanced the plant growth parameters. These clearly reveals the effectiveness of herbicides over the weeds and crop plant. Similar results were recorded in tuberose reported by Murthy and Gowda (1993). The next best treatment was application of pendimethalin @ 1.0 kg ha⁻¹ on 3 DAP fb hand hoeing + alachlor @ 1.5 kg ha⁻¹ on 30 and 150 DAP fb hand hoeing + pendimethalin @ 1.5 kg ha⁻¹ on 90 and 210 DAP (T₃).

The growth of plant is mainly depends on the photosynthetic activity of the leaves and transport to the developing organs. Leaves are considered as typical source in general. Herbicide treated plots have better source (leaves) and sink (flowers) relationship compared to unweeded check. Since, the weeds are effectively checked with herbicide application.

Table-3 : Effect of weed control treatments on plant height (cm) during 2017-2018.

T. No.	Treatments	Plant height (cm)	Days required for emergence of spike	Days required for emergence of rachis	Length of spike (cm)
T ₁	Pendimethalin @ 1.0 kg ha ⁻¹ on 3 DAP fb paraquat @ 1.0 kg ha ⁻¹ on 30 & 150 DAP + quizalofop-ethyl @ 50g ha ⁻¹ on 90 and 210 DAP	32.16	71.63	86.17	97.07
T ₂	Pendimethalin @ 1.0 kg ha ⁻¹ on 3 DAP fb hand hoeing + pendimethalin @ 1.5 kg ha ⁻¹ on 30, 90,150, 210 DAP	62.23	62.07	74.33	115.13
T ₃	Pendimethalin @ 1.0 kg ha ⁻¹ on 3 DAP fb hand hoeing + alachlor @ 1.5 kg ha ⁻¹ on 30 and 150 DAP fb hand hoeing + pendimethalin @ 1.5 kg ha ⁻¹ on 90 and 210 DAP	60.67	66.27	78.25	107.60
T ₄	Pendimethalin @ 1.0 kg ha ⁻¹ on 3 DAP fb hand hoeing + pendimethalin @ 1.5 kg ha ⁻¹ on 30 DAP fb paraquat @ 1.0 kg ha ⁻¹ on 120 DAP fb quizalofop-ethyl @ 50g ha ⁻¹ on 210 DAP	35.89	70.60	83.50	98.87
T ₅	Pendimethalin @1.0 kg ha ⁻¹ on 3 DAP fb hand hoeing + pendimethalin @1.5 kg ha ⁻¹ on 30, 120, 210 DAP	50.90	67.33	75.17	102.40
T ₆	Pendimethalin @1.0 kg ha ⁻¹ on 3 DAP fb hand hoeing + pendimethalin @1.5 kg ha ⁻¹ on 30 DAP fb hand hoeing + alachlor @ 1.5 kg ha ⁻¹ on 120 DAP fb hand hoeing + pendimethalin @1.5 kg ha ⁻¹ on 210 DAP	38.67	68.23	82.57	100.53
T ₇	Atrazine @ 1.0 kg ha ⁻¹ on 3 DAP	32.27	75.03	83.78	91.47
T ₈	Hand weeding at 30,90,150 and 210 DAP	41.87	66.90	74.87	105.61
T ₉	Weed free check	62.51	61.83	64.36	117.20
T ₁₀	Unweeded check	22.50	79.61	100.35	81.57
	SEd	1.81	2.82	3.30	4.67
	CD (P = 0.05)	3.77	5.85	6.86	9.70

Table-4 : Effect of weed control treatments on plant height (cm) during 2018-2019.

T. No.	Treatments	Plant height (cm)	Days required for emergence of spike	Days required for emergence of rachis	Length of spike (cm)
T ₁	Pendimethalin @ 1.0 kg ha ⁻¹ on 3 DAP fb paraquat @ 1.0 kg ha ⁻¹ on 30 & 150 DAP + quizalofop-ethyl @ 50g ha ⁻¹ on 90 and 210 DAP	31.22	74.05	85.57	96.07
T ₂	Pendimethalin @ 1.0 kg ha ⁻¹ on 3 DAP fb hand hoeing + pendimethalin @ 1.5 kg ha ⁻¹ on 30, 90,150, 210 DAP	61.79	62.18	68.55	114.60
T ₃	Pendimethalin @ 1.0 kg ha ⁻¹ on 3 DAP fb hand hoeing + alachlor @ 1.5 kg ha ⁻¹ on 30 and 150 DAP fb hand hoeing + pendimethalin @ 1.5 kg ha ⁻¹ on 90 and 210 DAP	61.52	65.77	73.90	106.63
T ₄	Pendimethalin @ 1.0 kg ha ⁻¹ on 3 DAP fb hand hoeing + pendimethalin @ 1.5 kg ha ⁻¹ on 30 DAP fb paraquat @ 1.0 kg ha ⁻¹ on 120 DAP fb quizalofop-ethyl @ 50g ha ⁻¹ on 210 DAP	39.80	70.54	85.94	97.37
T ₅	Pendimethalin @ 1.0 kg ha ⁻¹ on 3 DAP fb hand hoeing + pendimethalin @ 1.5 kg ha ⁻¹ on 30, 120, 210 DAP	49.79	67.67	73.16	103.03
T ₆	Pendimethalin @ 1.0 kg ha ⁻¹ on 3 DAP fb hand hoeing + pendimethalin @ 1.5 kg ha ⁻¹ on 30 DAP fb hand hoeing + alachlor @ 1.5 kg ha ⁻¹ on 120 DAP fb hand hoeing + pendimethalin @ 1.5 kg ha ⁻¹ on 210 DAP	38.74	69.13	84.41	103.10
T ₇	Atrazine @ 1.0 kg ha ⁻¹ on 3 DAP	33.12	74.67	85.20	95.40
T ₈	Hand weeding at 30,90,150 and 210 DAP	46.19	67.40	75.20	103.13
T ₉	Weed free check	62.19	62.17	66.50	120.30
T ₁₀	Unweeded check	23.07	79.44	102.90	79.12
	SEd	1.84	2.92	3.65	6.15
	CD (P = 0.05)	3.82	6.06	7.57	12.76

Conclusion

Therefore from these study it could be concluded that application of pendimethalin @ 1.0 kg ha⁻¹ on 3 DAP fb hand hoeing + pendimethalin @ 1.5 kg ha⁻¹ on 30, 90, 150, 210 DAP (T₂) effectively suppressed the weed growth and resulted higher vegetative and flowering characters.

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Effect of *Emblica officinalis* Gaertn. on Biomass Production of Traditional Winter Crops in Bundelkhand Region

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Abstract

Studies were carried out in experimental area of Institute of Agriculture Sciences, Bundelkhand University, Jhansi to elucidate the influence *E. officinalis* tree plantation on the biomass of winter crops of Bundelkhand region namely wheat, chickpea, lentil, mustard and barley. The effect of tree on plant height, seed weight per plant, root weight per plant and shoot weight & number of plants per quadrat were observed at different distances of 1m, 2m & 3m from tree base to identify the suitable crop combination with aonla plantation. The findings revealed that significant effect of *E. officinalis* tree on different biomass parameters varied according to test crop (Wheat, Chickpea, Lentil, Mustard and Barley). However, as the distance of crop increases from the tree the value for all the parameters like plant height, seed weight, shoot weight, root weight and number of plants also recorded an increase in their respective values.

Key Words : *Emblica officinalis*, biomass, crops, plant height, seed weight, root weight, shoot weight.

Introduction

Aonla, Amla or Indian gooseberry (*Emblica officinalis* Gaertn. Syn. *Phyllanthus emblica* L) which is the oldest minor fruit tree native to our country, is an immensely important agroforestry tree species for semi-arid region (Durgesh Nandini and Dhanai C.S., 2020). Aonla is known for its medicinal and therapeutic properties from the ancient time in India and considered as a wonder fruit. It is highly nutritious and is one of the richest sources of vitamin-C, amino acids and minerals (Srivasuki KP, 2012). The fruit of *E. officinalis* is considered as 'wonder fruit for health' because of its unique qualities, namely astringent, cooling anodyne, carminative, digestive, stomachic, laxative, aphrodisiac, diuretic, antipyretic, and trichogenous and also useful in the treatment of many diseases including diabetes, cough, asthma, bronchitis, headache, ophthalmic disorder, dyspepsia, colic, flatulence, skin diseases, leprosy, jaundice, scurvy, diarrhea, diabetes, and grayness of hair (Anonymous, 1952). Pickle and Morabba are prepared from fruit. Leaves find an important use as fodder and branches as firewood. The twig, bark and leaves have considerable importance as a tanning material.

Aonla is commonly adopted in agroforestry systems either on boundaries of farmsteads or intercropped along with seasonal crops due to its deep rooted system and deciduous cycle along with providing a number of uses yielding greater economic gains with low investments. In an agroforestry system, where crops are grown with woody perennials, there is a significant influence of tree component on growth and production of under canopy

crops through shade effect, nutrient, moisture, root competition and release of particular chemicals which is known as allelopathy. Thus, for successful implementation of agroforestry system, proper tree-crop combinations are needed to be recommended (C.S. Dhanai and Shayma Parveen, 2021). Hence, an attempt has been made to assess the effect of *E. officinalis* on the biomass of intercrops such as wheat, barley, mustard, chickpea and lentil which are commonly grown in Bundelkhand region. The study will help in understanding the effect of tree species on biomass production of these intercrops and adopting the suitable tree crop combination in aonla based agroforestry at farmer's field for maximizing economic returns with sustainable use of natural resources.

Material and Methods

Studies were carried out in the experimental area of Institute of Agricultural Sciences, Bundelkhand University, Jhansi to elucidate the biomass of winter crops of Bundelkhand region namely, wheat, chickpea, lentil, mustard and barley under *E. officinalis* plantations. Three observations were taken at 1 metre distance from stem of *E. officinalis* and then a quadrat was laid out (0.5m X 0.5 m) and the data was collected at the maturity of crop. The same procedure was followed for 2 metre and 3 metre distance for all the crops. The observations were recorded for plant height, seed weight per plant, root weight per plant and shoot weight & number of plants per quadrat for ten plants and then mean of those values were calculated.

Table-1 : Effect of *Emblica officinalis* on Biomass Production of Wheat.

Distance From Tree	Biomass Production				
	Plant Height	Seed Weight/Plant	Shoot Weight/Plant	Root Weight/Plant	No. Plant/ Quadrate
1 M	72.87	8.08	2.02	0.39	192.00
2 M	78.52	9.90	2.18	0.47	201.00
3 M	87.63	11.92	2.35	0.51	212.00
C.D. (0.005)	3.44	0.44	NS	0.47	3.54

Table-2 : Effect of *Emblica officinalis* on Biomass Production of Chickpea.

Distance From Tree	Biomass Production				
	Plant Height	Seed Weight/Plant	Shoot Weight/Plant	Root Weight/Plant	No. Plant/ Quadrate
1 M	40.66	10.77	4.49	0.66	17.00
2 M	42.09	12.04	4.51	0.72	20.00
3 M	43.90	12.58	4.75	0.84	21.00
C.D. (0.005)	1.19	0.52	NS	NS	NS

Table-3 : Effect of *Emblica officinalis* on Biomass Production of Lentil.

Distance From Tree	Biomass Production				
	Plant Height	Seed Weight/Plant	Shoot Weight/Plant	Root Weight/Plant	No. Plant/ Quadrate
1 M	41.32	2.69	3.49	0.53	23.00
2 M	42.26	2.71	3.78	0.57	25.00
3 M	42.43	2.74	3.89	0.61	27.00
C.D. (0.005)	NS	NS	NS	NS	1.31

Results and Discussion

The data on biomass production of wheat influenced by *E. officinalis* at different distances from tree base indicated that tree had a significantly inhibitory effect on height of plants, seed weight per plant, root weight per plant and number of plants per quadrate except shoot weight per plant which was found non-significant (Table-1). As the distance from the tree increased, all the parameters showed an increase in their values. This reflected that effect of tree was more prominent near the base of the tree as compared to farther distance from the tree. The maximum plant height in wheat crop was observed at 3m distance (87.63 cm) and minimum at 1m distance (72.87 cm) from tree base. The values for plant height at all three distances differed significantly from each other. Similarly seed weight per plant (11.92 gm), root weight per plant (0.51 gm) and number of plants per quadrate (212.00) were found maximum at 3m distance and differed significantly at distances of 1m and 2m from the tree base. For all of the above parameters, 1m distance registered the minimum value of 8.08 gm for seed weight per plant, 0.39 gm for root weight per plant and 192.0 for number of plants per quadrate. The minimum value for shoot weight per plant was recorded at 1m distance (2.02 gm) and maximum at 3m distance (2.35 gm) which were found statistically at par with each other.

The data shown in table-2 reveals the effect of *E.*

officinalis on biomass production of chickpea at different distances from tree base. The highest value of plant height was found at 3m distance (43.00 cm) and minimum at 1m distance (40.00 cm). Plant height at different distances differed significantly from each other. The seed weight per plant in chickpea was found maximum at 3m distance (12.58 gm) and minimum at 1m distance (10.77 gm) which showed the inhibitory effect of tree. The maximum values for shoot weight (4.75 gm), root weight (0.84 gm) and number of plants per quadrate (21.00) were recorded at 3m distance from the tree base. Similarly minimum values were recorded at 1m distance for shoot weight (4.49 gm), root weight (0.66 gm) and number of plants per quadrate (17.00) which is differed non-significantly from 1m and 2m distance from the base of *Emblica officinalis*. Tree effect was found significantly inhibiting on plant height and seed weight per plant. The tree showed a non-significant effect on root weight per plant, shoot weight per plant and number of plants per quadrate. As the distance from the tree increased, all these parameters displayed an increasing trend in their values.

The results related to effect of Aonla on Lentil under biomass study is presented in Table-3. The data showed that aonla tree showed a non-significant effect on height of plants, seed weight per plant, root weight per plant and shoot weight per plant except number of plants per quadrate which was significantly influenced. With the

Table-4 : Effect of *Emblca officinalis* on Biomass Production of Barley.

Distance From Tree	Biomass Production				
	Plant Height	Seed Weight/Plant	Shoot Weight/Plant	Root Weight/Plant	No. Plant/ Quadrate
1 M	56.27	1.43	1.65	0.38	179.00
2 M	59.38	1.80	1.76	0.45	198.00
3 M	62.22	1.92	2.29	0.49	207.00
C.D. (0.005)	NS	NS	0.05	NS	2.20

Table-5 : Effect of *Emblca officinalis* on Biomass Production of Mustard.

Distance From Tree	Biomass Production				
	Plant Height	Seed Weight/Plant	Shoot Weight/Plant	Root Weight/Plant	No. Plant/ Quadrate
1 M	97.32	9.78	7.72	3.12	12.00
2 M	101.48	10.62	8.23	3.20	15.00
3 M	102.68	11.13	8.81	3.31	16.00
C.D. (0.005)	1.67	0.39	NS	NS	1.31

increase in distance from tree base, the value of all the parameters also showed an increment. The maximum number of plants was recorded at 3m distance (27.00) and minimum at 1m distance (23.00) which differed significantly from each other. The plant height differed non-significantly from each other at distance of 1m, 2m & 3m and was found maximum at 3m distance (42.43 cm) in comparison to the minimum value of 41.32 cm at 1m distance. Similarly maximum seed weight (2.74 gm), shoot weight (3.89 gm) and root weight (0.61 gm) were observed at 3m distance from the tree base. While minimum value for seed weight (2.69 gm), shoots weight (3.49 gm) and root weight (0.53 gm) was observed at a distance of 1m from tree base and differed non-significantly at distance of 1m and 2m from the tree base.

Results on barley crop grown at different distances from the emblica tree base showed that tree effect was non-significant for three parameters viz. plant height per plant, seed weight per plant and root weight per plant and significant for shoot weight per plant as well as for number of plants per quadrate (Table 4). It was revealed from the data that as the distance from the tree increases the value for all the parameters also increases. The maximum plant height was found at 3m distance (62.22 cm) and minimum at 1m distance (56.27 cm) from base of aonla tree. Values of plant height at all the three distances from tree base differed non-significantly from each other. Similarly the maximum values for seed weight per plant (1.92 gm) and root weight per plant (0.49 gm) were recorded at 3m distance from the tree base whereas the minimum value recorded for seed weight per plant was 1.43 gm and root weight per plant was 0.38 gm which were recorded at 1m distance from the tree base and the values differed non-significantly from each other at 1m and 2m distances. The values for shoot weight per plant (2.29 gm) and

number of plants per quadrate (207.00) also showed maximum value at 3m distance and least value at 1.65 gm and 179.00 for shoot weight per plant and number of plants per quadrate respectively which differed significantly at 1m and 2m distance from tree base .

The study shows that aonla tree affected significantly the plant height, seed weight per plant and number of plants per quadrate in mustard crop (Table 6). However, the effect on shoot weight per plant and root weight per plant was found non-significant. With the increasing distance from the tree base, the value of all the parameters also registered an increase. The maximum plant height was recorded at 3m distance (102.68 cm) and minimum at 1m distance (97.32 cm). The values for plant height at all three distances differed significantly from each other. Similarly maximum values for seed weight per plant (11.13 gm) and number of plants per quadrate (16.00) were recorded at 3m distance and minimum value of 9.78 gm & 12.00 respectively at 1m distance from tree base. The maximum values for shoot weight (8.81 gm) and root weight (3.31gm) were recorded at 3m distance from tree base whereas minimum values of shoot weight (7.72 gm) and root weight (3.12 gm) were observed at 1m distance which differed non-significantly from 1m and 2m distance from the base of tree.

The findings of present study on biomass production of wheat as subjective by *E. officinalis* at a distance of 1m, 2m & 3m from tree base indicated that tree effect was significant for all the parameters except shoot weight per plant. The findings on biomass production of chickpea crop showed that tree effect was non-significant for all the parameters root weight, shoot weight and numer of plants except plant height and seed weight. The finding related to effect on Lentil under biomass study illustrated that tree effect was non-significant for all the parameters except number of plants. The value for number of plants was

significantly affected by the tree species. The findings with respect to biomass production of barley crop as influenced by *E. officinalis* at different distance from the tree base exhibited that tree effect was non-significant for all the parameters plant height, seed weight and root weight except shoot weight and number of plants. The results of biomass production of mustard crop showed that tree effect was significant for all parameters plant height, seed weight and number of plants except shoot weight and root weight. It is quite clear from above findings that effect of *Embllica officinalis* tree on different biomass parameters like plant height, seed weight, shoot weight, root weight & number of plants varied according to test crop (Wheat, Chickpea, Lentil, Mustard and Barley) and affected them significantly or non-significantly. However, as the distance of crop increases from the tree the value for all the parameters like plant height, seed weight, shoot weight, root weight and number of plants also yield increased values. The results are in agreement with S.K. Dhyani & R.S. Tripathi & (1998) as observed in crops under Alder, Mandarin and Cherry trees. It may be attributed to competition for soil water (Singh *et al.*, 1989; Wezel, 2000) and nutrients (Fernandes *et al.*, 1990). According to Newman *et al.* (1998), shade was also a key limiting factor in Paulownia elongata S.Y. Hu plantations. Since crop species differ in their tolerance to shade (Garrett *et al.*, 2009), this may be a prominent cause of variation found in biomass results in different test crops. But another very important reason for the inhibitory effect found in the studies may be due to allelopathy. A number of studies have proved that trees possess a negative effect on growth and biomass of crops through the mechanism of allelopathy. Allelochemicals are found in all plant parts like leaves, roots, rhizomes, stems, inflorescences and flowers (Putnam, 1988). Often, the release of these allelochemicals from the decomposing litter affects seed germination, growth and development of adjoining crop plants in agroforestry systems. It is therefore important that the allelopathic compatibility of crops with trees be determined before incorporating them into the agroforestry system as phytotoxins released by some intercrop trees could affect the establishment of crops (King, 1979; Rice, 1979). The allelopathic effect of aonla on understory crops has been already confirmed by many workers including Indu Singh (2005), Singh Bhupendra *et al.* (2010), C.S. Dhanai and Shayma Parveen (2021) etc.

Conclusion

The study clearly indicates that for successfully drawing

full potential of agroforestry systems, immensely cautious selection of tree crop combination should be considered. This demands more research in areas of tree crop compatibility and allelopathy in particular localities and ecological sites in which an agroforestry system is to be adopted for attaining the targets of maximizing economic viability and sustainability on long term basis.

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Evaluation of Different Fungicides Against Alternaria Blight of Linseed [*Linum usitatissimum* (L.)]

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Abstract

Alternaria blight of linseed [*Linum usitatissimum* (L.)] caused by *Alternaria lini* is most common disease of Bundelkhhand region of M.P. Efficacy of different fungicides, were tested In - Vitro and In – Vivo. Fungicides tested under the In – Vitro condition like Bavistin (0.10%), Topsin – M (0.15%), Benomyl (0.20), Ridomil (0.10%), Vitavax (0.10), Plantvax (0.20) and Chlorothalonil (0.15%) proved to be the most effective Bavistin and Topsin –M. The inhibiting the fungal growth of the pathogen In – Vitro is least effective fungicide Chlorothalonil to show minimum inhibition of the pathogen. Under the field condition observation recorded in which Bavistin was most effective than other fungicides.

Key words : Linseed, alternaria blight, *Alternaria lini*, management, fungicides in-vitro and in-vivo.

Introduction

Linseed [*Linum usitatissimum* (L.)] is an important oil seed crop grown for dual purposes seed and fibre. Linseed also referred as flax (*Linum usitatissimum* (L.)), is a self – pollinated crop widely adopted to temperate climates of the world. It is an annual plant belongs to the genus *Linum* and the family *Linaceae*. Linseed is globally cultivated for its fibre and its called flax. Fibre is used for manufacture of linen. Alternaria blight of linseed was first reported by Dey (1933) from Kanpur in U.P. The disease was found to cause heavy damage, especially in low lying ill drained fields. He described the symptoms of the disease. Black dot like spots appear on leaves, stems and buds, which enlarge to form circular to irregular spots, the affected leaves ultimately curl and dry up. The affected capsule may contain deformed, discoloured, blighted and papery seeds. Linseed plant is known to suffer from many diseases such as powdery mildew, rust, blight, canker, damping off, leaf spot, root rot, wilt and some non-parasitic diseases due to excess and deficiencies of trace elements Kolte and Fitt, (1997). Screening of literature on the Alternaria blight disease of linseed in India showed that there are only sporadic reports on its occurrence. A disease of linseed caused by *Alternaria* spp. was first observed on Govt. Research Farms, Kanpur and Gorakhpur and the fungus was named as *Alternaria lini* (Dey, 1933).

Materials and Methods

In-vitro bioassay of fungicides was done by poisoned food technique. The studies were carried out by using Potato Dextrose Agar medium test seven fungicides viz., Bavistin 0.1%, Topsin- M 0.15%, Benomyl 0.2%, Ridomil 0.1%,

Vitavax 0.1%, Plantvax 0.2%, and Chlorothalonil 0.15% were tested by poisoned food technique (Schmitz, 1930) by incorporating the test fungicides. In the Potato dextrose agar medium, after sterilization of the medium, The fungicide were incorporated in the media. 20 ml of such medium was poured in each of the sterilized Petri plates. They were inoculated at the centre with a 7 mm disc cut with sterilized cork borer of 20 actively growing 10 days old culture of the fungus. Suitable control without fungicides was maintained. The Petri plates were incubated at 25±1°C. Each treatment was replicated four times. Suitable control (without fungicide) was also maintained. The radial growth of *Alternaria lini* was recorded after seven days. The percent inhibition over control was calculated by the formula (Bliss, 1934) as given below :

$$\text{Percent inhibition over control} = \frac{C-T}{C} \times 100$$

Where, C = growth of fungus in control

T = growth of fungus in treatment

Field evaluation of fungicides : Field experiments on the evaluation of the seven test fungicides against Alternaria blight were conducted in Rabi season (2015 to 2017) using linseed cv. Shakhar. The experiments were laid out in a Randomized Block Design with three replications for each treatment. The plot size was 4 x 3 meter with ten rows per plot at a distance of 30 cm. between the rows and 7 cm. between the plants. All treatment were spray with Bavistin 0.1%, Topsin- M 0.15%, Benomyl 0.2%, Ridomil 0.1%, Vitavax 0.1%, Plantvax 0.2% and Chlorothalonil 0.15% along with a control (water spray) for comparison and seed germinate. The first spray was given just after the appearance of the disease. The second spray was given at an interval of 15

Table-1 : Effect of fungicide on the radial growth of the pathogen *In-vitro*.

S. No.	Treatments	Dose (%)	Radial growth (cm)	Percent inhibition
1.	Bavistin	0.10	0.0	100.00
2.	Topsin-M	0.15	0.0	100.00
3.	Benomyl	0.20	0.6	92.00
4.	Ridomil	0.10	1.7	77.33
5.	Vitavax	0.10	2.3	69.33
6.	Plantvax	0.20	4.7	37.33
7.	Chlorothalonil	0.15	5.6	25.33
8.	Control	0.00	7.5	-
	CD at 5%		(3.774)	-

Table-2 : Management of blight disease of linseed through the foliar spray under the field conditions.

S. No.	Treatments	Dose (%)	Seed germination (%)		Disease incidence (%)		Yield q/ha.	
			2015-16	2016-17	2015-16	2016-17	2015-16	2016-17
1.	Bavistin	0.10	96.12 (78.61)	95.00 (77.08)	8.33 (16.78)	7.16 (15.49)	8.45	7.90
2.	Topsin – M	0.15	94.40 (75.82)	93.45 (75.15)	10.83 (19.21)	9.46 (17.90)	7.65	7.25
3.	Benomyl	0.20	93.11 (74.77)	91.45 (73.00)	12.00 (20.27)	10.00 (18.44)	7.37	6.75
4.	Ridomil	0.10	89.50 (71.09)	89.03 (70.63)	16.16 (23.66)	14.43 (22.25)	6.80	5.65
5.	Vitavax	0.10	87.20 (69.04)	86.40 (68.36)	22.32 (28.86)	20.20 (26.71)	5.62	5.45
6.	Plantvax	0.20	85.10 (67.29)	84.65 (66.92)	26.23 (30.80)	23.60 (29.06)	4.95	4.90
7.	Chlorothalonil	0.15	84.35 (66.70)	82.25 (65.08)	32.83 (34.95)	29.96 (33.19)	4.26	4.22
8.	Control	0.00	73.30 (58.89)	72.90 (58.63)	37.46 (37.73)	36.20 (36.99)	3.35	3.25
	CD at 5%		(0.310)	(0.203)	(0.522)	(0.420)	(1.676)	(2.592)

days after the first spray. The final intensity of the disease was recorded 15 days after the second spray. The grain yield per plot was also recorded which was extrapolated to give the value of yield in Q/ha. The data were statistically analyzed.

Results and Discussion

The result presented in the table-1 and its corresponding shows that all the treatment were found significantly superior over control. However among in 7 fungicides only 2 fungicides Bavistin and Topsin – M, were found most effective and they completely inhibit the fungal growth whereas Benomyl, Ridomil, Vitavax, Plantvax were found next best inhibition fungal growth and they were statistically at par with each others.

The fungicides Chlorothalonil was least affective to show minimum inhibition of pathogen. The 100% inhibition of the fungal growth were found by the use of Bavistin and Topsin – M and next in order of superior, 92.00, 77.33, 69.33, 37.33, the Chlorothalonil was showed 25.33% inhibition over control. Holli and Meena (2015) used 7 fungicides for the management of *Alternaria* blight Viz., Vitavax, Copper – oxychloride,

Propiconazole, Dithane M- 45, Difenconazol, Carbendazim and Topsin – M. In – Vitro Propiconazole (0.1%) was found significantly superior over the rest of fungicide. Singh and Singh (2006) also tested 7 fungicides Viz., Chlorothalonil, Copper – oxychloride, azoxystrobin, Propineb, Copper–hydroxide, Mancozeb was against *Alternaria alternata* and revealed that all the fungicides tested significantly reduced the radial growth of the fungus significantly.

In-vivo : The result presented in the table-2 and its corresponding shows that all the evaluated seven fungicides were used to manage the disease under the field condition for foliar spray namely, Bavistin, Topsin – M, Benomyl, Chlorothalonil, Ridomil, Vitavax and Plantvax. These all fungicides used in both year 2015 – 16 and 2016 – 17. In order to compare their effect on the seed germination disease incidence and yield Q/ha. The observation recorded in which Bavistin was found most effective than other fungicides with the seed germination of 96.12 in 2015 – 16 and 95.00 in 2016 – 17 the disease incidence were maximum managed by Bavistin with 8.33 and 7.16 in year 2015 – 16, and 2016 – 17 respectively, The yield, were recorded 8.45 and 7.90 in 201 – 16 and

2016 – 17 respectively. These were statistically at par with each others. Second best fungicides was Topsin – M followed by Benomyl, Ridomil, Vitavax and Plantvax shows at 94.40 to 84.65% seed germination 9.46 to 23.60% disease incidence and 7.25 to 4.90 Q/ha yield. Among the tested fungicides Chlorothalonil was showed minimum seed germination 82.2% in 2016 –17, maximum disease incidence 32.83% in 2016–17 and minimum yield 4.22 Q/ha in the year 2016–17.

Gupta *et al.*, (2014) evaluated bio-agent and fungicides against Alternaria blight of linseed and found Mancozeb (0.2%) was the best fungicide for reducing disease intensity. Singh and Kerkhi (2010) evaluated botanicals, bio- agent and fungicide against Alternaria blight of linseed and observed that the maximum % disease control was recorded by (Iprodione 0.2%) in comparison to the botanicals and bio-agents.

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Sorghum and Minor Millets Consumption Pattern in North-Eastern Karnataka of India

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Abstract

Culinary characteristics of sorghum and minor millets crops and derived food in North-Eastern Karnataka of India were conducted a research using quantitative survey method. We found different forms of consumption pattern of sorghum and minor millets in their respective area and with habits and beliefs. Sorghum is mostly consumed as Roti (an unleavened bread). The major sensory quality attributes are related to texture, color and taste. In regard to minor millets is mostly consumed as anna (rice) because of its nutritious and tasty. All derived foods consumed in different levels of intervals period.

Key words : Anna, culinary, minor millets, roti, sorghum.

Introduction

Millet is one of the oldest foods known to humans and possibly the first cereal grain to be used for domestic purposes. It is mentioned in the Bible that it was used during those times to make bread. Millet has been used in Africa and India as a staple food for thousands of years. It is suggested that people were cultivating millet in India about 2500 BC. India is the largest producer of different kinds of millets called as coarse cereals and it is nutritionally superior over other fine cereals such as rice and wheat and hence it is known as nutritional cereals.

Millets encompasses two main groups of species i.e., major millets include Sorghum (Jola in Kannada vernacular or *Sorghum bicolor* (L.) Moench), India is a secondary centre of diversity (Singh, 2002) and Pearl millet (Sajje in Kannada vernacular or Bajra or *Pennisetum glaucum*). Minor millets include 6 crops which are Finger millet (Ragi in Kannada vernacular or *Eleusine coracana*), Kodo millet (Haraka or *Paspalum scrobiculatum*), Little millet (Saame/Saave or *Panicum sumatrense*), Foxtail millet (Navane or *Setaria italica*), Proso millet (Baragu or *Panicum milliaceum*), Barnyard millet (Oodalu or *Echinochloa frumentacea*) and Brown top millet (Koralu or *Urochloa ramosa* (L.) Nguyen).

Millet is the major staple food in North-Eastern Karnataka and is also valued greatly for other uses like poultry and animal feed. The landraces of sorghum, pearl millet and minor millets were continued to be maintained for cultural preferences and traditional practices by the farmers which could play an important role in the food security, income generation and food culture of the rural poor in the area. But, less attention is paid to sorghum, pearl millet and minor millets production, especially the popular traditional varieties grown by farmers and their potential value is under-estimated and under-exploited.

Hence, the area under millets cultivation in India has significantly reduced and thus, they are grown in one season and predominantly grown as mixed or intercrop along with other cereals, high value crops such as grain legumes (Pigeonpea, Greengram and Blackgram) or oil seed crops viz., mustard and niger (Patil and Kulkarni, 2011). All these factors, place them in danger of continued genetic erosion and disappearance. This lead to erode the genetic base and prevent the use of distinctive useful traits in crop adaptation and improvement.

The Indian Council of Agricultural Research (ICAR) in collaboration with the United States Agency for International Development (USAID) has taken up programmers/projects on germplasm collection, evaluation and utilization of sorghum during 1963-1964. The first major effort to assemble a world collection of sorghum was made in the 1960s by the Rockefeller Foundation in the Indian Agricultural Research Programme (House, 1985; Murty *et al.*, 1967). With these contexts and backgrounds, we conducted a research to understand the status of the traditional sorghum and minor millets varieties in North-Eastern Karnataka; with this intention the followed specific objective.

To find out the Consumption pattern of the conserved sorghum and minor millets crop varieties by farmers

Research Methodology

An interview of the respondent was considered as one of the essential method. With this, collected a detailed information on culinary characteristics and derived foods of sorghum and minor millets varieties were collected. Besides, documented the farmers consumption pattern of traditional sorghum and minor millets varieties from their socio-economic point of view. It was carried out as an

Table-1 : Distribution of farmers according to their consumption pattern of traditional sorghum and minor millets crop varieties. n=30

Intervals	Crops	Sorghum (jola)	Bajra (sajje)	Foxtail millet (navane)	Little millet (saame)	Other millets
Daily		30(100.00)	-	-	-	-
Once in a week		-	2(06.67)	1(03.33)	1(03.33)	1(03.33)
Twice in a week		-	2(06.67)	1(03.33)	3(10.00)	2(06.67)
Monthly		-	10(33.33)	2(06.67)	2(06.67)	2(06.67)
Occasionally (festivals)		-	20(83.33)	8(33.33)	8(50.00)	2(06.67)
Never		-	-	-	-	15(50.00)

The figure in parentheses indicates the percentage.

Table 2 : Distribution of farmers according to their different forms of consumption of traditional sorghum varieties. n=30

Intervals	Items	Roti (an unleavened bread)	Upittu	Sandige/Chakali (fired Snack)	Kadabu (Pudding)	Pop corn	Roasted sorghum (Seetani)	Holige (pancake)	Ambali/Nuchhu (porridge)	Ghuggari	Jolada Anna
Daily		30 (100.00)	-	-	-	-	-	-	-	-	-
Fortnight			06 (20.00)	03 (10.00)	-	-	-	10 (33.33)	-	-	-
Once in a month			02 (06.67)	10 (33.33)	-	-	-	-	-	-	-
Occasionally (festival)		-	12 (40.00)	15 (50.00)	28 (93.33)	30 (100.00)	24 (80.00)	30 (100.00)	25 (83.33)	30 (100.00)	30 (100.00)

The figure in parentheses indicates the percentage

in-depth individual discussion with a sample of 30 farmers in different districts of the study area. The items discussed were related to consumption pattern of sorghum and minor millets varieties. The results were used to design schedule for a quantitative survey.

Results and Discussion

Consumption pattern of traditional sorghum and minor millets crop varieties by farmers : The data presented in Table-1 shows that, cent per cent of the farmers preferred consuming sorghum regularly in their daily diet. The reasons might be due to that sorghum forms the staple food commodity of North-Eastern Karnataka and due to habitual decisions of individuals' culture makes them to choose sorghum. However, none of the farmers were using minor millets regularly in their diet and only few farmers consumed minor millets once in a week. In month wise, one-third (33.33 %) and meager (06.67 %) of the farmers were consuming bajra and other millets in their diet respectively. The reasons expressed by farmers were availability of millets declined due to easy availability of rice and wheat through public distribution system and difficulty in its processing, whereas rice is easier to clean and cook compared to millets. During some special occasions and festivals, most of the farmers *i.e.*, 83.33 per cent and 50.00 per cent were using bajra (Sajje) and little millet (Saame) respectively. Because in the study area, most people believed that only these specific items are to being preparation of festive food items for their regional festivals, due to their food taboos and with the intention that it maintains cultural identity of

the community. Similar line of results observed with earlier researcher (Yenagi *et al.*, 2011; Parawira and Muchuweti, 2008).

Different forms of consumption of traditional sorghum varieties by farmers : It was noticed from the table 2 that, in the study area cent (100.00 %) per cent of farmers consumed daily sorghum in the form of roti (an unleavened bread), according to them it is by habit, suits to prevailing climatic conditions of the locality coupled family traditions, reasons of health and it gives high amount of energy to do work.

It can also be observed from the above table that sorghum is also consumed in the form of Upittu by the respondents in the North-Eastern Karnataka *i.e.*, with an interval of "Once in a fortnight" (20.00%), "once in a month" (06.67 %) and "occasionally" (40.00 %), because it adds energy, nutrient in the dietary system as it contains dietary fiber which in turn hasten the process of digestion and also avoids obesity as compared to the rice and wheat flour. This is cognate with Messias *et al.* (2015).

Meanwhile, the respondents also consumed sorghum in other forms *i.e.*, Sandige/chakali (50.00 %), (33.33 %) and (10.00 %) with an interval of "occasionally", "once in a month" and "fortnight", respectively. The possible reason may be of its taste and preference of the children, aged family member's likes to eat these dishes, which in turn adds taste to main foodstuff.

In the surveyed area also we could observe that a high per cent of farm families consumed sorghum in the form of Holige (100.00 %), Popcorn (100.00 %), which

Table-3 : Distribution of farmers according to their different forms of consumption of minor millets crop. n=30

Intervals	Forms of consumption of minor millets							
	Bajra (Sajje)	Foxtail (Navane)		Little millet (Saame)		Ragi		Baragu, Oodalu and Haraka
	Roti (an unleavened bread)	Anna	Tiffin Items (dosa, Idli etc)	Uppitu	Anna	Malt	Tiffin Items	Anna
Daily	-	-	-	-	-	-	-	-
Once in a week	-	-	-	18 (60.00)	-	-	-	-
Once in a Fortnight	-	25 (75.00)	-	-	-	-	-	-
Once in a month	-	-	26 (86.67)	-	-	-	-	14 (46.67)
Occasionally (festival)	30 (100.00)	-	-	-	22 (73.33)	02 (06.66)	06 (20.00)	-

The figure in parentheses indicates the percentage

Table-4 : Distribution of farmers according to preference of traits for consumption of roti(an unleavened bread). n=30

Roti Traits	Frequency*	Percent	Most preferable variety
Colour	21	26.67	Maldandi
Softness	16	53.33	Basavana mothi
Taste	25	83.33	Basavana muthi, Gundu tene Jola, Kormudki, Chapadi Jola, Kenchu jola
Keeping quality	30	100.00	Basavana muthi, Gundu tene Jola

may be balled with crude sugar (jaggery) and also be pounded into a nutty-flavored flour, which is typically mixed with milk and sugar, buttermilk, salt or chillies. The other forms of sorghum were Kadabu (93.33 %) and Ambali (83.33 %) on special festival days such as Sankramana, Naga panchami, Dushera, Deepavali *etc.*, due to the customs and taboos of the localities. About (100.00 %) of the respondents consumed sorghum in the form Ghuggari (whole grain mixed with grains of Bengal gram) and jolada anna in “Occasionally” respectively. Another form of consumption of sorghum as roasted sorghum/ Seetani (80.00 %), it is prepared at milking stage of sorghum crop. In this process, fresh green earhead when turns to cream colour were placed in trench with fire. After 10-15 minutes of roasting, the earheads are removed from trench and seeds are separated by hand when the earhead is still hot. The green earheads threshing was done by holding them in both the hands and then rubbing it with palm to get the roasted seeds as “Seetani” for consumption. Further, there is a notion among the elders that eating roasted sorghum/Seetani for one month keeps the body healthier for whole year. Present results are conformity with Mallavva and Surekha (2019).

Different forms of consumption of traditional minor millets crop varieties by farmers : It was noticed from the table 3 that, in the study area cent per cent of farmers consumed bajra (Sajje) in form of roti (unleavened bread) “occasionally” on special festival days such as Sankramana and other ceremonies *etc.*, due to the

customs of the localities. In the mean while, 75.00 and 86.67 per cent of the farmers consumed Foxtail (Navane) in form of anna and Tiffin items “once in fortnightly” and “once in month”, respectively. It can also be observed that (60.00 %) and (73.33 %) of farmers consumed little millet in the form of Uppitu, Anna in the North-Eastern Karnataka *i.e.*, with an interval of “once in a week” and “occasionally”, respectively. In the mean time, the farmers consumed ragi in form of malt (06.66 %) and Tiffin items (20.00 %) such as dosa, idli *etc.*, in “occasionally”. In addition other millets like Baragu, Oodalu and Haraka were consumed in form of anna “occasionally”. The probable reason was availability of new products may compete with products derived from traditional crops varieties in terms of price and convenience, which together with changes in taste or an increased perception that traditional crops and varieties are associated with poverty or low status, may reduce their appeal. Our findings are similar to the study of Anderson (2012), Keller *et al.* (2005).

Farmers according to preference of traits for consumption of roti (an unleavened bread) : In table 4 observed that, farmers of North-Eastern Karnataka have identified varieties with distinct grain roti traits and are growing in their fields since many years.

Cent per cent of farmer told that Basavanna Muthi and Gundu tene jola have high gelatinized content that makes to prepared thin size roti, this unique characters helps to keep longer hours. Whereas, Basavana muthi, Gundu tene Jola, Kodmurki, Chapadi Jola, Kenchu jola

has good aroma and taste trait thus 83.33 per cent of farmers preferred. About more than half (50.00%) of farmer said that children's and elder in the family preferred to eat basavanna muthi since it has softness trait. Mean time, Thirty out of 21 farmers used maldandi variety in the roti preparation in the study area because white colour roti trait compared to other varieties.

Seetani : For preparation of seetani/hurda, the panicles were cut from the plant at milky grain stage. In 'Sakkari mukhari Jola' variety, the panicles were harvested when the grains turn cream colour as green earheads make poor threshing ability after roasting. The fresh panicles were then placed in a trench with fire prepared for this purpose. After 10-15 minutes of roasting, the panicles were removed from trench and seeds were separated by hand when the panicle was still hot. Threshing was done by holding the panicle in both the hands and then rubbing it with palm.

Jolada Kadubu : Heat 1 cup water until it boils. Mix jowar flour and flaxseed powder in a bowl or on a plate. Make a small well in the middle and pour half the boiling water. Mix with a ladle. Slowly add more boiling water and mix. Once well mixed and cool enough, knead well with hands till it forms dough. Make small balls out of the dough and flatten them on your palm. One cup of jowar flour will give 30-40 balls. These are Jolada Kadubu. Arrange on a plate and keep aside.

Jolada anna : Is prepared by deskinning jowar. It can be consumed instead of regular rice. It is a very good option for diabetics and weight watchers.

Wash jowar twice and soak in water for 5 minutes. Now drain the water and spread jowar on a clean kitchen towel for 5 minutes. Put the semi dry jowar in the food processor bowl fitted with chopper blade. Process for 3 minutes and stop. Mix the jowar and again process for 3 minutes. Now transfer the jowar to a sifting pan [kannada-mara, marathi-sup, hindi-soop] and winnow [sift] to remove the husk. Again transfer the jowar to the processor and process for 3 minutes. Stop and give a mix. Process for another 3-4 minutes and transfer to a sifting pan. Winnow to remove the husk.

Sorghum Ambali : Mix sorghum flour with luke warm water carefully to avoid formation of lumps. Add rice starch soup & salt to the above mixture and cook for 15-20 min. Cool the drink, or else ferment for overnight in earthen pot and can be consumed next day. Ghuggari whole grain mixed with grains of Bengal gram.

Conclusions

It is clear from the results that, the Sorghum and other

minor millets are consumed less frequently by the respondents. Hence, there is a need to encourage the consumers for consumption of minor millets by creating awareness regarding nutritional value of minor millets. Administrators and policy makers should take necessary actions for distributing sorghum and other minor millets through public distribution system which helps both growers and consumers.

At present the utility of these varieties is restricted for household use especially during festive seasons for traditional food preparations. Their specific grain quality trait needs to be exploited commercially to add value to the grain. The commercialization initiatives will help to realize higher profits by the farmers, when supported by the food industry. Hence, policy makers should think in line with increasing farmer's income and create avenues for the farming community and agri start ups to move along the way to sustain nutrition and business at the same time.

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Survival and Development of Spotted Bollworm *E. vittella* on different *Bt* Cotton Hybrids

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Abstract

Bt-cotton contains one or more genes derived from the soil bacterium *Bacillus thuringiensis* and introduced into the cotton genome through genetic modification (GM). The genes express insecticidal proteins in the plant parts and are generally referred as Cry (crystal) proteins which are toxic to leaf-eating caterpillar pests, more specifically to the three species of cotton bollworms. The current study aimed to study the survival and development of Spotted Bollworm *E. vittella* on different *Bt* cotton hybrids. This study was done at the Post Graduate Laboratory, Department of Agricultural Entomology, College of Agriculture, Latur, Maharashtra-India during 2018-19. During the period of study bioassay was conducted on *Bt*-cotton plant parts i.e., squares and bolls by using different larval instars of *E. vittella* by feeding them on squares and bolls of six BG-II cotton hybrids (AJEET-155, BHAKTI NCS-245, JAY, YUVA 7215-2, RCH-2, Dr. BRENT MRC-7347) and one non-*Bt*-cotton hybrid (NHH-44) as a control. Results of bio assay studies revealed that the mortality of early larval instars of *E. vittella* fed on squares and bolls of different *Bt* cotton hybrids was higher than the later larval instars. Exposure of later instar larvae to different plant parts of different *Bt* cotton hybrids also showed adverse effects on the growth and development such as reduced larval weights, prolonged larval developmental period, reduced pupation, formation of small pupae with less weight, reduction in adult emergence with low growth and survival indices for *E. vittella*. The growth and survival index values were also low for the larvae reared on squares compared to those reared on bolls of different *Bt* cotton hybrids.

Key words : Transgenic cotton, spotted bollworm, survival and development, genotype.

Introduction

Cotton is an international crop grown commercially in more than 80 countries on 33.19 million hectares area with 25.88 million tonnes of production and 780 kg per ha average productivity across the globe (USDA, 2019). In India cotton was cultivated on 12.25 million ha area with 5.66 million tonnes of production and 462 kg per ha of average productivity during 2018-19 (USDA, 2019). Maharashtra is leading cotton producing state which cultivates cotton in about 4.12 million ha area with 1.38 million tonnes of production having average productivity of 334 kg per ha during 2018-19 (CAB, 2019).

The yield of cotton mainly depends on weather, pests, diseases and management practices. Unfortunately, cotton is damaged by more than 160 species of insect-pests right from emergence till the final picking (Manjunath, 2004). Among which bollworms viz., *Helicoverpa armigera* (Hubner), the green bollworm; *Eariasvittella* (Fabricius), the spotted bollworm; *Eariasinsulana* (Biosdual), the spiny bollworm and *Pectinophora gossypiella* (Saunders), the pink bollworm infested cotton (Bhamare and Wadnerkar, 2018) and inflicted 30-80 per cent yield losses (Kranthi *et al.*, 2009). Even after the introduction of bollworm-resistant *Bt* cotton, which now covers more than 95 per cent of area under cotton, losses caused by insect-pests have been

estimated at a whopping 30 per cent (Dhaliwal *et al.*, 2010 and 2015). The 87.43 per cent avoidable yield losses were estimated due to bollworm complex in *Bt* cotton (Jadhav *et al.*, 2019). Worldwide more than US \$ 5 billion per annum accounted for managing the bollworm outbreak and its losses (Crop Life, 2017).

In India so far six *Bt* cotton events have been approved for commercial cultivation, however currently more than 95 per cent of the cotton area is covered by only Monsanto's two-gene (Cry 1Ac + Cry 2Ab) *Bt* event called Mon-15985 (Kranthi, 2016). Under this background, in view of the availability of various transgenic cotton hybrids for farmers and the variability in the performance of the Cry 1Ac and Cry 2Ab toxins among the plant parts and different growth stages of crops, the present investigation was planned to study the survival and development of bollworms on different *Bt* cotton hybrids. In India insect resistant (*Bt*) technology in cotton hybrids delivered broad based benefits by saving losses caused by bollworm and boosted cotton yield to 500 kg lint per hectare (ISAAA, 2017). However, recently many studies exhibited bollworm survive and develop on elite *Bt* cotton hybrids (Mahalakshmi and Prasad, 2013, Naik *et al.*, 2012, Soujanya *et al.* 2010, Naik *et al.*, 2014, Kranthi, 2016, Shera and Arora, 2016a, Likhitha and Bhamare, 2018a&b and; Rupnar, 2018). Moreover, severe damage to bolls by *P. gossypiella* and yield-losses

Table-1 : Growth indices of *E. vittella* reared on different plant part of *Bt* cotton hybrids.

Treatments	Growth Index		
	Squares (90 days old crop)	Bolls (120 days old crop)	Bolls (150 days old crop)
AJEET-155 BG-II	3.89	3.88	6.85
BHAKTI NCS-245 BG-II	4.14	4.27	7.84
JAY BG-II	3.55	3.37	6.30
YUVA 7215-2 BG-II	3.64	3.90	5.00
Dr. BRENT MRC-7347 BG-II	3.33	3.65	5.63
RCH-2 BG-II	3.37	4.17	7.17
NHH-44 Non-Bt	10.63	10.86	11.90

Table-2 : Survival indices of *E. vittella* reared on different plant part of different *Bt* cotton hybrids.

Treatments	Survival Index		
	Squares (90 days old crop)	Bolls (120 days old crop)	Bolls (150 days old crop)
AJEET-155 BG-II	0.53	0.53	0.70
BHAKTI NCS-245 BG-II	0.56	0.60	0.76
JAY BG-II	0.48	0.46	0.68
YUVA 7215-2 BG-II	0.47	0.50	0.63
Dr. BRENT MRC-7347 BG-II	0.44	0.47	0.64
RCH-2 BG-II	0.45	0.56	0.72
NHH-44 non-Bt	1.00	1.00	1.00

were observed in *Bt*-cotton in many regions of Gujarat and some parts of AP, Telangana and Maharashtra during 2014. High *P. gossypiella* larval recovery on *Bt*-II in conjunction with high LC₅₀ values for Cry1Ac and Cry2Ab in major cotton-growing districts of central and southern India provided evidence of field-evolved resistance in *P. gossypiella* to *Bt*-I and *Bt*-II cotton (Naik *et al.*, 2018).

Materials and Methods

The popular *Bt* cotton hybrids having different crop durations (early, medium and late) were selected and cultivated on the Research Farm of Department of Agricultural Entomology and the laboratory investigations on survival and development of Spotted bollworm *E. vittella* on field collected *Bt* cotton plant structures or parts at pre-determined intervals were conducted at the Post Graduate Laboratory, Department of Agricultural Entomology, College of Agriculture, Latur (Vasant Rao Naik Marathwada Krishi Vidyapeeth, Parbhani, Maharashtra)-India during 2018. The experiment was conducted with different larval instars by feeding them on squares and bolls of cotton hybrids.

The initial culture of bollworms *viz.*, *Eariasvittella* Fabricius were developed by collecting large number of larvae from the cotton field. The collected larvae were reared individually in round plastic vials by feeding them on natural diet (flowers, squares and bolls of non-*Bt* cotton) every day till pupation. Pupae were transferred to round clean plastic containers covering top with muslin cloth secured firmly with rubber band. The sexes were determined in pupal stages on the basis of distance between genital and anal apertures. The freshly emerged adults were released into standard oviposition cage

covered with black muslin cloth. The proportion of female and male in the cage was 1:5 in order to get fertilized eggs. Cotton swab dipped into 10 per cent honey solution was provided to serve as food for the adults. A strip of cotton cloth toweling (6×17 cm) was hung vertically inside each oviposition cage as oviposition substrate. The eggs on the toweling were stored in transparent plastic boxes. After hatching, neonate larvae were transferred separately into plastic vials to avoid cannibalism.

The experiment was carried out in completely randomized design (CRD) with three replications using ten larvae per replication with different larval instars by feeding them on squares and bolls of six BG-II cotton hybrids (AJEET-155, BHAKTI NCS-245, JAY, YUVA 7215-2, RCH-2, Dr. BRENT MRC-7347) and one non-*Bt* cotton hybrid (NHH-44) as a control. The cotton plant parts or structures *viz.*, squares and bolls of different cotton hybrids were collected randomly in labelled plastic bags at pre-determined interval of 90, 120 and 150 days old crop and placed individually in a plastic vial. Later laboratory reared different instar larvae of bollworms were released on different cotton structures at the rate of 10 larvae per replication. The vial was covered with a plastic lid for avoiding escape of larvae. The plant parts were replaced daily with fresh respective *Bt* plant parts (same on which larvae fed) till pupation to avoid death or growth reduction due to tissue drying or nutritional deterioration in the experimental treatment.

The larval mortality of *E. vittella* in all the instars was investigated individually by exposing them to different cotton plant structures *viz.*, squares and bolls of different cotton hybrids at 90 and; 120 and 150 days old crop, respectively. The observation on weight of the surviving

larvae was recorded after 24, 48 and 72 h of exposure and the weight of pupae was also recorded from each treatment. In addition, other parameters viz., per cent pupation and adult emergence from the surviving larvae were observed. The growth and survival index were calculated for each bollworm on different treatments using the formulae given by Vennila *et al.* (2006).

$$\text{Growth index} = \frac{\text{Per cent pupation}}{\text{Larval developmental period (days)}}$$

$$\text{Survival index} = \frac{\text{Number of moths emerged}}{\text{Total number of neonates tested}}$$

The data in respect of survival and development of bollworms on *Bt* cotton hybrids of different events was statistically analyzed by standard 'analysis of variance'. The null hypothesis was tested by 'F' test of significance at 5 per cent level (Gomez and Gomez, 1984).

Results and Discussion

Effect of different plant parts of different *Bt* cotton hybrids on larval mortality of *E. vittella* : All the *Bt* cotton hybrids under investigation revealed superior results over NHH-44 non-*Bt* cotton hybrid. The mortality of *E. vittella* larvae was evidenced during first, second and third instars only, when fed on squares of different *Bt* cotton hybrids at 90 days old crop. The larvae of *E. vittella* fed on squares of Dr. BRENT MRC-7347 BG-II noticed maximum mortality. The per cent larval mortality varied with the instars. At 120 days old crop evidenced that the first, second and third instar larvae of *E. vittella* fed on bolls of JAY BG-II registered maximum mortality. The larval mortality of *E. vittella* was less on green bolls compared to squares. The mortality of *E. vittella* larvae was noticed during first and second instars only, when fed on bolls of different *Bt* cotton hybrids at 150 days old crop. The larvae of *E. vittella* fed on bolls of YUVA 7215-2 BG-II noticed maximum mortality. The per cent larval mortality varied with the instars. The mortality of *E. vittella* decreased gradually with progress in the age of the larvae.

The results on the per cent mortality of different larval instars of *E. vittella* fed on squares and bolls of different *Bt* cotton hybrids at pre-determined intervals are in harmony with the results Rupnar (2018) who revealed that the mortality of early larval instars of *E. vittella* fed on squares and bolls of *Bt* cotton hybrids of different event was higher than the later instars. Among the *Bt* cotton hybrids of different events, NCS-207 BG-II registered maximum larval mortality over rest of *Bt* cotton hybrids. Analogously, Likhitha and Bhamare (2018b) revealed that the mortality of early larval instars of *E. vittella* fed on squares and bolls of *Bt* cotton hybrids of different event was higher compared to the later instars. Hallad *et al.*

(2014) indicated that the mortality of *E. vittella* was significant across genotypes or events at different days of interval. Tulasi 4 BG-II showed 100.0 per cent mortality followed by Tulasi 4 BG-I (99.4 per cent) and Nathbaba (99.3 per cent), the mortality was decreased to 87.7 and 65.7 per cent in Tulasi 4 BG-II and Nathbaba at 135 DAS, respectively.

Effect of different plant parts of different *Bt* cotton hybrids on larval weight of *E. vittella* :

The data on mean weight of *E. vittella* larval instars that survived beyond 24, 48 and 72 h after exposure on squares of different *Bt* cotton hybrids at 90 days old crop evidenced that minimum larval weight was recorded on all the *Bt* cotton hybrids under investigation compared to NHH-44 non-*Bt* cotton hybrid. The Dr. BRENT MRC-7347 BG-II hybrid was found less palatable to *E. vittella* as larval weight was very less compared to other *Bt* and NHH-44 non-*Bt* cotton hybrids. At 120 days old crop evidenced that minimum larval weight was recorded on all the *Bt* cotton hybrids under investigation compared to NHH-44 non-*Bt* cotton hybrid. The JAY BG-II cotton hybrid was revealed less palatable to *E. vittella* as larval weight was very less compared to other *Bt* and NHH-44 non-*Bt* cotton hybrid. At 150 days old crop evidenced that minimum larval weight was recorded on all the *Bt* cotton hybrids under investigation compared to NHH-44 non-*Bt* cotton hybrid. The YUVA 7215-2 BG-II hybrid was evidenced less palatable to *E. vittella* as larval weight was very less compared to other *Bt* and NHH-44 non-*Bt* cotton hybrid.

The results on effect of squares and bolls of different *Bt* cotton hybrids on larval weight of *E. vittella* are in close agreement with the findings of Rupnar (2018) who revealed that early instar larvae of *E. vittella* fed on squares and bolls of different *Bt* events hybrids evidenced diminution in larval weight. Among the *Bt* cotton hybrids of different events, NCS-207 BG-II found significantly superior over rest of *Bt* cotton hybrids. Analogously, Likhitha and Bhamare (2018b) reported that early instar larvae of *E. vittella* feeding on squares and bolls of *Bt* cotton hybrids of different events exhibited decrease in larval weight. More or less similar findings are reported by Naik *et al.* (2014) who observed that exposure of different instar larvae to plant parts of *Bt* event hybrids exhibited adverse effects on the growth and development of *P. gossypiella* with decline in larval weight. Analogously, Naik *et al.* (2012) revealed that exposure of later instar larvae of *H. armigera* to plant parts of *Bt* cotton hybrids of different events exhibited adverse effects on the larval weight. Soujanya *et al.* (2010) exhibited that the exposure of different instar larvae to plant parts of stacked *Bt* and *Bt* cotton cultivars exhibited adverse effects on the growth and development of *P. gossypiella* with decrease in larval weight.

Effect of different plant parts of different *Bt* cotton hybrids on pupation of *E. vittella* : All the *Bt* cotton hybrids under investigation showed better results over NHH-44 non-*Bt* cotton hybrid. The first, second and third instar larvae of *E. vittella* fed on squares of Dr. BRENT MRC-7347 BG-II registered lowest pupation. The per cent pupation varied with the instars. The gradual increase in per cent pupation of *E. vittella* was recorded in I, II and III instar larvae fed on squares of different *Bt* cotton hybrids. All the *Bt* cotton hybrids under investigation demonstrated superior results over NHH-44 non-*Bt* cotton hybrid. The first, second and third instar larvae of *E. vittella* fed on bolls of JAY BG-II registered lowest pupation. The gradual increase in per cent pupation of *E. vittella* was recorded in I, II and III instar larvae fed on bolls of different *Bt* cotton hybrids. All the *Bt* cotton hybrids under investigation proved effective over NHH-44 non-*Bt* cotton hybrid. The first and second instar larvae of *E. vittella* fed on bolls of YUVA 7215-2 BG-II registered lowest pupation. The gradual increase in per cent pupation of *E. vittella* was recorded when I and II instar larvae fed on bolls of different *Bt* cotton hybrids.

The results on the per cent pupation of surviving larvae of different instars of *E. vittella* fed on squares and bolls of different *Bt* cotton hybrids at pre-determined intervals are comparable with the findings of Rupnar (2018) who revealed that early instar larvae of *E. vittella* fed on squares and bolls of *Bt* cotton hybrids of different events recorded significantly lowest pupation with malformed pupae compared to non-*Bt* cotton hybrid. Among the *Bt* cotton hybrids of different events, NCS-207 BG-II was found superior over rest of *Bt* cotton hybrids. Similarly, Likhitha and Bhamare (2018b) revealed that feeding of early instar larvae of *E. vittella* on squares and bolls of *Bt* cotton hybrids of different events recorded lowest pupation with malformed pupae. More or less similar results were documented by Liu *et al.* (2017) who reported that the bollworm survival to pupation was significantly affected by strain, cultivar and the interaction between these factors. The concentration of Cry 1A toxins differed significantly among *Bt* cultivars and plant structures, but the interaction between these factors was not significant. Naik *et al.* (2012) revealed that exposure of later instar larvae to plant parts of *Bt* event hybrids observed least pupation with formation of small pupae having less weight.

Effect of different plant parts of different *Bt* cotton hybrids on pupal weight of *E. vittella* : The data on mean pupal weight of *E. vittella* reared on squares of different *Bt* cotton hybrids at 90 days old crop evidenced that minimum pupal weight was observed on all the *Bt* cotton hybrids under investigation compared to NHH-44

non-*Bt* cotton hybrid. At 120 days old crop evidenced that minimum pupal weight was recorded on all the *Bt* cotton hybrids under investigation compared to NHH-44 non-*Bt* cotton hybrid. At 150 days old crop evidenced that minimum pupal weight was recorded on all the *Bt* cotton hybrids under investigation compared to NHH-44 non-*Bt* cotton hybrid.

The results on mean pupal weight of *E. vittella* reared on squares and bolls different of *Bt* cotton hybrids at pre-determined interval are in accordance with the findings of Rupnar (2018) who revealed that early instar larvae of *E. vittella* fed on squares and bolls of *Bt* cotton hybrids of different events recorded significantly lowest pupal weight with malformed pupae compared to non-*Bt* cotton hybrid. Among the *Bt* cotton hybrids of different events, NCS-207 BG-II was found superior over rest of *Bt* cotton hybrids. Alike, Likhitha and Bhamare (2018b) noticed that rearing of early instar larvae of *E. vittella* on squares and bolls of *Bt* cotton hybrids of different events produced malformed pupae with lowest pupal weight. Naik *et al.* (2012) revealed that exposure of different instar larvae to plant parts of *Bt* event hybrids produced small pupae with lesser weight. Cry toxin levels were changed significantly as the season progressed (Akin *et al.*, 2004).

Effect of different plant part of different *Bt* cotton hybrids on adult emergence of *E. vittella* : All the *Bt* cotton hybrids expressed superior results over NHH-44 non-*Bt* cotton hybrid. The first, second and third instar larvae of *E. vittella* fed on squares of Dr. BRENT MRC-7347 BG-II registered lowest adult emergence at 90 days old crop. The per cent adult emergence varied with the instars. The gradual increase in per cent adult emergence of *E. vittella* was recorded in I, II and III instar larvae fed on squares of different *Bt* cotton hybrids. All the *Bt* cotton hybrids under investigation expressed superior results over NHH-44 non-*Bt* cotton hybrid. The first, second and third instar larvae of *E. vittella* fed on bolls of JAY BG-II registered lowest adult emergence at 120 days old crop. The gradual increase in per cent adult emergence of *E. vittella* was recorded in I, II and III instar larvae fed on bolls of different *Bt* cotton hybrids. All the *Bt* cotton hybrids under investigation expressed superior results over NHH-44 non-*Bt* cotton hybrid. The first and second instar larvae of *E. vittella* fed on bolls of YUVA BG-II registered lowest adult emergence at 150 days old crop. The gradual increase in per cent adult emergence of *E. vittella* was recorded in I and II instar larvae fed on bolls of different *Bt* cotton hybrids.

The results on adult emergence of *E. vittella* fed on squares and bolls of different *Bt* cotton hybrids at pre-determined intervals are overlapped with findings of

Rupnar (2018) who evidenced that early instar larvae fed on squares and bolls of *Bt* cotton hybrids documented minimum adult emergence of *E. vittella*. Similarly, Likhitha and Bhamare (2018b) indicated that rearing of early instar larvae of *E. vittella* on squares and bolls of *Bt* cotton hybrids of different events recorded lowest adult emergence. Analogously, Naik *et al.* (2012) revealed that exposure of later instar larvae of *H. armigera* to plant parts of *Bt* event hybrids exhibited adverse effects on adult emergence. Srinivasa Rao and Arjuna Rao (2008) observed that late instar (third, fourth and fifth instar) larvae of *H. armigera* could survive and successfully develop into adults even on *Bt* cotton but in less proportion. Cry toxin levels were changed significantly as the season progressed (Akin *et al.*, 2004). Thus the present findings are in line with these findings.

Growth and survival indices of *E. vittella* reared on different plant part of different *Bt* cotton hybrids : The growth and survival indices for *E. vittella* were very low when reared on squares and bolls on different *Bt* cotton hybrids compared to NHH-44 non-*Bt* cotton hybrid. Both growth index and survival index values were high for the larvae of *E. vittella* reared on bolls compared to squares. The low growth and survival indices can be attributed to longer developmental period, low per cent pupation and less adult emergence on *Bt* cotton hybrids. The results on growth and survival indices of different larval instars of *E. vittella* fed on squares and bolls of different *Bt* cotton hybrids at pre-determined interval are in concurrence with the findings of Rupnar (2018) who stated that the growth and survival index values for *E. vittella* were low for the larvae fed on squares compared to those fed on bolls of *Bt* cotton hybrids of different events. Similarly, Likhitha and Bhamare (2018b) claimed that the growth and survival indices for *E. vittella* were low for the larvae reared on squares compared to those reared on bolls of *Bt* cotton hybrids of different events.

Conclusion

From the present investigation it can be concluded that the mortality of early larval instars of *E. vittella* fed on squares and bolls of different *Bt* cotton hybrids was higher than the later larval instars. Exposure of later instar larvae to different plant parts of different *Bt* cotton hybrids also showed adverse effects on the growth and development such as reduced larval weights, prolonged larval developmental period, reduced pupation, formation of small pupae with less weight, reduction in adult emergence with low growth and survival indices for *E. vittella*. The growth and survival index values were also low for the larvae reared on squares compared to those reared on bolls of different *Bt* cotton hybrids.

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Effect of Irrigation Schedules and Hydrogel Levels on Nutrient status of Isabgol (*Plantago Ovata* Forsk.)

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Abstract

A field experiment entitled "Response of Isabgol (*Plantago ovata* Forsk.) to hydrogel levels under different irrigation schedule" was conducted at Instructional Farm of Agronomy, Department of Agronomy, Rajasthan College of Agriculture, MPUAT, Udaipur during the *rabi* season of 2018-19 and 2019-20 to study the effect of hydrogel levels under different irrigation schedules. The results revealed that application of irrigation at IW-CPE ratio in Isabgol crop produced significantly increased nutrient content. The crop irrigated at IW-CPE ratio of 0.50 accumulated highest quantum of nutrient content in seed and straw which was found at par with IW-CPE ratio of 0.40 and both these ratio significantly increased nitrogen content in seed by 5.74, 9.73 phosphorus content by 2.18, 3.59 and potassium content by 8.83, 12.26 per cent, respectively over IW-CPE ratio of 0.30 and 0.20. Application of hydrogel up to 5.0 kg ha⁻¹ significantly increased nitrogen, phosphorus and potassium content by seed and straw over application of 2.5 kg ha⁻¹ and control. The magnitude of increase in seed nitrogen, phosphorus and potassium content was 1.21, 2.11; 1.03, 2.45 and 2.67, 4.45 per cent, respectively. Further increase in hydrogel level to 7.5 kg ha⁻¹ though positively influenced uptake of nutrients but failed to record statistical significance over 5.0 kg hydrogel ha⁻¹.

Key words : Irrigation schedule, isabgol, hydrogel, nutrient content.

Introduction

Blond psyllium (*Plantago ovata* Forsk) is a winter season medicinal crop. It belongs to the family Plantaginaceae and genus *Plantago*. It is known as Psyllium, Isabgol, Ispaghula, Spogel seed. Isabgol is a 30-35 cm tall short-stemmed annual herb. Isabgol is cultivated in about 417109 haectare area in Rajasthan with a production of 226480 tonnes (Anonymous, 2018-19). Its cultivation is mainly centralized in northern Gujarat and districts of South-west of Rajasthan namely Jalore, Barmer, Pali, Jaisalmer, Jhalawar and Sirohi. The seed husk is the commercial part and is separated by physical process. It contains colloidal mucilage (30%), mainly consisting xylose, arabinose, galacturonic acid with rhamnose, galactose etc. The husk has the property of absorbing and retaining water. The husk (epicarp) is used against constipation, irritation of digestive tract etc. In addition, these are also used in food industries for preparation of ice cream, candy etc. (Killedar *et al.*, 2016).

Irrigation water is a costly and scarce resource and available of water to agriculture is expected to reduce. Isabgol are able to tolerate moderate levels of water stress. Soil moisture stress reduces the rate of photosynthesis and also the rate of translocation of nutrients, which ultimately influences the growth and yield of the crop. Thus, scheduling of irrigation on the basis of critical growth stages help in determing the time of irrigation. The application of agro-chemicals is known to play an important role in plant response to stresses.

Hydrogel developed by the Indian Agricultural Research Institute (IARI), New Delhi. Hydrogel are macromolecular cross-linked hydrophilic polymeric chains with the ability to absorb water or aqueous fluids. The main function of this is it can absorb a minimum of 400 times of its dry weight of pure water and gradually release it according to the needs of the crop plant. It acts like a sponge and absorb water which is releases slowly to the crops to get a sustained supply of moisture (Shikha *et al.*, 2019).

Keeping in view the above facts, an investigation entitled "Response of Isabgol (*Plantago ovata* Forsk.) to hydrogel levels under different irrigation schedule" was conducted at RCA, MPUAT, Udaipur.

Materials and Methods

A field experiment was conducted during two consecutive *rabi* seasons of 2018-19 and 2019-20 to assess the effect of irrigation schedules based on IW-CPE ratio and hydrogel levels on nutrient uptake and total uptake of Isabgol (*Plantago ovate* Forsk.) at the Instructional Farm, Rajasthan College of Agriculture, Udaipur, situated at 24° 35' N latitude, 73° 42' E longitude with an altitude of 581.35 m above mean sea level. The region falls under NARP agro-climatic zone IV a (Sub- Humid Southern Plains and Arawali Hills) of Rajasthan. The soils of experimental site was clay loam in texture, slightly alkaline in reaction, low in available nitrogen (270.60 to 271.30 kg ha⁻¹), medium in available phosphorus (18.07 to 18.90 kg ha⁻¹) and high in available potassium status (312.70 to 315.40 kg ha⁻¹). The experiment was laid out in Split plot

Table-1 : Effect of irrigation scheduling and hydrogel levels on nutrient content (kg ha⁻¹) of isabgol (Data pooled over two years).

Treatments	Nitrogen		Phosphorus		Potassium	
	Seed	Straw	Seed	Straw	Seed	Straw
IW-CPE ratio						
0.20	2.373	0.661	0.751	0.316	0.715	3.278
0.30	2.478	0.696	0.762	0.326	0.743	3.369
0.40	2.629	0.756	0.779	0.341	0.815	3.459
0.50	2.640	0.761	0.781	0.343	0.816	3.463
S.Em.+	0.005	0.003	0.001	0.001	0.002	0.004
C.D. (P=0.05)	0.014	0.010	0.004	0.003	0.007	0.011
Hydrogel Levels (kg ha⁻¹)						
Control	2.496	0.704	0.755	0.326	0.750	3.366
2.5	2.519	0.715	0.766	0.331	0.764	3.383
5.0	2.550	0.726	0.774	0.334	0.785	3.409
7.5	2.555	0.730	0.777	0.335	0.789	3.411
S.Em.+	0.004	0.002	0.001	0.001	0.002	0.003
C.D. (P=0.05)	0.012	0.005	0.004	0.002	0.006	0.008

Design with total 16 treatment combination consisting of four irrigation schedule viz., IW-CPE ratio 0.20, 0.30, 0.40 and 0.50 and four hydrogel levels viz., 0.0, 2.5, 5.0 and 7.5 kg ha⁻¹ and replicated four times. The treatments were allotted randomly in each replication. The plot size was 5.0 x 3.0 m. The seed of isabgol @ 6.0 kg ha⁻¹ was sown in furrow manually by dropping the seed in the furrow row to row distance of 30 cm. The crop of isabgol was fertilized through Urea, SSP and MOP, respectively were applied into the already opened furrows before sowing. The half dose of nitrogen and full dose of phosphorus and potash was applied at the time of sowing, remaining half dose of nitrogen was top dressed after 1st irrigation.

Irrigation was applied as per treatment based on cumulative pan evaporation (CPE) values. The water was conveyed through open field channel and measured by Parshall flume. The depth of each irrigation was kept 60 cm. The CPE was taken as a sum of daily evaporation from USWB class A pan evaporimeter minus the rainfall since the previous irrigation. A Common irrigation of 60 mm was applied uniformly in all the treatment just after sowing for germination of seed. Irrigation channels were presoaked before 24 hours of irrigation to avoid seepage losses at the time of irrigation. The whole quantity of hydrogel as per treatment was applied manually in furrows and incorporated into soil at the time of sowing. Other crop management practices were followed as per recommendation of area. The crop harvested from net plot at physiological maturity. The seed and straw samples collected from each plot at harvest were dried in oven at 65°C till a constant weight. These samples were grounded in laboratory mill, passed through 40 mm mesh sieve and used for estimating of N, P and K content in seed and straw. The following standard methods of analysis were used:

Nitrogen : Nessler's reagent colorimetric method (Snell and Snell, 1949)

Phosphorus : Ammonium vanadomolybdate phosphoric yellow colour method (Jackson, 1973)

Potassium : Flame photometric method (Jackson, 1973)

Results and Discussion

Nitrogen

IW-CPE ratio : Data (Table-1) show that increasing irrigation regime up to IW-CPE ratio 0.40 significantly increased nitrogen content in seed and straw as compared to irrigation at IW-CPE 0.3 and 0.2. Further increase in irrigation regime from IW-CPE ratio of 0.40 to 0.50 though increased nitrogen content in seed as well as in straw but failed to record statistical significance.

On pooled basis, application of irrigation at IW-CPE ratio of 0.40 significantly increased nitrogen content in seed and straw by 5.74, 9.73 and 7.93, 12.56 per cent, respectively over irrigation at IW-CPE ratio 0.30 and 0.20.

Hydrogel levels : Data presented in Table-1 indicates that increasing level of hydrogel from 0 to 5.0 kg ha⁻¹ significantly increased nitrogen content in seed and straw however further increase in hydrogel level from 5.0 to 7.5 kg ha⁻¹ though increased nitrogen content in seed and straw but failed to record statistical significance. Thus when compared to application of 2.5 kg hydrogel ha⁻¹ and control, application of 5.0 kg hydrogel ha⁻¹ significantly increased mean nitrogen content in seed and straw by 1.21, 2.11 and 1.51, 3.03 per cent, respectively.

Phosphorus

IW-CPE ratio : It is explicit from data (Table-2) that scheduling of irrigation through IW-CPE ratio up to 0.40

significantly increased phosphorus concentrations in seed and straw as compared to irrigation at IW-CPE ratio of 0.30 and 0.20. Further increase in IW-CPE ratio to 0.50 though increased phosphorus concentration in seed and straw but failed to record statistical significance over IW-CPE ratio 0.40.

The pooled results indicate that irrigation at IW-CPE ratio 0.40 significantly enhanced phosphorus content in seed and straw by 2.18, 3.59 and 4.39, 7.33 per cent, respectively over irrigation at IW-CPE ratio of 0.30 and 0.20.

Hydrogel levels : Increasing level of hydrogel from 0 to 5.0 kg ha⁻¹ significantly increased phosphorus content in seed and straw, however further increase in hydrogel level from 5.0 to 7.5 kg ha⁻¹ though increased phosphorus content in seed and straw but failed to record statistical significance. Thus when compared to application of 2.5 kg hydrogel ha⁻¹ and control, application of 5.0 kg hydrogel ha⁻¹ significantly increased mean phosphorus content in seed and straw by 1.03, 2.45 and 0.89, 2.39 per cent, respectively.

Potassium

IW-CPE ratio : It is evident from data (Table-1) that scheduling of irrigation through IW-CPE ratio up to 0.40 significantly increased potassium content in seed and straw over irrigation at IW-CPE ratio of 0.30 and 0.20. Further increase in irrigation regime from IW-CPE ratio 0.40 to 0.50 though increased potassium content in seed and straw but failed to attain statistical significance.

Thus compared to IW-CPE ratio of 0.30 and 0.20, irrigation at IW-CPE ratio of 0.40 significantly increased mean potassium content of seed and straw by 8.83, 12.26 and 2.60, 5.23 per cent, respectively.

Hydrogel levels : An examination of data presented in Table-1 indicate that increasing level of hydrogel from 0 to 5.0 kg ha⁻¹ significantly increased potassium content in seed and straw, however, further increase in hydrogel level from 5.0 to 7.5 kg ha⁻¹ though increased potassium content in seed and straw but failed to record statistical significance. Thus when compared to application of 2.5 kg hydrogel ha⁻¹ and control, application of 5.0 kg hydrogel ha⁻¹ significantly increased mean potassium content in seed and straw by 2.67, 4.45 and 0.76, 1.26 per cent, respectively.

Effects of irrigation schedule on Nutrient content

The plant analysis revealed that successive increase in irrigation level up to IW-CPE ratio of 0.40 brought about significant improvement in nitrogen, phosphorus and potassium content in seed and straw over irrigation at IW-CPE ratio of 0.30 and 0.20. The marked improvement

in nitrogen, phosphorus and potassium content of both plant parts with higher irrigation levels seems to be due to increase availability in the root zone on account of increased moisture supply. Secondly it can be attributed to the efficient extraction/translocation due to increase in root ramification/activities as irrigation plays vital role in maintaining physico-chemical and biological properties of soil. This might have promoted growth of roots as well as their functional activity leading to higher extraction of nutrients from soils to plant parts. The results of the present investigation are in close agreement with the findings of Bhunia *et al.* (2006), Jat (2013), Kumawat *et al.* (2013), Wanjari *et al.* (2017) and Dalal (2018).

Effects of Hydrogel levels on Nutrient content

Application of increasing rate of hydrogel up to 5.0 kg ha⁻¹ significantly improved nitrogen, phosphorus and potassium status of seed and straw over application of 2.5 kg hydrogel ha⁻¹ and control. The positive influence of hydrogel application on nutrient status of seed and straw seems to be due to their increased availability in the root zone. Further adequate moisture availability in the root zone of rhizosphere increased the movement of nutrient in soil solution and finally their absorption by growing plant. Since most of nutrients (N, P, K) in seed is relocated from their reserves in vegetative parts, better nutritional conditions of seed with hydrogel application seems to be on account of their higher concentration in plants. The results are in close agreement with findings of several researchers (Tyagi *et al.*, 2015, Singh *et al.*, 2017 and Rakshit *et al.*, 2018). They also ascribed marked improvement in nutritional status of plant under hydrogel application due to their increase availability in the root zone and higher extraction due to better growth of roots.

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Pre-Sowing Treatments Influence Germination of Two Important Edible Wild Fruit Plants (*Myrica esculenta* and *Rubus ellipticus*) of Garhwal Himalayas

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Abstract

Indigenous edible wild fruits are of high importance in terms of nutrition, beverages, and pharmaceutical values. They provide invaluable benefits to the entire biosphere in terms of hydrological cycle, oxygen supply and provide fuel and food to the local inhabitants of Garhwal Himalayas, but these wild fruits are depleting day by day and are not used in a commercial scale due to ignorance and many other causes. Propagation is one of the biggest aspects for their conservation and the depleting level of these edible wild fruits' plants. In present study the seeds were first cold stratified with alternate layer of moist sand and seed and kept for 7, 14 and 21 days at 5°C temperature and further these seeds were subjected to treated with various concentrations of GA₃ (i.e., 250, 500 and 750 ppm). After that, the pretreated seeds were placed under seed germinator at temperature of 25°C for improving germination efficiency in of two wild edible fruit plants namely *Myrica esculenta* and *Rubus ellipticus* of Garhwal Himalayas. The results showed that increase in duration of stratification and pre-treatment of GA₃ significantly increased both the germination and growth attributes of *Myrica esculenta* and *Rubus ellipticus*. The data were analyzed by factorial CRD with three replications. The combined effect of stratification and GA₃ treatment significantly affected all the parameters taken under this study as compared to their individual effect. Among all the treatment combinations, 21 days stratification + 250 ppm GA₃ (T₃S₁) recorded highest germination percentage (62%) and (51%) and germination rate (1.63) and (1.30) respectively in *Myrica esculenta* and *Rubus ellipticus*. Similarly, highest seedling length (14.73 cm) and (11.67 cm), seedling vigor index (913.34) and (595.27), seedling fresh (1.831 g) and (1.958 g) and dry weight (0.366 g) and (0.392 g) was again recorded in same treatment combination followed by treatment 21 days stratification + 500 ppm GA₃ (T₃S₁) in *Myrica esculenta* and *Rubus ellipticus* respectively. Keeping the importance of these wild edibles and on the basis of above findings, it can be concluded that for future commercial cultivation the 21 days stratification and 250 ppm GA₃ can be considered as the most suitable approach to reduce the dormancy and to improve the germinability as well as the seedling growth of these edible wild fruit species.

Key words : *Myrica esculenta*, *Rubus ellipticus*, stratification, GA₃, seed germination

Introduction

Wild edible fruit plants are those species occurring in the wild are grown in local scale and have economic potentials, confining them into mostly traditional and local uses only. Many wild edible fruit plants are closely intimately associated with the culture, traditions, festivals and rituals of various local Indian communities. These plants are mainly found in those areas where there is no or negligible human interaction as majority of these areas have difficult geography and climatic conditions. Garhwal Himalayas region of Uttarakhand is home for various wild edible fruiting plants which have high economical value. Collection of fruits from these wild edible plants for food and utilizing them for multipurpose use is an age-old practice in various communities residing in rural India. Many ethnic and local communities residing in the high hills of Uttarakhand, depend upon such wild edible plants, they are nutritionally rich and can supplement nutritional requirements, especially the vitamins and micronutrients

and also include them in traditional diets thus making an important contribution to their health improvement. In addition to this these plants provide invaluable benefits to the entire biosphere in terms of hydrological cycle, oxygen supply. More often, during the periods of food scarcity besides providing timber, firewood, fodder, they serve as famine insurance. Local communities not only consumed these wild edible fruit plants for food but also use them as an excellent source of their income generation, species like *Myrica esculenta* collected from the forest and sold in local market whereas some species, such as, *Hippophae* spp. and *Prunus armeniaca* etc. are commercially utilized for making value added products, such as squash and other beverages (Samant and Dhar, 1997).

Kaphal (*Myrica esculenta*) and Wild raspberry (*Rubus ellipticus*) are most edible wild fruit plants which are found naturally in Garhwal region of Uttarakhand. Both edible wild fruit plants have immense nutritional and medicinal properties and are important part of the local

Table-1 : Effect of stratification and GA₃ on germination percentage of Kaphal (*Myrica esculenta*) and Wild raspberry (*Rubus ellipticus*).

Stratification (T)	Kaphal (<i>Myrica esculenta</i>)					Wild raspberry (<i>Rubus ellipticus</i>)				
	Gibberellic acid (S)									
	S ₁	S ₂	S ₃	S ₀	Mean	S ₁	S ₂	S ₃	S ₀	Mean
T ₁	32.33	31.00	28.33	23.00	28.67	27.00	25.00	22.33	20.00	23.58
T ₂	44.33	40.33	37.00	34.33	39.00	37.67	34.00	32.00	30.00	33.42
T ₃	62.00	58.33	54.33	48.33	55.75	51.00	46.33	42.00	33.00	43.08
T ₀	26.00	24.00	21.00	18.00	22.25	18.33	17.33	16.33	0.00	13.00
Mean	41.17	38.42	35.17	30.92		33.50	30.67	28.17	20.75	
Factors	SE (±)		CD (5%)			SE (±)		CD (5%)		
T	0.33		0.95			0.35		1.00		
S	0.33		0.95			0.35		1.00		
T×S	0.66		1.90			0.69		2.00		

T₁= 7 days stratification, T₂= 14 days stratification, T₃= 21 days stratification, T₀= Control.

S₁= GA₃@250 ppm, S₂= GA₃@500 ppm GA₃, S₃= GA₃@750 ppm GA₃ and S₀= Control

Table-2 : Effect of stratification and GA₃ on germination rate of Kaphal (*Myrica esculenta*) and Wild raspberry (*Rubus ellipticus*).

Stratification (T)	Kaphal (<i>Myrica esculenta</i>)					Wild raspberry (<i>Rubus ellipticus</i>)				
	Gibberellic acid (S)									
	S ₁	S ₂	S ₃	S ₀	Mean	S ₁	S ₂	S ₃	S ₀	Mean
T ₁	0.77	0.74	0.67	0.51	0.67	0.65	0.61	0.54	0.47	0.57
T ₂	1.18	1.02	0.87	0.81	0.97	0.93	0.83	0.77	0.72	0.81
T ₃	1.63	1.53	1.43	1.28	1.46	1.30	1.18	1.06	0.80	1.08
T ₀	0.59	0.54	0.47	0.44	0.51	0.43	0.41	0.39	0.00	0.31
Mean	1.04	0.96	0.86	0.76		0.83	0.76	0.69	0.50	
Factors	SE (±)		CD (5%)			SE (±)		CD (5%)		
T	0.012		0.025			0.012		0.024		
S	0.012		0.025			0.012		0.024		
T×S	0.024		0.049			0.024		0.049		

people life residing in these areas. *Myrica esculenta* belongs to family Myricaceae and commonly known as “Kaphal” is a delicious fruit which is mainly eaten raw (Singh *et al.*, 1986; Rastogi and Mehrotra, 1991). Fruits of *Myrica esculenta* start maturing from the month of April to June but have poor shelf-life of only 2-3 days (Patel and De, 2006). Its fruits prevent human being from certain degenerative diseases and stress disorders as they have high amount of phenolics, flavonoid and natural antioxidants which can play vital role in reducing the oxidative stress. Wild raspberry (*Rubus ellipticus* Smith.), popularly known as Hinsalu, Yellow Himalayan raspberry in Uttarakhand is an under estimated plant of Rosaceae family has tremendous potential for reclaiming barren and degraded soils (Singh and Singh, 1995). Its fruits start maturing from mid-May and continue up to mid-June and possess medicinal properties like astringent, febrifuge, kidney, stomachic, diaphoretic and diuretic. Other than its uses as medicine it acts an instant source of energy packets for the people travelling to mountains as they can find them growing everywhere (Manandhar, 2002).

Due to forest degradation, urbanization, intensive agriculture and many other causes these valuable wild edible fruits plants are in face of severe genetic erosion

leading to extinction, so there is strong need to conserve them. In conservation of these plants' propagation play an important role as it is a basic tool since centuries to make possible the generations to pass through and sustain production. Sexual propagation is a relatively easy method for most of the edible wild fruit plant crops and its success totally depend upon on germination but germination in these plants have a major limitation, that they fail to show good germination under laboratory conditions as compared to its the native environment (Gupta, 2003). This is mainly due to factors like dormancy which act as a barrier in germination process. Generally, germination in Kaphal and Wild raspberry is low due to the presence of physiological dormancy and is reported by various other researchers (Zencirkiran *et al.*, 2010; Hamilton and Carpenter, 1975).

Different methods such as stratification, scarification, water soaking and chemical treatments are used for breaking dormancy in such seeds to improve germination. Seeds when soaked in water promotes germination by softening of hard seed coat, activating enzymes and diluting the effects of inhibitors. Pretreatments viz: cold stratification and gibberellic acid (GA₃) have been proved effective to get better results of

Table-1 : Effect of stratification and GA₃ on germination percentage of Kaphal (*Myrica esculenta*) and Wild raspberry (*Rubus ellipticus*).

Stratification (T)	Kaphal (<i>Myrica esculenta</i>)					Wild raspberry (<i>Rubus ellipticus</i>)				
	Gibberellic acid (S)									
	S ₁	S ₂	S ₃	S ₀	Mean	S ₁	S ₂	S ₃	S ₀	Mean
T ₁	32.33	31.00	28.33	23.00	28.67	27.00	25.00	22.33	20.00	23.58
T ₂	44.33	40.33	37.00	34.33	39.00	37.67	34.00	32.00	30.00	33.42
T ₃	62.00	58.33	54.33	48.33	55.75	51.00	46.33	42.00	33.00	43.08
T ₀	26.00	24.00	21.00	18.00	22.25	18.33	17.33	16.33	0.00	13.00
Mean	41.17	38.42	35.17	30.92		33.50	30.67	28.17	20.75	
Factors	SE (±)		CD (5%)			SE (±)		CD (5%)		
T	0.33		0.95			0.35		1.00		
S	0.33		0.95			0.35		1.00		
T×S	0.66		1.90			0.69		2.00		

T₁= 7 days stratification, T₂= 14 days stratification, T₃= 21 days stratification, T₀= Control.

S₁= GA₃@250 ppm, S₂= GA₃@500 ppm GA₃, S₃= GA₃@750 ppm GA₃ and S₀= Control

Table-2 : Effect of stratification and GA₃ on germination rate of Kaphal (*Myrica esculenta*) and Wild raspberry (*Rubus ellipticus*).

Stratification (T)	Kaphal (<i>Myrica esculenta</i>)					Wild raspberry (<i>Rubus ellipticus</i>)				
	Gibberellic acid (S)									
	S ₁	S ₂	S ₃	S ₀	Mean	S ₁	S ₂	S ₃	S ₀	Mean
T ₁	0.77	0.74	0.67	0.51	0.67	0.65	0.61	0.54	0.47	0.57
T ₂	1.18	1.02	0.87	0.81	0.97	0.93	0.83	0.77	0.72	0.81
T ₃	1.63	1.53	1.43	1.28	1.46	1.30	1.18	1.06	0.80	1.08
T ₀	0.59	0.54	0.47	0.44	0.51	0.43	0.41	0.39	0.00	0.31
Mean	1.04	0.96	0.86	0.76		0.83	0.76	0.69	0.50	
Factors	SE (±)		CD (5%)			SE (±)		CD (5%)		
T	0.012		0.025			0.012		0.024		
S	0.012		0.025			0.012		0.024		
T×S	0.024		0.049			0.024		0.049		

germination in wild edibles. Stratification involves keeping dormant seeds in a cold moist medium at temperature below 7°C for different time period depending upon the different plant species. Stratification plays an important role in providing the stimulus required to overcome dormancy, increase germination and is reported to break dormancy in many fruit species (Jensen and Eriksen, 2001).

The removal of dormancy is associated with several metabolic events which rely mostly on the mobilization of seed reserve materials in order to produce energy and intermediates for syntheses of cellular components indispensable for successful germination and subsequent growth and development of the seedling. A pivotal role of hormones and other regulatory molecules, which are activated or synthesized early during dormancy breaking (GAs, cytokinins, ethylene, jasmonic acid), and others disappear at the same time (ABA). Exogenous application of growth regulators like gibberellic acid, on the other hand by activating the different hydrolytic enzymes which are required in breakdown of reserve food material helps in increasing the seed germination process (Karam and Al-Salem, 2001) confirms the effectiveness of GA₃ in breaking dormancy and increasing germination.

Considering the effectiveness of above presented information, the present research experiment was carried out to analyze influence of pre-sowing treatments on germination of *Myrica esculenta* (Kaphal) and *Rubus ellipticus* (Wild raspberry).

Materials and Methods

The present experiment was conducted in laboratory of Department of Horticulture, H.N.B. Garhwal University, Srinagar Garhwal (UK). The details of materials used and methodology followed during the course of investigation are presented under following headings;

Collection and authentication of seed material : The mature seeds of *Myrica esculenta* (Kaphal) and *Rubus ellipticus* (Wild raspberry) were collected from trees growing naturally in the Khirsu, forest division of Pauri Garhwal, Uttarakhand, during mid of April when their fruits start ripening.

Seed Pretreatments : After collection, seeds were surface sterilized by soaking in 5% sodium hypochlorite (NaOCl) solution for 10 min and subsequently rinsed thoroughly with sterilized water prior to stratification treatment.

Table-3 : Effect of stratification and GA₃ on seedling length of Kaphal (*Myrica esculenta*) and Wild raspberry (*Rubus ellipticus*).

Stratification (T)	Kaphal (Myrica esculenta)					Wild raspberry (Rubus ellipticus)				
	Gibberellic acid (S)									
	S ₁	S ₂	S ₃	S ₀	Mean	S ₁	S ₂	S ₃	S ₀	Mean
T ₁	13.53	13.36	13.01	12.56	13.11	10.72	10.53	10.42	9.69	10.34
T ₂	13.86	13.71	13.64	12.66	13.47	11.16	11.02	10.87	10.01	10.76
T ₃	14.73	14.65	13.93	12.79	14.03	11.67	11.53	11.25	10.21	11.17
T ₀	11.92	11.80	11.62	11.54	11.72	9.55	9.38	9.19	0.00	7.03
Mean	13.51	13.38	13.05	12.39		10.77	10.62	10.44	7.48	
Factors	SE (±)			CD (5%)		SE (±)			CD (5%)	
T	0.02			0.05		0.01			0.02	
S	0.02			0.05		0.01			0.02	
T×S	0.05			0.01		0.02			0.04	

Table-4 : Effect of stratification and GA₃ on seedling vigour of Kaphal (*Myrica esculenta*) and Wild raspberry (*Rubus ellipticus*).

Stratification (T)	Kaphal (Myrica esculenta)					Wild raspberry (Rubus ellipticus)				
	Gibberellic acid (S)									
	S ₁	S ₂	S ₃	S ₀	Mean	S ₁	S ₂	S ₃	S ₀	Mean
T ₁	437.46	414.10	368.62	288.87	377.26	289.37	263.33	232.66	193.78	244.78
T ₂	614.62	553.02	504.65	434.59	526.72	420.13	374.72	347.98	300.51	360.84
T ₃	913.34	854.50	757.02	618.45	785.83	595.27	534.31	472.63	337.11	484.83
T ₀	309.95	283.10	244.05	207.74	261.21	175.19	162.67	150.22	0.00	122.02
Mean	568.84	526.18	244.05	207.74		369.99	333.76	300.87	207.85	
Factors	SE (±)			CD (5%)		SE (±)			CD (5%)	
T	5.87			12.01		5.19			10.62	
S	5.87			12.01		5.19			10.62	
T×S	11.73			24.01		10.38			21.24	

Stratification treatments : For stratification treatment 50 seeds each were placed in between the layers of moist sand in petri-plate and then kept inside refrigerator at 5°C temperature for period of 7, 14 and 21 days. A seed without stratification treatment is considered as control, during this pre-treatment, care is taken to maintain proper moisture in the sand.

Growth regulator treatment : For growth regulator treatment, pre-stratified seed were soaked in different concentrations of GA₃ solution (250, 500 and 750 ppm) for a period of 24 hours. After 24 hours of soaking the seeds were kept over Wattman filter paper in petri-dishes and then placed inside seed germinator, which was set at 25°C temperature. Whenever it was needed to keep filter papers moist, additional water was added.

Following germination parameters were taken for this seed germination experiment;

Germination percentage (%) : The germination in each treatment was recorded by visual observation every day for period of 30 days. Number of seedlings were counted and finally expressed as germination percentage (%).

Germination Percentage

$$= \frac{\text{Total number of seed germinated}}{\text{Total number of seed sown}} \times 100$$

Germination rate : The germination rate is calculated by using the following formula given by Agrawal (1994).

$$\text{Germination rate} = \frac{N_1}{D_1} \frac{N_2}{D_2} \frac{N_3}{D_3} \dots \frac{N_x}{D_x}$$

Where, N = Number of germinated seed

D = Days of germination

Seedling length(cm) : Seedling length was measured by using ruler, taking five randomly selected seedlings from each replication.

Seedling Vigor Index (VI) : Seedling vigor index was calculated according to the following formula :

Seedling vigor index (VI) = Germination Percentage (%)

Seedling Length (cm)

Fresh and Dry weight of seedling (g) : After measurement of root and shoot length, fresh weight and dry weight of seedlings were recorded. Then the root and seedlings were put into paper packet and placed into the preheated oven (70°C ± 2°C) for 48 hours. After cooling in desiccators, the dry weights were taken.

Statistical Analysis : The data was analyzed according to the procedure of analysis of variance for factorial completely randomized design (Snedecar and Cochran,

Table-5 : Effect of stratification and GA₃ on fresh weight of seedling in Kaphal (*Myrica esculenta*) and Wild raspberry (*Rubus ellipticus*).

Stratification (T)	Kaphal (<i>Myrica esculenta</i>)					Wild raspberry (<i>Rubus ellipticus</i>)				
	Gibberellic acid (S)									
	S ₁	S ₂	S ₃	S ₀	Mean	S ₁	S ₂	S ₃	S ₀	Mean
T ₁	1.60	1.54	1.51	1.46	1.53	1.70	1.66	1.64	1.53	1.63
T ₂	1.73	1.70	1.64	1.47	1.64	1.81	1.78	1.75	1.56	1.73
T ₃	1.83	1.81	1.78	1.49	1.73	1.96	1.87	1.83	1.60	1.82
T ₀	1.43	1.41	1.38	1.36	1.39	1.50	1.45	1.42	0.00	1.09
Mean (S)	1.65	1.61	1.58	1.45		1.74	1.69	1.66	1.17	
Factors	SE (±)		CD (5%)			SE (±)		CD (5%)		
T	0.003		0.009			0.005		0.015		
S	0.003		0.009			0.005		0.015		
T×S	0.006		0.019			0.010		0.03		

Table-6 : Effect of stratification and GA₃ on dry weight of seedling in Kaphal (*Myrica esculenta*) and Wild raspberry (*Rubus ellipticus*).

Stratification (T)	Kaphal (<i>Myrica esculenta</i>)					Wild raspberry (<i>Rubus ellipticus</i>)				
	Gibberellic acid (S)									
	S ₁	S ₂	S ₃	S ₀	Mean	S ₁	S ₂	S ₃	S ₀	Mean
T ₁	0.325	0.309	0.304	0.293	0.300	0.344	0.332	0.328	0.306	0.327
T ₂	0.347	0.337	0.328	0.294	0.326	0.362	0.358	0.350	0.313	0.346
T ₃	0.366	0.361	0.355	0.298	0.345	0.392	0.374	0.366	0.320	0.363
T ₀	0.285	0.281	0.277	0.271	0.279	0.300	0.291	0.284	0.00	0.219
Mean (S)	0.331	0.322	0.316	0.289		0.349	0.339	0.332	0.235	
Factors	SE (±)		CD (5%)			SE (±)		CD (5%)		
T	0.001		0.002			0.001		0.003		
S	0.001		0.002			0.001		0.003		
T×S	0.001		0.004			0.002		0.006		

1988). There were 16 treatment combinations for each i.e., *Myrica esculenta* and *Rubus ellipticus*. Each treatment was replicated thrice. Two-way ANOVA was used to compare means of appropriate experimental treatments at 5% probability level. The results are presented with the help of tables, graphs and photographs.

Results and Discussion

Efficient propagation of nursery stock from seed requires extensive knowledge of the germination methods and requirements needed for the species. Little is known about the propagation requirements for *Myrica esculenta* and *Rubus ellipticus*. This deficit is due, in part, to a lack of demand for these species in the past. Extensive work has been done on the propagation of other wild edible fruit plants, specifically those of commercial value to the other industrial purpose. Information generated from the present study and the parameters taken are as follows.

Germination percentage : The data presented in Table-1 reveals that, the combine effect of pre-sowing seed treatment i.e., 21 days stratification and 250 ppm GA₃ (T₃S₁) recorded maximum (62%) germination percentage in seeds of Kaphal (*Myrica esculenta*) and (51%) in Wild raspberry (*Rubus ellipticus*) respectively followed by 21 days stratification and 500 ppm GA₃ (T₃S₂).

This shows that pretreatment of stratification and GA₃ influence germination percentage of both these plants.

The reason behind such combined pretreatment effect is that, stratification breaks dormancy on the other hand gibberellic acid stimulates germination by activation of amylase enzyme which convert insoluble starch into soluble sugars and it also initiates the radical growth by removing some metabolic blocks and thus ultimately affecting seed germination. These results are found in consistent with Rehman and Park (2000) in Golden rain tree, Koyuncu (2005) in Black mulberry, Pandey and Tamta (2013) in *Quercus spp.* Zadeh *et al.* (2015) in *Echinacea purpurea* and Bhatt *et al.* (2000) in Kaphal (*Myrica esculenta*).

Germination rate : The data presented in Table-2 shows that, the maximum germination rate (1.63) in Kaphal (*Myrica esculenta*) and (1.30) in Wild raspberry (*Rubus ellipticus*) when seeds treated with combine pretreatment of 21 days stratification and 250 ppm GA₃ (T₃S₁) followed by 21 days stratification and 500 ppm GA₃ (T₃S₂). The seeds which were not pretreated shows slowest germination rate while seeds with combined pretreatment recorded the fastest germination rate. The results indicate that combined pretreatment of stratification and GA₃ hastens the process of germination which in turn increases the germination rate.

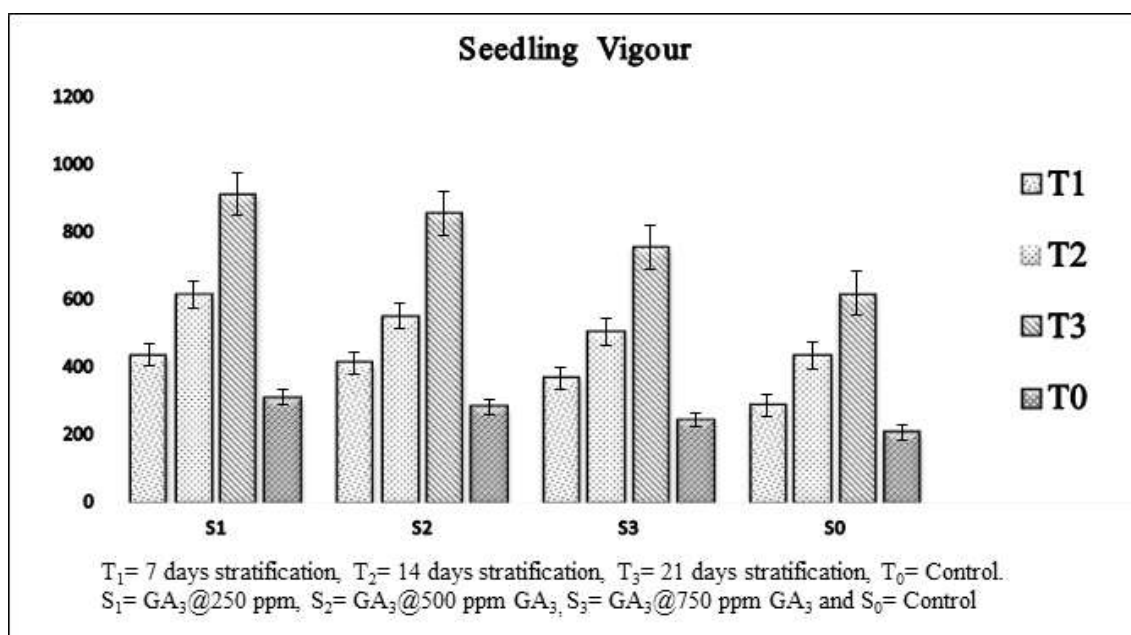


Fig.-1 : Effect of stratification and GA₃ on seedling vigour of Kaphal (*Myrica esculenta*).

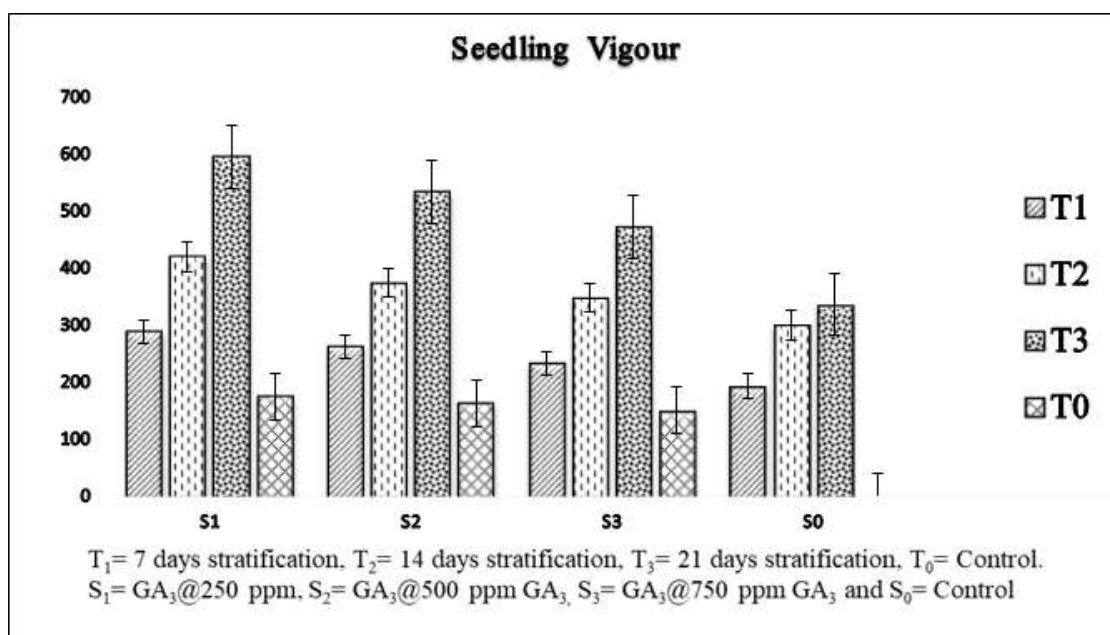


Fig.-2 : Effect of stratification and GA₃ on seedling vigour of Wild raspberry (*Rubus ellipticus*).

It is because stratification and GA₃ used in combination could have activate the metabolic and physiological activities including changes in level of growth retarding hormones resulting in early germination (Khan, 1977). These finding of combine pretreatment on germination rate influence is supported by result of Rehman *et al.* (2011) and Pandey and Tamta (2013).

Seedling length (cm) : Data presented in Table-3 shows that, seedling length (cm) of Kaphal (*Myrica esculenta*) and Wild raspberry (*Rubus ellipticus*) was observed maximum (14.73cm) and (11.67 cm) respectively in

combined pre-treatment i.e., 21 days stratification and 250 ppm GA₃ (T₃S₁) followed by 21 days stratification and 500 ppm GA₃ (T₃S₂).

This increase in seedling length can be attributed by the presence of specific enzyme like amylase, protease and lipase which promote cell division and growth (Carpentier, 1988; Iqbal *et al.*, 2007). The result obtained in the present experiment are in are supported by findings of Farhoudi *et al.* (2015) in *Echinacea purpurea*, Amooaghaie (2009) in *Ferula ovina*, Bhan and Sharma (2011) in Wild apricot.

Seedling Vigor Index (VI) : Data presented in Table-4 reveals that, the seeds treated with combined pre-treatment with 21 days stratification and 250 ppm GA₃ (T₃S₁) resulted in maximum seedling vigor index (913.34) and (595.27) in Kaphal (*Myrica esculenta*) and Wild raspberry (*Rubus ellipticus*) respectively followed by 21 days stratification and 500 ppm GA₃ (T₃S₂).

Higher seedling vigour index of these edible wild fruit plants can be related to higher seed germination and height of seedling which lead to overall assimilation and distribution of food material with the plant (Brain and Hemming, 1955) and hence resulted in higher seedling vigour (Pampanna and Sulikeri, 1995). Similar results were observed in *Betula utilis* (Mir, et al., 2018), *Magnolia grandiflora* (Hassan and Fetouh 2014) and *Albizia procera* (Jabbar, et al., 2010)

Fresh and Dry weight of seedling : Results presented in Table-5 and Table-6 showed that, fresh and dry weight of seedling of both the edible wild fruit plants were significantly affected by different seed pre-treatments. Among all the pre-treatment maximum fresh (1.83g) and (1.96 g) and dry weight (0.366g) and (0.392 g) observed when seeds of Kaphal (*Myrica esculenta*) and Wild raspberry (*Rubus ellipticus*) were treated with combination of pre-treatment 21 days stratification and 250 ppm GA₃ (T₃S₁) followed by 21 days stratification and 500 ppm GA₃(T₃S₂).

This increase in fresh and dry weight of seedling can be attributed to growth parameters like number of leaves and seedling length as increase or decrease in these observations directly influence fresh and dry weight of seedling. Results of study are strengthened by findings of Macchia et al. (2001) in *Echinacea* spp, Nicolas et al. (1996) in *Fagus sylvatica*, Rawat et al. (2010) in *Punica granatum* and Hassan and Fetouh (2014) in *Magnolia grandiflora* as depict similar findings.

Conclusions

The present study demonstrate that combination of stratification duration followed by GA₃soaking is a simple, efficient and cost-effective method for better seed germination in both these edible wild fruit plants. Findings of present study will be helpful in boosting conservation efforts of not only these but also other related edible wild fruit plants.

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Physiological Studies on the Effect of Seed Pelleting and Crop Establishment Methods on Seed Quality of Sesame (*Sesamum indicum* L.)

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Abstract

The experiment was conducted in kharif season during 2019-2020 to find out physiological studies on the effect of seed pelleting and crop establishment methods on seed quality of sesame (*Sesamum indicum* L.). Data revealed that seed quality traits viz., seed germination (90.73 %), shoot length (11.373 cm), root length (8.61 cm) seedling dry weight (0.024 mg), seedling vigour index-I (1786.83) and seedling vigour index-II (2.28) were maximum with in M3S2 (ridges and furrows method of sowing and seed pelleting (Neem leaf powder 760g + 120g Azospirillum + 120g Phosphobacteria for 1kg of seed with rice gruel as adhesive) interaction over other treatments in sesame. seed carbohydrate % (20.47), seed protein (23.21) and seed oil % (48.77) were significantly maximum in sesame with S2 seed pelleting.

Introduction

Sesame (*Sesamum indicum* L.) is commonly known as 'Til' also called as "Queen of oil seeds". It is belong to family pedaliaceae, and origin place is Africa. The chemical composition of sesame shows that the seed is an important source of oil (50-60%), protein (18-25%), carbohydrate and ash. Seed priming is a pre-sowing strategy for improving seedling establishment by modulating pre-germination metabolic activity prior to emergence of the radical and generally enhances germination rate and plant performance (Farooq & Rehman, 2006). Seed priming is a pre-sowing strategy for improving seedling establishment by modulating pre germination metabolic activity prior to emergence of the radicle and generally enhances germination rate and plant performance. The main effects of seed priming are the acceleration of germination and plant emergence and sometimes the improvement of seed viability and the acceleration of seedling growth. There are reports that seed priming permits early DNA replication, increase RNA and protein synthesis, enhances embryo growth, repairs deteriorated seed parts and reduces leakage of metabolites (McDonald, 2000). Seed priming is seen as a viable technology to enhance rapid and uniform emergence, high vigor and better yields in some field crops (Murungu *et al.* 2004).

Materials and Methods

The present investigation entitled "Physiological studies on the effect of seed pelleting and crop establishment methods on growth, biomass partitioning, productivity and seed quality of sesame (*Sesamum indicum* L.)" was under taken during Kharif season 2019-20 at Experimental

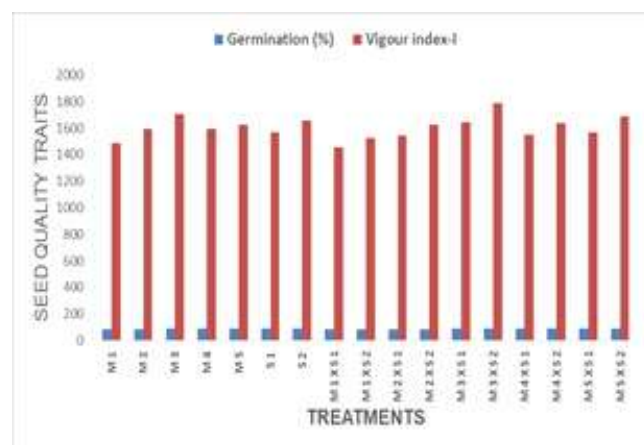
Research farm, P.C. unit, Sesame and Niger (AICORP), JNKVV, Jabalpur (M.P.). Estimation of biochemical constituent was done in the laboratory of the Department of Plant Physiology, JNKVV, Jabalpur.

Carbohydrates in the samples were estimated by the method as described by Sadasivam and Manickam (1992). The protein 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). In split plot design (SPD) with three replications having treatments comprised of main plot viz. M₁- Farmer's practice (BC), M₂- Dibbling in flat bed (DFB), M₃- Dibbling in ridges and furrows (DRF), M₄- Drum seeding (DS), M₅- Seed drill sowing (SD) and two sub plot viz., S₁- Non pelleted, S₂- Pelleted (Neem leaf powder 760g + 120g Azospirillum + 120g phosphobacteria For 1kg of seed with rice gruel as adhesive).

Results and Discussion

A. Seed quality parameters

Germination % : In the present study, germination % ranged from 84.47 % - 90.73 %. With respect to crop establishment method and seed pelleting significant difference was observed on germination % of Sesame. M₃ (ridges and furrows method of sowing) was noted in maximum germination % (90.52) as compared to M₁ (farmer's practices) minimum germination % (84.68) and seed pelleting on germination % S₂ = pelleted (Neem leaf powder 760g + 120g *Azospirillum* + 120g Phosphobacteria for 1kg of seed with rice gruel as adhesive) was noted maximum germination % (87.97) as compared to S₁ (no pelleting) minimum germination % (87.56).



Vigour index-I : In the present study, vigour index-I ranged from 1452.18 – 1786.83. With respect to crop establishment method and seed pelleting significant difference was observed on vigour index-I of Sesame. M_3 was noted in maximum vigour index-I (1705.16) and seed pelleting on vigour index-I S_2 was noted maximum vigour index-I (1569.22). Biradarpatil *et al.* (2006) reported that groundnut seed quality parameters did not vary significantly with the methods of production. However, seeds produced under broad bed and furrows are showed superiority in germination, seedling length, vigour index and dry weight of seedlings over raised bed method. Similar finding were also reported by Gangadharayya *et al.* (2019) found who observed foxtail millet seeds primed with T_{12} (seed priming with *Azospirillum* sp. @20% + *Pseudomonas fluorescens* @ 20% + phosphobacter @ 20% + $ZnSO_4$ 0.1% + Boron 0.1%) recorded significantly higher seedling vigour index I and II (1671 and 2206) respectively.

Vigour index-II : In the present study, vigour index-II ranged from 1.120–2.280. With respect to crop establishment method and seed pelleting significant difference was observed on vigour index-II of Sesame. M_3 (ridges and furrows method of sowing) was noted in maximum vigour index-II (2.250) as compared to M_1 (farmer's practices) minimum vigour index-II (1.150) and seed pelleting on vigour index-II S_2 = pelleted (Neem leaf powder 760g+ 120g *Azospirillum* + 120g *Phosphobacteria* for 1kg of seed with rice gruel as adhesive) was noted maximum vigour index-II (1.788) as compared to S_1 (non-pelleting) minimum vigour index-II (1.698).

Shoot length (cm) : In the present study, shoot length ranged from 8.713 cm – 11.373 cm. With respect to crop establishment method and seed pelleting significant difference was observed on shoot length of Sesame. M_3 was noted in maximum shoot length (11.305) as

compared to M_1 minimum shoot length (8.750) and seed pelleting on shoot length S_2 was noted maximum shoot length (9.913) as compared to S_1 minimum shoot length (9.809). Similar results were also reported by Suman (2002) revealed that the seed pelleted with $ZnSO_4$ with or without filler material recorded significantly higher plant height at 50 per cent flowering (69.04 cm) and harvest (81.11 cm), increased seed yield (2002 kg ha⁻¹) and quality parameters such as germination (5.66 %), root length (20.91 cm), shoot length (17.11 cm) and vigour index (36.37) in sunflower.

Root length (cm) : In the present study, ranges for root length were found to be 7.24 cm – 8.61 cm. With respect to crop establishment method and seed pelleting significant difference was observed on root length of Sesame. M_3 was noted in maximum root length (8.57 and seed pelleting on root length S_2 was noted maximum root length (7.92) as compared to S_1 (Non-pelleting) minimum root length (7.85). However, their interaction has significant effect on root length M_1S_1 (farmer practice's and Non-pelleting) was noted minimum root length (7.24) as compared to treatment M_3S_2 (ridges and furrows method of sowing and pelleted maximum root length (8.61).

Dry weight of 10 seedlings (g) : In the present study, dry weight of 10 seedlings ranged from 0.013 g – 0.024 gm. With respect to crop establishment method and seed pelleting significant difference was observed on dry weight of 10 seedlings of Sesame. M_3 was noted in maximum dry weight of 10 seedlings (0.023) as compared to M_1 minimum dry weight of 10 seedlings (0.014) and seed pelleting on dry weight of 10 seedlings S_2 was noted maximum dry weight of 10 seedlings (0.024) as compared to S_1 minimum dry weight of 10 seedlings (0.022). However, their interaction has significant effect on dry weight of 10 seedlings M_1S_1 (farmer practice's and non-pelleting) was noted minimum dry weight of 10 seedlings (0.013) as compared to treatment M_3S_2 (ridges and furrows method of sowing and pelleted (Neem leaf powder 760g+ 120g *Azospirillum* + 120g *Phosphobacteria* for 1kg of seed with rice gruel as adhesive) maximum dry weight of 10 seedlings (0.024). Similar findings were also reported by Longjiang *et al.* (1997) found progressive increase in seedling emergence and stand establishment in pelleted seeds of maize. Biradar patil *et al.* (2006) reported that groundnut seed quality parameters did not vary significantly with the methods of production. However, seeds produced under broad bed and furrows are showed superiority in germination, seedling length, vigour index and dry weight of seedlings over raised bed method.

Table-1 : Effect of crop establishment methods, seed pelleting and their interaction on seed quality parameters in sesame crop.

S. No.	Treatments	Germination (%)	Vigour index-I	Viour index-II	Root length (cm)	Shoot length (cm)	Seedling dry weight (mg)
Main plot							
1.	M1	84.68	1488.51	1.150	7.29	8.750	0.014
2.	M2	86.57	1592.7	1.375	7.77	9.272	0.16
3.	M3	90.52	1705.16	2.250	8.57	11.305	0.023
4.	M4	87.58	1594.77	1.890	7.86	9.851	0.018
5.	M5	89.48	1627.45	2.050	7.92	10.128	0.021
6.	SEm±	0.044	1.34	0.003	0.002	0.003	0.002
7.	CD (5%)	0.146	4.45	0.010	0.005	0.011	0.001
Sub plot							
1.	S1	87.56	1569.22	1.698	7.85	9.809	0.22
2.	S2	87.97	1655.28	1.788	7.92	9.913	0.24
3.	SEm±	0.010	0.96	0.003	0.001	0.002	0.001
4.	CD (5%)	0.032	3.06	0.010	0.003	0.006	0.002
Interaction							
1.	M1xS1	84.47	1452.18	6.43	7.24	8.713	0.013
2.	M1xS2	84.90	1524.85	6.87	7.33	8.787	0.014
3.	M2xS1	86.33	1543.35	7.57	7.72	9.217	0.015
4.	M2xS2	86.80	1623.49	7.73	7.82	9.327	0.016
5.	M3xS1	90.30	1642.39	8.77	8.52	11.237	0.022
6.	M3xS2	90.73	1786.83	8.85	8.61	11.373	0.024
7.	M4xS1	87.40	1552.22	7.33	7.84	9.813	0.016
8.	M4xS2	87.77	1637.33	7.53	7.88	9.887	0.019
9.	M5xS1	89.30	1569.88	7.67	7.91	10.063	0.020
10.	M5xS2	89.67	1685.02	7.83	7.93	10.193	0.022
11.	SEm±	0.062	1.90	0.019	0.003	0.005	0.002
12.	CD (5%)	0.074	6.97	0.136	0.006	0.013	0.001

B. Biochemical estimations

Seed carbohydrates % : In the present study, seed carbohydrates % ranged from 16.33 % - 20.60 %. With respect to crop establishment method and seed pelleting significant difference was observed on seed carbohydrates % of Sesame. M₃ was noted in maximum seed carbohydrates % (20.47) as compared to M₁ minimum seed carbohydrates % (16.57) and seed pelleting on seed carbohydrates % S₂ was noted maximum seed carbohydrates % (18.75) as compared to S₁ minimum seed carbohydrates % (18.41).

Seed Protein % : In the present study, seed protein % ranged from 20.23 % - 23.30 %. With respect to crop establishment method and seed pelleting significant difference was observed on seed protein % of Sesame. M₃ was noted in maximum seed protein % (23.21) and seed pelleting on seed protein % S₂ was noted maximum

seed protein % (22.01). However, their interaction has significant effect on seed protein % M₁S₁ (farmer practice's and was noted minimum seed protein % (20.23) as compared to treatment M₃S₂ maximum seed protein % (23.30). Kadam et al. (2000) reported that broad bed furrows registered maximum and significantly higher protein content in kernel as compared to border method and ridges and furrows.

Seed oil % : In the present study, seed oil % ranged from 44.50 % - 48.83 %. With respect to crop establishment method and seed pelleting significant difference was observed on seed oil % of Sesame. M₃ was noted in maximum seed protein % (48.77) as compared to M₁ minimum seed protein % (44.62) and seed pelleting on seed oil % S₂ pelleted was noted maximum seed oil % (46.69). However, their interaction has significant effect on seed oil % M₁S₁ was noted minimum seed oil % (44.50) as compared to treatment M₃S₂ maximum seed oil % (48.83).

Table-2 : Effect of crop establishment methods seed pelleting and their interaction on carbohydrates (%), oil (%), and protein (%) in sesame crop.

S. No.	Treatments	Seed carbohydrates percent	Seed oil percent	Seed protein percent
Main plot				
1.	M1	16.57	44.62	20.37
2.	M2	17.50	45.48	21.47
3.	M3	20.47	48.77	23.21
4.	M4	18.73	46.27	21.63
5.	M5	19.62	47.72	22.63
6.	SEm±	0.011	0.023	0.015
7.	CD (5%)	0.035	0.075	0.049

S. No.	Treatment	Seed carbohydrates percent	Seed oil percent	Seed protein percent
Sub plot				
1.	S1	18.41	46.45	21.73
2.	S2	18.75	46.69	22.01
3.	SEm±	0.013	0.011	0.012
4.	CD (5%)	0.042	0.036	0.039

S. No.	Treatment	Seed carbohydrates percent	Seed oil percent	Seed protein percent
Interaction				
1.	M1xS1	16.33	44.50	20.23
2.	M1xS2	16.80	44.73	20.50
3.	M2xS1	17.37	45.30	21.33
4.	M2xS2	17.63	45.68	21.60
5.	M3xS1	20.33	48.70	23.13
6.	M3xS2	20.60	48.83	23.30
7.	M4xS1	18.57	46.13	21.50
8.	M4xS2	18.90	46.40	21.77
9.	M5xS1	19.43	47.63	22.43
10.	M5xS2	19.80	47.80	22.83
11.	SEm±	0.015	0.032	0.021
12.	CD (5%)	0.096	0.082	0.089

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Co-Inoculation of *Rhizobium* and Phosphate Solubilizing Bacteria for Improving Growth and Nodulation of Mung Bean (*Vigna radiata* L.)

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Abstract

A field experiment was being carried out in the summer season, 2020- 2021 at College of Agriculture, Raipur, Chhattisgarh to study the dual inoculation of stress tolerant *Rhizobium* and Phosphorus solubilizing bacteria (PSB) on the growth and nodulation of mung bean crop. The experiment was laid out in RCBD with nine treatments replicated thrice. Treatments include two strains of *Rhizobium* (Mung8 and Mung3512) and PSB (PSB-5-69 and PSB-5-71), used for inoculation as single and dual inoculation in experiment with mung crop including one un-inoculated, control. *Rhizobium* and PSB isolates obtained from culture deposits of Microbiology Laboratory, IGKV, Raipur were studied for biochemical characterization and colony characteristics. *Rhizobium* colonies were observed as white, translucent, convex colonies and smooth surface in YEMA plate. Similarly PSB Colonies were observed as yellowish and round in Pikovskaya media plates showing clear zones. As per biochemical studies, they were found positive in Urease test, Catalase test, Starch hydrolysis test, Citrate test, also ferment glucose and sucrose as per TSI test. Experimental results showed that plant height increased significantly from 27.31 cm at control to 39.72 cm at treatment, Mung8+ PSB-5-69. Significantly highest nodule no./plant i.e., 35.11 and nodule dry weight i.e., 104.98 mg plant⁻¹ were observed in dual inoculated mung crop with of Mung8+PSB-5-69 followed by Mung8+PSB-5-71 whereas in control significant decrease was seen (12.21 no./plant and 20.22 mg plant⁻¹). Combined inoculation of N fixing microbes and PSB showed better improvement in symbiosis of mung crop than single inoculation.

Key words : Mung bean, *Rhizobium*, PSB, nodulation, dual inoculation.

Introduction

Mung bean (*Vigna radiata*) is a major pulse crop that belongs to family, Fabaceae, grown in an area of 2.75 m ha having an average production of 1.19 Mt and productivity of 432 kg ha⁻¹ in India (Purushottam and Singh, 2015). It is mostly used as a protein supplement in subtropical areas around the world contains about 25% protein. The area and productivity of mung bean crop in Chhattisgarh is found to 8.40 ha, Production (4.07 MT) and Productivity (485 kg/ha) (Commissioner Land Record 2017). In addition to its high nutritive value, an important feature of the mung bean crop is its ability to establish a symbiotic relationship with *Rhizobium*, through biological nitrogen fixation. The green biomass of the crop as well as residues can be incorporated in the soil as green manuring for enhancing soil fertility. The replenishment of nutrients and soil quality maintenance is dependent on organic materials due to beneficial impacts in terms of soil physical, chemical, and biological properties (Reddy *et al.*, 2003).

Bio-fertilizers are bio-inoculants of specific beneficial microorganisms that help crops to grow and develop by transforming inaccessible nutrients into available nutrients. Despite the presence of native *Rhizobium* in soil, not all of them are capable of producing nodules (Mandale *et al.* 2020). Additional inoculation with effective competitive microbes is needed. Phosphorous is such an

important macronutrient which is very often present in the soil in unavailable form. Many soil bacteria particularly those belonging to the genera *Bacillus* and *Pseudomonas* possess the ability to bring insoluble phosphates in the soluble forms by secreting organic acids (Roychowdhury *et al.* 2015).

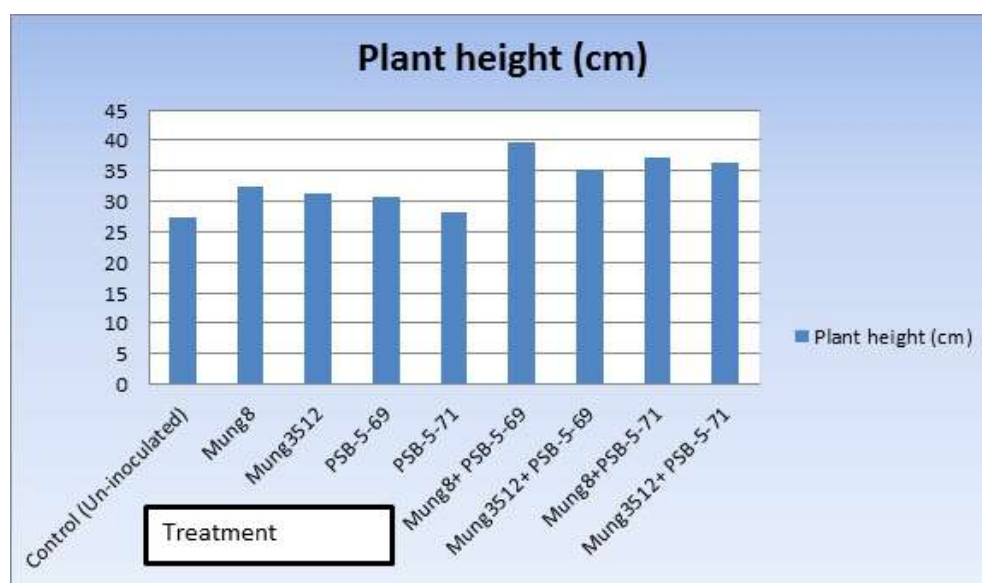
Organic techniques combined with effective microorganisms (EMs) for long-term production increase is a promising strategy. Synergistic relationship among plant growth promoting micro-organisms exist. Co-inoculation of nitrogen fixing microbes and phosphorus solubilizing microbes could serve the purpose of supplying both N and P nutrients and may improve plant growth than their sole application. It is seen that positive effect on the yield and nutrient uptake of legume crops as well as nodulation improvement due to combined inoculation of PSB and nitrogen fixing microbes (Khan *et al.*, 2007). Dual inoculation of nitrogen fixers and phosphate solubilizers in legumes may have synergistic effects resulting into better crop yield. Therefore, this study was taken to explore potential role of dual inoculation of *Rhizobium* and PSB towards the nutrient management for mung bean crop to enhance the symbiosis.

Materials and Methods

A field experiment was conducted at the Research farm (Organic farming model), Indira Gandhi Krishi

Table-1 : Biochemical characterization of *Rhizobium* and PSB isolates and their colony morphological characteristics.

Name of <i>Rhizobium</i> isolates	Biochemical characterization of <i>Rhizobium</i> isolates and their colony characters						
	Urease test	Catalase test	Starch hydrolysis test	Citrate test	TSI test	Gram reaction	Colony morphology
Mung 8	+ve	+ve	+ve	+ve	Glucose, Sucrose and Lactose fermentation No gas/H ₂ S Production	-ve	White translucent, Circular, Entire smooth
Mung 3512	+ve	+ve	+ve	+ve	Glucose, Sucrose and Lactose fermentation No gas/H ₂ S Production	-ve	White translucent, Circular, Entire smooth
Biochemical characterization of PSB isolates and their colony characters							
PSB-5-69	+ve	+ve	+ve	+ve	Sucrose and Lactose fermentation No gas/ H ₂ S Production	-ve	Round and yellowish, Entire smooth, Convex
PSB-5-71	+ve	+ve	+ve	+ve	Sucrose and Lactose fermentation No gas/H ₂ S Production	-ve	Round and yellowish, Entire smooth, Convex

Fig.-1 : Effect of *Rhizobium* and PSB isolates on plant height of mung bean at 40 DAS

Vishwavidyalaya, Raipur (Chhattisgarh) during 2020-2021 with the mung bean (*Vigna radiata*) crop, Variety: (Hum). The experiment was laid out in RBD with 3 replications to find out the synergistic effect of isolates on symbiotic performances in mung crop. Treatments were nine including two Mung bean *Rhizobium* and two PSB isolates which were applied as single and dual inoculation along with one absolute control. Seeds of mung crop (Var. Hum) was collected from IGKV Raipur. Raipur is situated in the plains of Chhattisgarh at 21°16' N latitude and 81°36' E longitude with an altitude of 298.56 metres above the mean sea level (MSL). Isolates were collected from the microbiology repository of the Department of Agricultural Microbiology, CoA, Raipur and were used as treatments with mung bean (Variety Hum) in field experiment.

For inoculum preparation, YEMA and Pikovskayas plates were streaked with loopfuls of *Rhizobium* and PSB

slants and incubated at 28±2°C and a single discrete colony of each isolate was inoculated into 25 ml of concerned broth in a 50 ml conical flask and incubated at 28±2°C for 48 hours before being kept on a rotational shaker for seven days. Different biofertilizer packets as per different strains were developed for seed treatment @ 10g/kg seed of mung bean as per treatment. The seeds were inoculated plot wise with the freshly prepared carrier based rhizobial cultures of the respective strains before sowing. Other package of practices was taken up as per schedule.

Colony morphology and Gram's reaction : On YEMA and PVK agar medium, phenotypic pattern of colony characters for *Rhizobium* and PSB isolates were observed. Gram reaction test was also carried out (Graham and Parker, 1964).

Biochemical characteristics of isolates

Rhizobium and Phosphate solubilizing bacterial isolates

Table-2 : Synergistic effect of *Rhizobium* and PSB on Nodulation behaviour of mung bean.

Treatment	Name of isolates	No. of nodules plant ⁻¹	Nodule fresh weight (mg plant ⁻¹)	Nodule dry weight (mg plant ⁻¹)
T ₁	Control (Un-inoculated)	12.21	64.88	20.22
T ₂	Mung 8	30.28	134.98	82.12
T ₃	Mung 3512	25.87	121.25	74.34
T ₄	PSB-5-69	20.62	112.95	62.78
T ₅	PSB-5-71	18.87	89.78	53.18
T ₆	Mung 8+ PSB-5-69	35.11	201.45	104.98
T ₇	Mung 3512 + PSB-5-69	29.82	176.66	84.24
T ₈	Mung 8 + PSB-5-71	32.31	184.98	93.21
T ₉	Mung 3512+ PSB-5-71	27.11	145.32	72.48
	CD (5%)	2.107	11.38	7.16

were characterized using standard biochemical method as given in the Bergey's manual of systematic bacteriology (2001). Various biochemical characterizations were done viz., urease test, catalase test, starch utilization test, Triple sugar iron test and citrate test.

Urease test : When loopful cultures of all isolates were grown in urea broth containing the pH indicator phenol red, the presence of urease was detected. The presence of ammonia creates an alkaline environment as the substrate urea is split into its products, causing the phenol red to turn a deep pink colour, indicating a positive result. A negative reaction is indicated by the colour yellow.

Catalase test : This test was done for the enzyme catalase, which hydrolyzes H₂O₂ into H₂O and O₂. A smear of strain was first applied to a clean, dry glass slide, and then a few drops of 3% H₂O₂ were added to the slide. A positive test showed the production of gas bubbles (within 5-10 seconds) and effervescence, while a negative test showed no bubbles or only a few scattered bubbles.

Starch hydrolysis test : For starch utilization, inoculation by streaking of each isolates in starch agar medium was done and incubated at 30°C. After 24hrs of incubation iodine solution (0.1N) is flooded to the plates to determine the capability of microbes to use starch. A clear zone around bacterial colonies indicated starch hydrolysis, while a blue/black area around indicated the presence of starch. (Nigam and Xaxlo, 2017).

Citrate test: Tubes with Simmon's citrate agar slants were inoculated with the bacterial culture and incubated at 37°C for 48 hours. The changes of color of the inoculated slants from green to blue was indicative of citrate positive test.

Triple sugar iron test : The triple sugar iron test was done to detect the ability of the organism to ferment sugars and to produce hydrogen sulphide. If only glucose is fermented, acid production in bottom of tube shows yellow colour, but if either Sucrose or Lactose is fermented, acid is produced showing both bottom and

slant Yellow. While slant and bottom is red, no fermentation occurs.

Morphological growth parameters

In each treatment, three plants were chosen at random and observations were taken. The Plant height (cm) of tagged plants in each plot was measured using a graduated scale divided in cm and mm at 40 DAS, and the average was calculated. Three plants per plot were uprooted carefully at 40 days after sowing (DAS) keeping the nodules intact. Roots of uprooted plants were washed thoroughly under running tap water, nodules are carefully detached from the roots, counted and no. of nodules per plant was recorded for each plot. After recording the fresh weight, the nodules were kept in small paper bags and were dried in hot air oven at 60°C till their constant oven dry weight is obtained. Nodule fresh and dry weight per plant was then calculated for each plot.

Statistical analysis

All observations of this experimental study were tabulated in a systematic manner and analyzed using analysis of variance (ANOVA) for randomised block design RBD (Panse and Sukhatme, 1967). When the F-test was significant for comparing treatment means, the standard error of means (SEM $\pm$) and CD were determined (Panse and Shukhatme, 1978).

Result and Discussion

Colony morphology and Gram staining : The preserved isolates in mother slants were revived by inoculating them in 50 ml respective broths (*Rhizobium* in YEMA media and PSB in Pikovaskya media) followed by incubation at 28°C $\pm$ 2°C for 48 hrs. *Rhizobium* isolates in YEMA media produced colonies like translucent to opaque, regular, convex, circular, mucilaginous colonies, 1-2 mm in diameter and whitish in appearance. PSB strains were found accomplished of forming a clear zone on solid media Pikovskaya. Colonies of all the isolates were found to be round and yellowish in color (Table 1). Based on the

biochemical and morphological tests, PSB isolate was found to be belonged to *Pseudomonas sp.* The isolated bacteria were recognized in discussion with Bergey's Manual of Systematic Bacteriology. After the Gram reaction, all the bacterial isolates of *Rhizobium* and PSB were examined under microscope, results showed that all isolates are Gram negative bacteria imparting dark pink to red colour in the reaction (Wadhwa *et al.*, 2017). The description of morphological characters and cultural characters and Gram reaction are given in below (Table No.1).

Biochemical characteristics of inoculums : Isolates of *Rhizobium* and Phosphate solubilizing bacteria were tested for different biochemical characterization viz., urease test, catalase test, starch utilization test, Triple sugar iron test and citrate test using standard biochemical method as given in the Bergey's manual of systematic bacteriology (2001).

In the urease test, all the *Rhizobium* and PSB isolates showed a positive result, showed dark pink color. Similarly the highest intensity of the pink color was shown by all PSB isolates of mung bean crop. Same result is also observed by Gauriet.al. (2012). In catalase test, all the isolates were grown on nutrient agar media for 24 hours. After putting H₂O₂, effervescence was found due to break down of H₂O₂ into H₂O and oxygen indicating positive catalase test for isolates. Bedi, M.K. and Naglot, A., (2011) also reported the same result. Further in the starch hydrolysis test, all *Rhizobium* and PSB isolates showed positive result for starch hydrolysis. Similar type of results was also carried out by Yadav and Verma, (2014). Positive isolates showed clear zone around the colonies and colonies with yellow coloration of colonies. The amylase assay of strain was evaluated by starch hydrolysis test (Budi *et al.*, 2000).

Rhizobium and PSB isolates were tested for utilizing citrate. For this purpose, *Rhizobium* isolates were grown on Simmon's citrate agar for 24-48 hours. Results obtained in this test indicated that all *Rhizobium* isolates, and PSB isolates showed positive results. Similar type of results was also observed by Niste *et al.* (2015). The TSI test was done to detect the ability of the organism to ferment sugars and to produce hydrogen sulfide. Through TSI test, *Rhizobium* isolates i.e., Mung8 and Mung3512 were found for all glucose, sucrose and lactose fermentation. Similarly PSB isolates through TSI test PSB-5-69 and PSB-5-71 were found for sucrose and lactose fermentation. In all isolates there was no gas/H₂S Production.

Plant morphology study as affected by inoculations : Plant height data were recorded at 40 DAS showed significant difference in plant height in inoculated plants

over control. At 40 DAS plant height was maximum (39.71cm) under the treatment Mung8+ PSB-5-69. The minimum plant height of (27.31) cm was noted T₁ (Fig.1) . The Results are in agreement with the observations of (Bahadur and Tiwari 2014) who stated that increase in plant height with inoculation as compared to control.

The nodulation behaviour of mung bean crop like nodule no., fresh weight and dry weight as affected by different treatments at 40 DAS were given in Table no.2. Results in Table no.2 indicates that nodulation was significantly high in plants given inoculation with Mung8+ PSB-5-69 followed by Mung8+ PSB-5-71. Nodule number per plant was increased from 18.87 to 35.11 due to inoculation treatment with *Rhizobium* and PSB strains. In control plants, where no inoculation is there, 12.21 nodules per plant was observed. Among 8 inoculated treatments, Mung8+PSB-5-69 showed significantly maximum no. of nodules per plant 35.11 followed by Mung8+PSB-5-71 and Mung3512+ PSB-5-69 showing nodule no. 32.31 and 29.82 per plant respectively (Table 2).

The fresh weight of nodules (mg plant⁻¹) were significantly increased due to inoculation treatments over other treatments. This study revealed that highest value of nodule fresh weight was 201.25 mg followed by 185.98mg plant⁻¹ due to isolates mung8+PSB-5-69 and Mung8+PSB-5-71 respectively. Nodule dry weight plant⁻¹ was observed to increase from 20.22 to 105.12 mg. Significantly maximum dry weight of nodules (105.12 mg plant⁻¹) was seen under treatment, Mung8+ PSB-5-69 followed by Mung8+ PSB-5-71 (93.21 mg plant⁻¹) (Table 2). As per Qureshi *et al.* (2011), inoculation in plants resulted in producing higher nodule number and nodular mass over control.

Conclusions

Combined inoculation of N fixing microbes and PSB showed better improvement in yield of mung than either group of organisms alone due to synergistic effect, which was clearly observed in the present investigation. From experimental results it was found that dual inoculation effect of Mung 8+PSB-5-69 was superior followed by Mung8+ PSB-5-71 which resulted significant increase in nodulation behaviour over control.

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Biofilm Formers in Farm Fresh Produce : Food Safety Threat

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Abstract

Foodborne outbreaks associated with fresh fruits and vegetables are on the rise globally. Biofilm formation is one of the important traits of pathogens making them strongly attached to substrates as well as express virulence. Biofilm is an aggregate of microorganisms in which cells are either stuck to each other or accumulate at interfaces and are encapsulated within a matrix of slimy sheath, a chemical compound substance known as Extracellular Polymeric Substance. Formation of biofilms occurs with the attachment of microorganisms to conditioned surface that may be active/passive depending upon bacterial motility, transportation of planktonic (free floating) cells by gravity and diffusion from surrounding fluid phase. The present study investigates the biofilm forming ability of pathogenic bacteria isolated from farm fresh produce (here, vegetables). A total of 20 isolates were screened after obtaining from different vegetable samples taken into account for their biofilm forming ability. Initial screening for biofilm formation was done using Congo Red agar plate test. Results revealed that 9 isolates were potential biofilm formers and rest non biofilm formers. However, spectrophotometric study suggested their efficiency from moderate to strong biofilm production capacity. Results of the work underline the biofilm forming and potentially virulent capacities of isolates from the surface of farm fresh produce.

Key words : Fresh vegetables, biofilm formation, assay.

Introduction

Biofilms are microbe aggregation that attach to one other and to surfaces while remaining entrenched in an extracellular polymeric material matrix. The production of biofilms is driven by a variety of internal and environmental causes. Single or many bacterial species can produce them as a single layer or three-dimensional structures. Percival et al. (2000) demonstrated that bacteria in biofilms are capable of fast phenotypic and genotypic adaptation to changing environmental circumstances. In both natural and man-made environments, biofilm development happens under a variety of situations. They are a heterogeneous environment made up of microbial cell aggregates and the exopolysaccharide component (Costa et al., 2018)

Pathogenic bacteria are capable of clinging to and growing on food surfaces as well as surfaces of other processing equipment, making biofilm development a critical problem in the food business. Previous research has revealed that microorganisms with the potential to form biofilms are one of the most common sources of food contamination and disease precipitation. *S. enterica* soil contamination was documented by Islam et al. (2004a, b) in crops such as radish, lettuce, carrot, and parsley, and lasted for more than 6 months. Similar findings were published by Barak and Liang (2008), who found that *S. enterica* affects a wide range of agricultural products,

including tomatoes. *Salmonella* is quite persistent in plant settings, according to Teplitski et al. (2009). *Listeria*, *Salmonella*, *Shigella*, *E. coli*, *Pseudomonas*, *Acinetobacter*, *Flavobacterium*, and *Enterococcus* are among the many food-borne illness-causing microorganisms that bind to surfaces in contact with food and secrete biofilms (Yuan et al. 2018). As a result, they can function as vectors for the transmission of these infections to people (Berger et al. 2010). Furthermore, in such circumstances, total destruction or removal is difficult.

Fresh produce, such as fruits and vegetables, has been on the rise in markets, and cases of foodborne illnesses caused by their consumption have also been on the rise in recent decades (Berger et al. 2010; Byrne et al. 2014; Kozak et al. 2013), prompting microbiologists to develop strategies to reduce the occurrence of foodborne outbreaks around the world (Lynch et al. 2009). Even when traditional sanitation measures have been used to clean and treat fresh products, the potential of microbial contamination still exists.

Denis et al. (2016) recently investigated the prevalence and trends of bacterial contamination in fresh fruits and vegetables sold in Canadian markets and discovered a number of pathogenic organisms with notable seasonal variations in their incidence, despite the fact that the prevalence was generally low. In India, though, the situation is likely to be different.

The goal of this research is to determine the biofilm forming ability of bacteria isolated from fresh food, such as fruits and vegetables, to create biofilms. For the study, they were considered for their role in foodborne outbreaks. It would aid in identifying the microorganisms' propensity for causing foodborne disease. More study into the mechanism of biofilm development and regulation might lead to a reduction in the presence of these bacteria on fresh produce and aid in the management of foodborne illness outbreaks. As a result, the following were recommended as the study's objectives :

To isolates biofilm formers from fresh fruits and vegetables

To assess the the isolates for their biofilm forming ability

Material and Methods

Sample collection, preparation and analysis : Farm fresh produce was collected from a local market Hisar lying in the vicinity of CCSHAU, Hisar, Haryana India. The samples were collected in L.D.P.E. and then brought for in vitro works.

Bacterial Strain Isolation : Bacterial strains to be separated were chosen based on the microorganisms' ability to produce biofilms. The serial dilution procedure was used to obtain isolation. One gram of dirt was dissolved in ten millilitres of distilled water for serial dilution. Each of the seven test tubes was filled with 9 mL distilled water. One millilitre of stock solution was aseptically transferred to the first test tube, resulting in a 10^{-1} dilution. The solution was then vortexed for adequate mixing, and 1 ml from this tube (10^{-1}) was aseptically transferred to the next test tube, resulting in 10^{-2} . Similar transfers were carried out until a dilution of 10^{-9} was reached. Dilutions ranging from 10^{-2} to 10^{-9} were placed on sterile Medium Agar plates and incubated for 48 to 72 hours at 37°C. Bacterial colonies were isolated using the streak plate method and the spread plate technique. To identify the required microorganism, selective media were utilized.

Morphological Characterization of the Isolates Obtained : The isolates were studied morphologically on solid medium. To examine cellular morphology, smears of pure colonies were made and examined under a microscope.

Colony characteristics : On a nutrient agar plate, colony properties such as colony size, shape, opticity, margin, and motility were investigated.

Gram's staining : A bacterial smear was produced and heat fixed on a slide. The smear was soaked with crystal violet for 30 seconds before being washed gently with tap

water. The smear was then inundated with Gram's iodine for 30 seconds before being rinsed with tap water. Keep the slide slanted and decolorize the stain with 90 percent ethyl alcohol by dropping the reagent drop-by-drop until the crystal violet fails to wash away. After 15 seconds, wash it with tap water and counter stain with safranin, then wash it again with tap water and air dry. A light microscope was used to observe the smear while it was submerged in oil. Gram-positive bacteria coloured violet, whereas Gram-negative bacteria coloured red (Vincent,1970).

Congo red agar plate test : The enrichment process yielded a total of 20 isolates from various leafy vegetables. All of the isolates were kept in nutritional agar slants and tested for their capacity to form biofilms on Congo Red Agar (CRA) plates. Test cultures were streaked onto CRA agar plates and incubated at 30 degrees Celsius for 24–48 hours. On the CRA plates, biofilm-forming bacteria appeared as dark black colonies, whereas non-formers appeared as red colonies. Based on the apparent colour of the colonies, they were divided into three groups: strong, moderate, and weak biofilm formers (Amrutha *et al.*, 2017).

Microtitre plate assay : 100 µl of the isolates were incubated at 37 °C for 18 hours in a microtitre plate. After incubation, the contents of the wells were removed and washed with 0.2 mL phosphate buffer saline (PBS pH 7.2) to eliminate any free-floating planktonic bacteria. After that, 20 l of crystal violet was used to stain the wells. The excess pigment was washed away with distilled water, then 100 litres of decoloriser were applied. An ELISA auto reader was used to determine the optical density (OD) of stained adherent bacteria at a wavelength of 580 nm (Amrutha *et al.*, 2017).

Result and Discussion

Morphological Characterization of isolates : The following morphological and biochemical tests were performed for the identification of the isolates. Cultural characteristics of different isolates : A few isolates were rod -shaped, with white colony and slow to moderate growth, While other were cream white, transparent with fast growth.

Gram staining : It is a method of differentiating the bacterial species into 2 large groups i.e. Gram positive (which retain the color of crystal violet) and Gram-negative (red or pink colored). Basis on the color obtained in the electron microscope, they are termed as Gram – negative or positive. Most of the isolates were found to be gram positive Studies show that gram positive bacteria have better biofilm forming ability.

CRA plate method : The CRA plate test was used to determine whether biofilm formation was occurring. The

usual colour variation from pink/red to black was used to examine and interpret the phenotypic development of slime by all isolates. Biofilm formers were represented by black colonies, whereas non-biofilm formers were represented by red colonies. Nine of the participants were biofilm makers, whereas the remainder were non-biofilm formers, according to the figure 1. Though CRA plate test is fast and easy to perform among the phenotypic methods, its sensitivity, specificity, and accuracy are low when compared to other qualitative and quantitative methods (Fitzpatri *et al.*, 2005).



Fig.-1 : Medium to jet black colonies indicate biofilm formers.

Microtitre plate assay : According to the results of the microtitre plate (MTP) assay, only a few isolates with OD values > 0.24 were strong biofilm formers, while the remainder were moderate and weak biofilm formers (with OD values between 0.12–0.24 and 0.12) (Fig. 2). Previous research on the MTP assay found that it produced more reliable and accurate findings when compared to qualitative tests like the CRA plate and test tube assay, which had previously been endorsed (Deighton and Balkau 1990).

Conclusion

The possibility for biofilm formation in fresh fruits and vegetables was investigated in this study. The findings show that the microbial flora associated with fresh fruits and vegetables is capable of biofilm formation, which is required for pathogenic strain pathogenicity. When compared to the CRGA methods, the MTP assay produced the most consistent findings. As a result, the current study's findings shed light on the possible hazard posed by the microbial flora of fresh fruits and vegetables. As a result, methodical and sanitary handling of fruits and vegetables is critical for assuring safe goods, and preventative measures must be created to prevent food safety threat.

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Movement of Salts in Soil Column as Affected by Different Sources of Organic Manures

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Abstract

A soil column study was conducted in the laboratory for assessing the effect of addition of spent wash lagoon dried and spent wash liquid in comparison with press mud on the movement of salts through soil column. The column study revealed that the SWS (L) recorded the highest effect on leaching of calcium, magnesium, sodium, chloride and sulphate. The maximum movement of salts in leachate was observed due to the addition of SWS (L) which was followed by SWL. The maximum movement of salts was observed in first leachate. However, minimum salts were observed in fourth leachate. The pH and EC of leachate decreased with increasing leachate number. The control and press mud treatments had equal effects on movement of salts. Amongst the cations calcium leached in higher amounts as compared with magnesium, sodium and potassium. The chlorides leached easily as compared with other anions from all the sources of organic manures.

Key words : Column study, movement of salts leaching

Introduction

The farmers adjoining sugar distilleries are using spent wash solid lagoon dried [SWS (L)] and spent wash liquid [SWL] in crop production without knowing their ill effects on soil physical properties. Research work on hydrological aspects of spent wash containing products is urgently needed.

Yadav (1989) observed that the Ca^{2+} , Mg^{2+} , Na^+ , K^+ , CO_3^{2-} , HCO_3^- , Cl^- and SO_4^{2-} and organic carbon content of top soil increased, but pH was decreased due to application of spent wash. Initial application of spent wash (2:1000) removed the native cations and anions from the soil. The maximum movement of ions through soil columns was observed from silty clay soil followed by gravelly loam and silty clay loam soil. The building of soil salinity was maximum in the silty clay loam soil and minimum in the gravelly loam soil. No research works on spent wash containing products in soil column seem to be reported in the literature. Quantification of nutrient movement and its accumulation from agricultural soils is, therefore, important for both fertilizer and environmental management (Shepherd and Bennett, 1998) in such scenarios; the effect of various sources of organic manures on the leaching losses of salts was studied in soil columns.

Materials and Methods

For the soil column study, one mm thick PVC pipes having 10 cm diameter and 50 cm length were used. The PVC pipe was fitted snugly into a cut (2.5 cm) at top portion of a

PVC bottle of the same diameter so that it served as an opening for collecting the leachate below the soil column. A piece of filter paper was placed at the bottom, over which 2.5 cm column of washed quartz sand and 45 cm column of soil (2.0 mm sieved) were successively placed. The quantity of soil (4.420 kg) required for column height of 45 cm to maintain 1.25 Mg cm^{-3} bulk density was calculated by using following formula:

$$r^2 \times h \times \text{B.D.}$$

$$= 3.1416$$

R = Radius of the column (5 cm)

H = Height of the column (45 cm)

B.D. = Bulk density (1.25 Mg cm^{-3})

At first 3.920 kg soil was weighed and transferred to the column. The soil in the column was compacted with hammer till the soil level of 40 cm was reached. To the remaining 500 g soil, the requisite amount at the rate of 1.5 per cent (w/w) of an organic source was mixed ($73.50 \text{ g of SWS (L) PM and FYM column}^{-1}$) and for SWL $250 \text{ mL SWL column}^{-1}$ was added. The mixed soil was transferred to the top of the soil column and compacted to upper 5 cm. The total height of the soil column thus 45 cm. The soil column thus prepared was placed in a plastic bucket contain water and was allowed to saturate by capillarity.

After equilibration of 48 hours, the column was leached with one litre water by constant head method (Klute and Dirksen, 1986). For this one litre volumetric flask filled with one liter mark with tap water was used.

Table-1 : Effect of sugarcane industrial byproducts and FYM on pH and EC of leachate.

Treatments	pH				EC (dS m ⁻¹)			
	Leachate number				Leachate number			
	1	2	3	4	1	2	3	4
Control (CK)	8.30	8.05	7.50	7.45	2.25 (1440) ^a	1.12 (717) (50) ^b	0.80 (512) (29)	0.75 (480) (06)
SWL	8.30	8.00	7.67	7.31	4.50 (2880)	2.01 (1286) (55)	1.34 (858) (33)	0.88 (563) (34)
SWS (L)	8.25	8.00	7.60	7.25	6.49 (4154)	4.75 (3040) (27)	3.73 (2387) (21)	2.82 (1805) (24)
PM	8.00	8.15	7.80	7.50	2.25 (1440)	1.30 (832) (42)	0.82 (525) (37)	0.64 (410) (22)
FYM	8.25	7.90	7.80	7.74	2.92 (1869)	2.19 (1402) (25)	0.95 (608) (57)	0.70 (448) (26)

Note* a = figures in parenthesis indicate salt concentration in ppm (EC X 640)

b = figures in parenthesis indicate percent decrease over successive leachate.

Table-2 : Effect of sugarcane industrial byproducts and FYM on calcium, magnesium, sodium and potassium content (me L⁻¹) in leachate.

Treatments	Calcium					Magnesium				
	Leachate number					Leachate number				
	1	2	3	4	Total	1	2	3	4	Total
Control (CK)	25.61	9.79	8.75	7.98	52.13	7.16	2.30	2.00	2.07	13.53
SWL	52.99	19.39	13.06	7.48	92.92	13.08	6.72	2.68	3.27	25.75
SWS (L)	75.15	61.82	52.42	34.3	223.69	13.74	12.10	5.76	8.20	39.80
PM	29.40	13.06	8.64	6.72	57.82	5.07	2.68	0.58	0.57	8.90
FYM	31.80	20.93	8.83	5.76	67.32	6.65	3.65	2.30	1.34	13.94
Treatments	Sodium					Potassium				
	1	2	3	4	Total	1	2	3	4	Total
	1	2	3	4	Total	1	2	3	4	Total
Control (CK)	10.10	2.70	3.00	2.38	18.18	0.143	0.146	0.072	0.062	0.423
SWL	13.06	3.28	5.46	4.59	26.39	0.167	0.082	0.053	0.040	0.342
SWS (L)	11.26	8.95	8.40	7.31	35.92	0.146	0.118	0.087	0.074	0.425
PM	8.50	2.81	3.99	3.57	18.87	0.115	0.062	0.043	0.041	0.261
FYM	9.52	3.31	4.83	3.40	21.06	0.133	0.112	0.043	0.038	0.283

The flask was inverted 2 cm height for maintaining constant head of water. The leachates were collected at 64 days at 16 days intervals for four times. Thus, there were four leachates.

The leachates were collected in one litre capacity bottles and were analyzed for pH, EC, cations and anions. The total soluble salts from EC of leachate were calculated by multiplying 640 of each leachate. The cations and anions were estimated by standard procedure as described by Page *et al.* (1982).

Results and Discussion

pH and EC : The pH of leachate decreased from first leachate to the fourth leachate in all the treatments (Table 1). At first leachate all the treatments recorded similar value of pH except PM. But there is a variation in pH at fourth leachate. The maximum decrease in pH at fourth leachate was recorded in SWS (L) treatment which might

be because of highly acidic nature of spent wash (pH 4.0). The decreased leachate pH values in the second, third and fourth collected leachate as compared with first leachate from organic manure amended soils may be due to the displacement of calcium, magnesium and sodium from soil colloids by the added source organic manures viz., FYM, PM SWS (L). The FYM treatment had decreased pH from 8.25 to 7.74 which is suitable for best crop growth. The decrease in pH was attributed to liberation of humic acid, fulvic acid and hymatomelonic acid.). The data on decreased leachate pH values, in all the collected leachate from all the amended sources of organic manures than those for control soil are in agreement with observation of Yadav (1989) and it must be due to displacement of acidity from soil colloids by the added dissolved salts through organic manures. Zhang *et al.* (2004) studied the effect of muck amended on leaching of minerals and heavy metals in sandy soil. They

Table-3 : Effect of sugarcane industrial byproducts and FYM on carbonate, bicarbonate, chloride and sulphate content (me L⁻¹) in leachate.

Treatments	Carbonates					Bicarbonates				
	Leachate number					Leachate number				
	1	2	3	4	Total	1	2	3	4	Total
Control (CK)	0.16	0.08	0.09	0.27	0.60	6.74	2.84	2.25	1.04	12.87
SWL	0.49	0.22	0.44	0.27	1.42	116.09	6.55	6.33	5.33	134.30
SWS (L)	0.26	0.22	0.22	0.77	1.47	6.90	3.52	4.07	3.58	18.07
PM	0.38	0.22	0.28	0.82	1.70	6.33	4.57	5.28	5.17	21.35
FYM	0.22	0.25	0.28	0.60	1.35	5.81	3.08	6.68	4.84	20.41
	Chlorides					Sulphates				
Control (CK)	22.62	6.82	6.09	1.27	36.80	2.73	3.79	3.50	2.51	12.53
SWL	59.70	8.80	10.12	2.20	80.32	2.37	7.88	7.28	6.20	23.73
SWS (L)	88.32	15.40	9.02	2.53	115.27	3.08	9.54	8.80	8.84	30.26
PM	22.16	3.96	6.38	1.76	34.26	2.77	4.417	4.20	4.09	15.53
FYM	24.06	10.56	8.80	1.65	45.07	3.46	5.41	5.15	5.09	19.11

observed that the leachate pH for all muck application rates was less than the control.

The EC values in the first leachate collected from the spent wash liquid and spent wash lagoon dried amended soils were relatively high as compared with FYM and PM and control treatments. The PM and control treatments recorded exactly similar values of EC in all the leachate. The EC was also decreased from first to fourth leachate (Table 1). With increase in number of leachate there was decrease in salts contents were observed in all treatments. This is because of the fact that the amount of salts was completely removed from soil. The higher drastic decrease in salt content was noticed between first and second leachate. The maximum decrease in EC (55 %) at second leachate as compared with first leachate was observed in SWL treatment. However, only 25 per cent decrease in EC was noticed in FYM treatment at second leachate as compared with first leaching. The PM and control treatments recorded the similar values of EC. A large variation in EC was recorded due to addition of sources of organic manures in the first leachate which was not observed in the fourth leachate. The amount of salts leached after the first and second leaching event was much higher as compared to third and fourth leaching. In general, the amount of salts leached after the fourth leaching were more or less similar in FYM, PM and control. In general, at second leachate the salts are leached half times as compared to first leachate. The lowest salts were leached out of the soil column after fourth leaching. The lowest salts were leached out of soil column after fourth leaching was no organic manures had been applied at all the leachate. The results showed that all the added salts through various sources were leached at fourth leaching. The EC concentrations in all the treatments were slightly higher to the original soil and it will come equally to original EC at fourth leaching except

SWS (L) treatment. It indicates that in inceptisol soil salts leaching did not seem too much problem as most of salts of organic manures application stayed within the rhizosphere zone after four succession leaching event even at SWL application. The amount of salts leached per column in all the treatments at fourth leaching was fairly constant except SWS (L) treatment. Broschat (1995) had also observed that salts (K) leaching remained relatively constant over time. After forth leaching, the value of EC in leached water was ranged from 0.70dS m⁻¹ in FYM to 0.88 dS m⁻¹ in SWL treatments.

Cation concentration : The concentration of Ca²⁺, Mg²⁺, Na⁺ and K⁺ were found to be higher in all the amended organic sources in inceptisol as compared with control (Table 2). The more or less exactly similar values of Ca²⁺, Na⁺ and K⁺ were observed in addition of PM and FYM at fourth leachate. After third leaching, the amount of K leached per column was fairly constant in PM, FYM and SWL treatments. It must be because of sorbed K⁺ was retained by non-specific exchange sites, which would be readily desorbed via cation exchange reactions, and potentially leached out from soil column. Broschat (1995) had also observed that potassium leaching remained constant over time. In every leachate the SWS (L) recorded the highest concentration of Ca²⁺, Mg²⁺, Na⁺ and K⁺ which was followed by SWL treatments. The order of movement of salts in soil column is as follows: SWS (L) > SWL > FYM > PM > Control. Results showed that the spent wash containing products removed higher amounts of salts from soil. The similar trend was also noticed in case of total concentration of all the cationic nutrients. The amount of K leached after the second leaching event was much higher as compared to first leaching. It must be because of release of fixed potassium. These results are in agreement with the observations of Sharma and Sharma (2011). Zhang *et al.* (2004) reported that the

concentration of Na^+ , Ca^{2+} , and K^+ in leachate from all the muck amended soils decreased to below 10 mg L^{-1} in the fourth leachate. Concentration of Ca^{2+} , Mg^{2+} , Na^+ and K^+ decreased from first to fourth leachate. The results suggested that the application of a spent wash containing substances viz., spent wash liquid (SWL) and spent wash lagoon dried SWL (L) were increased the salt concentration in water which may results water pollution. Similar values of Ca^{2+} , Na^+ and K^+ were observed in addition of PM and FYM at fourth leachate. In every leachate SWS (L) recorded the highest concentration of Ca^{2+} , Mg^{2+} and Na^+ and K^+ concentration and it was followed by SWL treatment. The similar trend was also observed in case of total concentration all the cationic nutrients. The movement of salts was generally related to the CEC of organic substances and soil type. The CEC of SWS (L), PM and FYM were 593.9, 37.6, and 69.1 $\text{cmol (p}^+ \text{) kg}^{-1}$. The use of SWS (L) has removed greater amounts of Ca^{++} , Mg^{++} and Na^+ from the soil column followed by SWL FYM, PM and control treatments. The PM amended to inceptisol had the least effect of Ca^{++} , Mg^{++} and Na^+ removal through soil column.

Anion concentration : The SWS (L) resulted in higher removal of Cl^- , and SO_4^{2-} whereas SWL and PM showed higher removal of CO_3^{2-} , and HCO_3^- respectively. The CO_3^{2-} , Cl^- , HCO_3^- , SO_4^{2-} concentrations were found to be higher in every leachate in SWS (L) amended soil column which was followed by spent wash liquid. The data indicates that by the addition of spent wash containing compounds removed the anions very rapidly as compared with PM, FYM and control treatments. The results suggests that application of spent wash containing products may increase the salt concentration in water which may cause water pollutions. The HCO_3^- , Cl^- , and SO_4^{2-} concentrations were declined markedly from first to fourth leachate suggesting that most of the salts in the SWS (L) were readily leached from the soil. The chloride concentration declined by 88.32 to 2.53 meq L^{-1} from first

to fourth leachate in SWS (L) amended soils more or less similar values of chloride concentration in all the leachate was reported in PM, FYM and control treatments. Amongst the anions chloride removed in large quantities as compared with carbonates bicarbonates and sulphates. The chloride moved down the depth of profile suggested that chloride ions are highly soluble which leached down with the water. These observations are supported by a number of investigators (Mian, et al., 1998).

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Studies on Population Build Up and Damage Potential of Major Stored Grain Insect Pest

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Abstract

Population build up and damage potential of major stored grain insect pests viz., *Caryedon serratus* (Oliver), *Callosobruchus analis*, *Rhyzopertha dominica* (F.) and *Sitophilus oryzae* (L.) was studied under laboratory condition. *C. serratus* caused a seed damage of 51.17, 96.67 and 100.00 per cent and weight loss of 10.83, 33.47 and 45.17 per cent after two, four and six months, respectively. In turn 85.67, 303.67 and 312.00 adults emerged after two, four and six months of storage, respectively. Groundnut was highly prone for the attack by *C. serratus* followed by pigeon pea to *C. analis* and least infestation was observed in paddy. Hence, proper care must be taken while storing these crops with timely interventions to manage these devastating pests.

Key words : Groundnut, sorghum, paddy, pigeonpea, storage insects, damage.

Introduction

Food grains produced are often stored for future needs, but due to improper handling and unscientific storage methods it has led to economic loss. Nearly 70 per cent of the grains annually produced in the country is retained by the farmers for their own food, cattle feed, seed etc. In storage the losses are mainly due to insects, mites and pathogens. The presence of insects in stored products has always posed unique problems as they cause both quantitative and qualitative loss and consumer tolerance towards insect pests in stored grains is zero (3). Adults crawl or fly through seams and folds or chew into sealed packages and multiply, diminishing the product quality and quantity. The type of pest observed on a stored product depends on the commodity, but some insects vary widely in their food preferences and may infest a wide range of commodities (7). In India, the annual storage loss of food grains was estimated as 13.98 million tonnes worth Indian Rupees 6845 crores every year (9). A recent study showed that 3.9-6.0 per cent cereals, 4.3-6.1 per cent pulses and 2.8-10.1 per cent oilseeds are lost during harvest, post-harvest operations, handling and storage in India (10). Hence the study was conducted to know the population build up and damage potential of major insects pests viz., *Caryedon serratus* (Oliver), *Callosobruchus analis*, *Rhyzopertha dominica* (F.) and *Sitophilus oryzae* (L.) under storage condition.

Materials and Methods

Various stored grain insect pests were collected from the infested lot of pigeon pea, paddy, sorghum and groundnut seeds from the central store of Main Agricultural Research Station, Raichur and the cultures of different insects were

further maintained in pre sanitized plastic container of two litre capacity separately on groundnut, paddy, pigeon pea and sorghum seeds. The containers were covered with muslin cloth and fastened tightly with the help of rubber band. Fresh seeds were provided regularly and exposed separately for the multiplication of insects at room condition. The insects emerged from this culture were reared throughout the period of experimentation and used for infestation during the experiments

Infestation free seeds of three kilogram of groundnut, paddy, pigeon pea and sorghum were sun dried and kept in hot air oven for two hours at 50°C to sterilize and make the sample free from previous infestation (6). Three plastic jar of one kilogram capacity were taken and one kilogram infestation free grains were filled in the jar and 20 adults were collected from stock culture and introduced into each jar.

The observations were recorded on per cent grain damage, population build up and weight loss of the seeds at bimonthly interval. Hundred seeds were drawn from each treatment at random seeds were sorted into damaged and undamaged seeds. Damage was worked out by counting number of damaged seeds.

Observation on per cent weight loss was recorded by counting number of un infested seeds and number of infested seeds. Weight loss was worked out by using the following formula

$$\text{Per cent weight loss} = \frac{(\text{Initial weight} - \text{Final weight})}{\text{Initial weight}} \times 100$$

The seeds were thoroughly mixed and samples of 100 seeds were drawn for five times from each bottle and

Table-1 : Damage potential of different stored grain insect pests (in percentage).

Treatments	2014 storage period (months)			2015 storage period (months)			Pooled storage period (months)		
	Two	Four	Six	Two	Four	Six	Two	Four	Six
Groundnut	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a
Groundnut + * <i>C. serratus</i>	24.33 (29.56) ^d	93.33 (75.11) ^e	100.00 (90.05) ^d	78.00 (62.43) ^d	100.00 (90.05) ^d	100.00 (90.05) ^d	51.17 (45.70) ^d	96.67 (79.55) ^e	100.00 (90.05) ^d
Paddy	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a
Paddy + <i>R. dominica</i>	2.33 (8.75) ^b	6.00 (14.06) ^b	24.67 (29.79) ^b	2.67 (9.27) ^b	12.33 (20.52) ^b	17.67 (24.78) ^b	2.50 (9.02) ^b	9.17 (17.59) ^b	21.17 (27.38) ^b
Pigeonpea	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a
Pigeonpea + <i>C. analis</i>	8.00 (16.36) ^c	28.33 (32.17) ^d	31.76 (34.26) ^c	8.00 (16.42) ^c	13.67 (21.69) ^b	22.00 (27.97) ^c	8.00 (16.39) ^c	21.00 (27.28) ^d	26.83 (31.21) ^c
Sorghum	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a
Sorghum + <i>S. oryzae</i>	7.00 (15.25) ^c	17.33 (24.56) ^c	31.00 (33.84) ^c	3.67 (10.87) ^{bc}	16.67 (24.09) ^c	23.00 (28.64) ^c	5.33 (13.32) ^c	17.00 (24.33) ^c	27.00 (31.31) ^c
S.Em±	0.70	0.68	0.32	1.57	0.50	0.72	0.79	0.46	0.44
CD @ 1%	2.94	2.86	1.33	6.61	2.09	3.03	3.33	1.93	1.87

*20 Adults were released; Figures in the parentheses are arcsine transformed values.

Table-2 : Weight loss caused by different stored grain insect pests (in percentage).

Treatments	2014 storage period (months)			2015 storage period (months)			Pooled storage period (months)		
	Two	Four	Six	Two	Four	Six	Two	Four	Six
Groundnut	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a
Groundnut + * <i>C. serratus</i>	13.80 (21.81) ^d	33.13 (35.16) ^d	47.73 (43.72) ^e	7.87 (15.47) ^c	33.80 (35.56) ^e	42.60 (40.76) ^d	10.83 (19.14) ^c	33.47 (35.36) ^d	45.17 (42.25) ^e
Paddy	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a
Paddy + <i>R. dominica</i>	1.27 (6.46) ^c	15.57 (23.25) ^c	16.73 (24.16) ^d	0.20 (2.51) ^{ab}	0.83 (5.23) ^b	3.00 (9.90) ^b	0.73 (4.91) ^b	8.20 (16.65) ^c	9.87 (18.31) ^d
Pigeonpea	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a
Pigeonpea + <i>C. analis</i>	0.47 (3.90) ^b	7.10 (14.31) ^b	11.43 (19.77) ^c	1.93 (7.98) ^b	3.00 (9.90) ^d	4.83 (12.69) ^c	1.20 (6.28) ^b	5.05 (12.57) ^b	8.13 (16.58) ^c
Sorghum	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a	0.00 (0.00) ^a
Sorghum + <i>S. oryzae</i>	1.73 (7.52) ^c	4.17 (11.78) ^b	6.67 (14.97) ^b	0.30 (3.14) ^{ab}	1.40 (6.77) ^c	2.93 (9.81) ^b	1.02 (5.76) ^b	2.78 (9.61) ^b	4.80 (12.65) ^b
S.Em±	0.29	1.49	0.14	1.38	0.25	0.62	0.53	0.83	0.33
CD @ 1%	1.22	6.28	0.61	5.81	1.06	2.61	2.23	3.49	1.39

*20 Adults were released; Figures in the parentheses are arcsine transformed values

then damaged seeds in 100 seeds were counted for each sample.

$$\text{Per cent damage} = \frac{\text{Number of damaged seeds}}{\text{Total number of seeds}} \times 100$$

The observation on population build up was recorded by counting the total number of adult beetles emerged from each crop separately for all the pests at bimonthly intervals.

Results and Discussion

Damage potential and population build-up of *C. serratus*,

R. dominica, *C. analis* and *S. oryzae* was studied on groundnut, paddy, pigeon pea and sorghum, respectively. The results of the experiment are presented here under.

Seeds were stored for six months and observation was made at bimonthly interval in treatments with and without release of known number of insects. Pooled results also showed that after two months of storage maximum damage of 51.17 per cent was recorded in groundnut with insect release which was significantly superior followed by pigeon pea (8%) and sorghum (5.33%) with insect release. Lowest damage was

Table-3 : Population build-up of insects on different stored grains (Number of adults emerged per kg seeds).

Treatments	2014 storage period (months)			2015 storage period (months)			Pooled storage period (months)		
	Two	Four	Six	Two	Four	Six	Two	Four	Six
Groundnut	0.00 (1.00) ^a	0.00 (1.00) ^a	0.00 (1.00) ^a	0.00 (1.00) ^a	0.00 (1.00) ^a	0.00 (1.00) ^a	0.00 (1.00) ^a	0.00 (1.00) ^a	0.00 (1.00) ^a
Groundnut+ * <i>C. serratus</i>	66.00 (8.15) ^d	253.67 (15.96) ^e	262.00 (16.22) ^d	105.33 (10.30) ^d	353.67 (18.83) ^e	362.00 (19.05) ^e	85.67 (9.30) ^d	303.67 (17.45) ^d	312.00 (17.69) ^e
Paddy	0.00 (1.00) ^a	0.00 (1.00) ^a	0.00 (1.00) ^a	0.00 (1.00) ^a	0.00 (1.00) ^a	0.00 (1.00) ^a	0.00 (1.00) ^a	0.00 (1.00) ^a	0.00 (1.00) ^a
Paddy + <i>R. dominica</i>	5.33 (2.46) ^b	25.33 (5.13) ^b	34.67 (5.97) ^b	9.67 (3.26) ^b	35.33 (6.02) ^c	44.67 (6.76) ^c	7.50 (2.89) ^b	30.33 (5.59) ^b	39.67 (6.38) ^c
Pigeonpea	0.00 (1.00) ^a	0.00 (1.00) ^a	0.00 (1.00) ^a	0.00 (1.00) ^a	0.00 (1.00) ^a	0.00 (1.00) ^a	0.00 (1.00) ^a	0.00 (1.00) ^a	0.00 (1.00) ^a
Pigeonpea + <i>C. analis</i>	14.33 (3.89) ^c	30.33 (5.59) ^c	35.67 (6.05) ^b	23.00 (4.89) ^c	30.33 (5.59) ^b	35.67 (6.05) ^b	18.67 (4.42) ^c	30.33 (5.59) ^b	35.67 (6.05) ^b
Sorghum	0.00 (1.00) ^a	0.00 (1.00) ^a	0.00 (1.00) ^a	0.00 (1.00) ^a	0.00 (1.00) ^a	0.00 (1.00) ^a	0.00 (1.00) ^a	0.00 (1.00) ^a	0.00 (1.00) ^a
Sorghum + <i>S. oryzae</i>	10.00 (3.31) ^{bc}	47.33 (6.95) ^d	59.00 (7.74) ^c	12.33 (3.64) ^b	57.33 (7.64) ^d	65.67 (8.16) ^d	11.17 (3.49) ^b	52.33 (7.30) ^c	62.33 (7.96) ^d
S.Em ±	0.23	0.08	0.10	0.12	0.07	0.06	0.15	0.08	0.07
CD @ 1%	0.98	0.35	0.41	0.52	0.32	0.24	0.62	0.33	0.29

*20 Adults were released; Figures in the parentheses are $\sqrt{x}$ 1 transformed values.

recorded in paddy with insect release (2.50%). No seed damage was recorded in unreleased treatments. Similarly after four months of storage least damage was recorded in paddy (9.17%) followed by sorghum (17.00%). Highest damage was observed in groundnut (96.67%) which was significantly superior, followed by pigeon pea (21.00%) (Table 1). No damage was recorded in unreleased treatments. After six months of storage cent per cent damage was observed in groundnut with insect release which was significantly superior over other treatments and no damage was observed in unreleased treatments. Hence a maximum seed damage of 51.17, 96.67, and 100.00 per cent was recorded in groundnut with insect release after two, four and six months, respectively which was significantly superior these results are in conformation with (12) who recorded 73 per cent pod damage in stored groundnut in Gujarat (11) reported under artificial infestation damage up to 90 per cent was caused by *C. serratus* on groundnuts within three months of storage. Similarly (8) also recorded pod damage caused by ten pairs of *C. serratus* on stored groundnut and observed 90 per cent damage after three months of storage.

Seeds were stored for six months and weight loss was recorded at bimonthly interval in treatments with and without release of known number of insects. Pooled results of weight loss when seeds were stored for a period of six months are presented below.

After two months of storage maximum weight loss of 10.83 per cent was recorded in groundnut with insect release which was significantly superior followed by

pigeon pea (1.20%) and sorghum (1.02%) with insect release. Lowest weight loss was recorded in paddy with insect release (0.73%). No weight loss was recorded when no insects were released. Similarly after four months of storage least weight loss was recorded in sorghum (2.78%) followed by pigeon pea (5.05%). Highest weight loss was observed in groundnut (33.47%) which was significantly superior (Table 2). No weight loss was recorded in unreleased treatments. After six months of storage 45.17 per cent weight loss was observed in groundnut with insect release which was significantly superior over other treatments and no weight loss was observed in treatments when no insects were released. Hence weight loss of 10.83, 33.47 and 45.17 per cent caused by *C. serratus* in groundnut with insect release after two, four and six months of storage, respectively are in conformation with (8) who recorded weight loss by ten pairs of *C. serratus* on stored groundnut up to 70.67 per cent after three months of storage (1) recorded weight loss of 15.9 per cent in groundnuts. Similarly Literature pertaining to damage and adult emergence in paddy is lacking however (2) reported that after six months of storage paddy recorded 3.03 per cent weight loss under storage condition.

Adults emerged from one kg seeds were recorded at bimonthly interval. Treatments included with and without release of known number of insects. Pooled results of adult emergence when seeds were stored for a period of six months are presented below.

After two months of storage maximum adult emergence of 85.67 were recorded in groundnut with

insect release which was significantly superior followed by pigeon pea (18.67) and sorghum (11.17) with insect release. Lowest adult emergence was recorded in paddy (7.50). No adult emergence was recorded unreleased treatments. Similarly after four months of storage least number of adults were recorded in paddy and pigeon pea (30.33) followed by sorghum (52.33). Highest number of adults was observed in groundnut (303.67) which was significantly superior (Table 3). No adult emergence was recorded in unreleased treatments. After six months of storage 312.00 adults were observed in groundnut with insect release which was significantly superior over other treatments and no adult emergence was observed in treatments when no insects were released. Hence a maximum of 85.67, 303.67 and 312.00 adult emergence which was recorded in groundnut with insect release after two, four and six months of storage are in agreement with (5) who noticed peak activity of *C. serratus* was noticed in the month of December with 24.3 adults per 500 g of sample (4) recorded an adult emergence of 138.8 after 72 days after storage.

Conclusion

Groundnut was highly prone for the attack by *C. serratus* followed by pigeon pea to *C. analis*. Hence, proper care must be taken while storing these crops with timely interventions to manage these devastating pests.

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Nutritional and Organoleptic Characteristics of Cookies Prepared from Sprouted Pea Flour Blends

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Abstract

The present investigation aimed to formulate and develop sprouted pea flour cookies by substituting refined wheat flour with pea flour to fight with malnutrition from cheap source as baked products for mankind at different levels (at 0, 05, 10, 15, 20 and 25%). Results indicated that the cookies prepared with 90% of refined wheat flour and 10% of sprouted pea flour (SPF) (T3) were most acceptable in view of sensory analysis. The carbohydrates, crude fat, fibre and energy value of treatment T1 was found maximum while protein, ash, Ca, P, Fe and moisture was found maximum in treatment T6. Blending of refined wheat flour with SPF upto 10% was most likely to be acceptable by panel.

Key words : SPF, composite flour, legumes and high nutritional value.

Introduction

Utilization of composite flour in formulation and development of various baked food products is an attractive approach to meet the global challenge of protein-calorie malnutrition.

The incorporation of composite flour into traditional refined wheat flour based food products provided farther nutrients from non-wheat material and improved the proximate, nutritional organoleptic value of the products De Ruiter D. (1978).

To overcome the protein calorie malnutrition and to increase intake of dietary protein in to the diet, the combination of cereal based products with legumes is of considerable importance (Kadam *et al.*, 2012). Legumes (the poor man's meat) play a vital role in human nutrition since they are rich sources of protein, fat, calories, certain minerals and vitamins etc. (Deshpande, 1992).

Peas are recognized as a low in fat (3%), high in protein (24%), carbohydrates (58%) and dietary fibre (12%) carrying food (Iqbal *et al.*, 2006). Pea containing a rich amount of vitamin A, vitamin C, vitamin B complex, iron, calcium, copper, zinc and manganese. No significant value of anti-metabolites or toxicity has been reported in pea (Garg *et al.*, 2015; Narayanan *et al.*, 2015). The pea flour and pea protein exhibits different functional properties like solubility, emulsifying and foaming properties, gelling ability and water holding capacity. These functional properties are desirable in different foods to increase stability and storage period (Ettoumi and Chibane, 2015).

Functional foods; foods and food components that provide a health benefit beyond basic nutrition (for the

intended population). For examples conventional foods; fortified, enriched or enhanced foods; and dietary supplements (MacAulay *et al.* 2005).

Cookies are admired for their taste, aroma, convenience, and long shelf stability, increasing consumer demand for healthier foods has triggered the development of cookies made with natural ingredients exhibiting functional or nutritional properties and providing specific health benefits beyond those to be gained from traditional nutrients Hai-Jung Chung (2007).

Materials and Methods

The present investigation was undertaken on "Nutritional and Organoleptic Characteristics of Cookies Prepared from Sprouted Pea Flour Blends" at MGCGVV, Chitrakoot, Satna (M.P.), INDIA.

Experimental materials : The wheat and pea was procured from the local market and all other ingredients (sugar, vegetable oil, glucose, ammonium bicarbonate, common salt sodium bicarbonate, vanilla and baking powder) were purchased from the retail market and department. The materials were transported to department.

Preparation cookies through selected wheat and pea sprouted grains

Processing of grains : The grains (wheat and pea) were washed and cleaned to remove the dirt, dust and foreign matter by winnowing.

Sprouting process : Wheat and pea grains were sprouted as described by (Murugkar, 2014)

Development and optimization of baked products (Cookies) : First of all studies were conducted to

Table-1 : Preparation and developed of products with Wheat and pea sprouts cookies.

S. No.	Treatments	Wheat	Ragi
1.	T ₁	100	-
2.	T ₂	95	5
3.	T ₃	90	10
4.	T ₄	85	15
5.	T ₅	80	20
6.	T ₆	75	25

standardize the formulation for the development of the different cereal-pulses based baked products (Cookies). Cookies were processed using the traditional creamery method described by Whitley (1970).

Proximates value :

Moisture : Moisture was analyzed using the MBS4 moisture analyzer at 100°C for 10 minutes. Protein, Fat, Carbohydrates and Ash content in the sample was estimated by the procedure indicated in the AOAC (1984).

Estimation of Minerals : Minerals content of cookies were estimated through the Gopalan table values (Gopalan *et al.* 2000).

Calorific Value : The total energy values were estimated with using the values of 4, 4, and 9 for protein, carbohydrate and fat respectively as follows: Total calorie (kcal/100g) = [(% available carbohydrates X4) + (% protein X4) + (% fat X9)].

Organoleptic value : The organoleptic qualities of nutritious cookies were evaluated by a nine point hedonic scale as indicated by the Amerine *et al.* (1965).

Statistical analysis : The data were subjected to analysis of variance (ANOVA). The Completely Randomized Design (CRD) at 5% level of significant.

Results and Discussion

Proximate composition of wheat and pea cookies (%)

Moisture content : Moisture content was highest in treatment T6 (3.60%) whereas lowest moisture content was found in treatment T2 (2.45%) are presented in Table-2. furthermore, cookies absorbed moisture content from surrounding atmosphere due to hygroscopic nature of wheat flour. Increases in moisture per cent of cookies during storage were reported by Butt *et al.*, (2004) and Sharif *et al.*, (2009).

Carbohydrates content : The maximum carbohydrates content was found to be in treatment T2 (65.02%) whereas the minimum carbohydrates content was found to be in treatment T6 (63.53%) are presented in Table 2. This might be due to the supplementation of legume and similar findings have been supported by Mahgoub (1999).

Protein content : The wheat and pea supplemented cookies ranged from 12.26 to 14.07 %. The maximum protein % of wheat and pea flour based cookies were in treatment T6 (14.07%) whereas minimum protein per cent of wheat and pea based cookies products was in treatment T2 (12.26%) are presented in Table 2. This could be due to the supplemental with the pulses findings have been given by Vardis and Trichopoulou *et al.*, (2009).

Fat content : The fat content of wheat based cookies is 19.55 per cent and that of wheat and pea cookies ranged from 17.90 to 19.11 per cent in 90 days storage period. The values of fat per cent reported in present study were more or less similar to the value reported by Curley (2008).

Fibre content : Maximum fibre content in treatment T6 (3.46%) whereas minimum fibre content was found to be in treatment T2 (3.17%). The mean fibre content of wheat and pea supplemented cookies were significantly higher than the treatment T1 cookies are presented in Table 2. Similar issues were reported by Tariqual *et al.*, (2007).

Ash content: - Cookies ranged from 1.95 to 2.31 per cent ash content. The ash content was higher in treatment T6 (2.31%) whereas lowest ash content was found to be in treatment T2 (1.95%) in Table 2. Similar findings were reported by Hahn *et al.*, (1990).

Energy value : Data depicted in Table-2 clearly shown the maximum energy value was found to be in treatment T2 (481.11 kCal) whereas the minimum energy value was found to be in treatment T6 (471.49 kCal). Addition of legume increased energy value of cookies and similar findings were recorded by Rana *et al.* (2015) and Thongram *et al.* (2016).

Mineral content (mg/100g) :

Calcium (Ca) : The calcium content was higher in treatment T6 (33.65 mg) whereas lowest calcium content was found to be in treatment T2 (24.62 mg) presented in Table 2. The result shows that supplemented of pea to the wheat improve their calcium content. Similar issues have been reported by Kanu *et al.*, (2009).

Phosphorous (P) : Maximum fibre content in treatment T6 (154.64 mg) whereas minimum fibre content was found to be in treatment T2 (120.60 mg). The mean phosphorous content of wheat and pea supplemented cookies was significantly higher than the control cookies are presented in Table-2. Similar work was carried out by Uthumporn *et al.*, (2015) and Nicole *et al.*, (2010).

Iron (Fe) : Data shown in the table-2 that the maximum energy value was found to be in treatment T6 (3.56 mg) whereas the highest iron content was found to be in

Table-2 : Proximate composition of wheat and pea blended cookies.

Treatment	Carbo-hydrates	Protien	Fat	Fibre	EV	Ash	Ca	P	Fe	Moisture
T ₁	65.65	11.90	19.21	3.11	408.28	1.99	21.45	112.57	2.56	2.45
T ₂	63.83	11.85	19.14	3.09	399.78	2.27	23.72	113.55	2.60	2.45
T ₃	62.08	11.96	19.02	2.95	391.09	2.37	26.62	116.69	2.68	2.70
T ₄	60.30	11.94	18.88	2.96	382.47	2.52	28.64	118.00	2.79	2.55
T ₅	58.89	11.88	18.52	2.92	374.81	2.70	30.45	120.93	2.85	2.95
T ₆	57.39	12.03	18.16	2.93	366.40	3.02	33.49	122.10	2.92	3.60
Sem	0.03	0.311	0.029	0.052	0.039	0.028	0.021	0.060	0.048	0.028
CD	0.09	0.959	0.088	0.162	0.120	0.087	0.065	0.186	0.148	0.088
CV	0.08	4.538	0.264	3.051	0.018	2.042	0.133	0.090	3.072	1.77
SIG	S	S	S	S	S	S	S	S	S	S

Table-3 : Sensory score combination of the wheat and pea cookies.

Treatment Mean	Appearance	Colour	Crispiness	Taste	Texture	Overall acceptability
T ₁	7.10	6.90	7.45	7.10	7.80	7.18
T ₂	7.10	7.25	7.25	7.25	7.30	7.32
T ₃	7.80	7.05	7.40	7.80	8.30	7.45
T ₄	7.00	6.85	6.85	6.90	6.70	6.86
T ₅	7.10	6.85	7.25	7.50	7.40	7.22
T ₆	7.20	6.95	6.75	7.20	6.80	7.02
Sem	0.030	0.034	0.035	0.030	0.035	0.035
CD	0.094	0.105	0.106	0.094	0.107	0.109
CV	0.729	0.847	0.836	0.722	0.813	0.851
SIG	NS	S	S	S	S	S

treatment T2 (2.66 mg). The iron content revealed that there is significant difference among the formulations. Results clearly showed that higher amount of pea flour substituted into formulation resulted in increased iron content in cookies. Similar findings were found in Uthumporn *et. al.*, (2015).

Organoleptic Analysis

Appearance : Sensory scores shown in table 3, of wheat and pea based cookies ranged from 6.15 to 7.15 in appearance. The maximum appearance was found to be in treatment T3 (7.15) whereas minimum appearance was found to be in treatment T4 (6.15). Appearance was found to be significantly lower in wheat based cookies as per Ganorkar and Jain (2014).

Colour : The maximum colour was found to be in treatment T3 (6.75) whereas minimum colour was found to be in treatment T4 (6.05). Colour was found to be significantly higher in wheat flour based cookies. The scores for colour recorded due to the Millard reaction Narender *et. al.*, (2007).

Crispiness : Sensory scores of wheat and pea based cookies ranged from 6.05 to 7.10 in crispiness. The maximum crispiness was found to be in treatment T3 (7.10) whereas minimum crispiness was found to be in treatment T4 (6.05). Crispiness was found to be significantly lower in wheat based cookies. Reduction in fat per cent had most significant effect over crispiness of cookies, as it becomes harder Srivastava and Rao (1993).

Taste : The maximum taste was found to be in treatment

T3 (7.50) whereas minimum taste was found to be in treatment T4 (6.10). Taste was found to be significantly lower in wheat based cookies. This might be halfway due to increase in moisture content during the storage and resultant hydrolytic and oxidative degradation changes during storage. Our results support the findings of other works Galla *et. al.* (2017).

Texture : The maximum texture was found to be in treatment T3 (7.25) whereas minimum texture was found to be in treatment T5 (7.50). Texture was found to be significantly lower in wheat based cookies. Aziah *et. al.*, (2012) found that texture of cookies become hard with incorporation if protein rich legume flour.

Overall Acceptability : The maximum overall acceptability was found to be in treatment T3 (7.15) whereas minimum overall acceptability was found to be in treatment T4 (6.06). Overall acceptability was found to be significantly lower in wheat based cookies, Padiyar (2010).

Conclusion and Future Scope

The present study revealed that cookies can be successfully formulated and developed by the substitution of RWF up to 25%. And T3 (RWF90 + SPF10%) shown best organoleptically. The Proximates of the standardized cookies in respect to protien, ash, moisture and minerals (calcium, phosphorus and iron) was superior to that of the control one (T1). The findings cleared that calorific value of cookies decreased with increased levels of SPF in cookies.

The investigation indented to develop the functional food fortified with wheat, ragi, green gram and

microgreens to enrich the nutritional value of baked products. This could make more acceptable for the consumers and feasible in context of marketing opportunities.

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Impact Assessment of GKY Training Programme on Socio-Economic Upliftment of Migrant Workers in Seoni District (M.P.)

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Abstract

To find out the impact of PM GKY scheme this study was conducted towards the mitigation of migration of labours during Covid-19 shock. KVK Seoni conducted 3 days off campus training on Mushroom production and it was found that nutritional profiles of mushroom, types of mushroom, raw material and value addition etc. The study revealed that 25.71 percent of the respondents were female whereas 74.28 percent were male. Information in context of occupational background revealed that 5.71 percent of the participants was involved in farming, 17.14 percent was housewife, 68.57 was labourer followed 8.57 percent of trainees belonged to both house wife and labourer background. Migrant labour got a handsome amount of net profit of 10000 to 10800 rupees per unit in a season after selling their mushroom. Use of Spent mushroom Substrate (SMS):- It has been observed that as regrettably many articles do not provide a specific reference to SMS.

Key words : BC ratio, covid-19 shock, mitigation of migration, mushroom, PM GKY Scheme and SMS.

Introduction

The Indian Prime Minister announced great lockdown in March 2020 had most likely triggered the biggest disruption of livelihoods in human history. News flashes in popular media-such as bustling cities coming to halt and the plight of migrant workers walking hundreds of miles on empty highways-made it abundantly clear that the COVID-19 pandemic would be a significant blow to the Indian economy.

In March 2020, Pradhan Mantri Garib Kalyan Yojana (PM-GKY) had been announced, with the INR 1.7 lac crore (about 25 billion US\$) COVID package was designed to help both rural and urban Indians deal with the pandemic shock. Since the COVID-19 pandemic resulted about 24% decline in Indian GDP during April-June 2020 quarter, the nation's agricultural and allied sector, somewhat surprisingly, seems to have done remarkably well during the same period (Varshney *et al.* 2020). This is clearly good news for the country—especially from the poverty and food security points of view—as almost two-third of Indians live in the rural areas and depend on agriculture and allied services for his or her livelihoods (Census, 2011).

Trainings and demonstrations are integral a part of KVK Extension System. KVK have dual role-one is training of farmers another is demonstration. KVK playing an important role in encouraging Schedule Caste landless rural women to take up simple and quick Income Generating Activity (IGA) from where they can earn additional income. Mushroom cultivation is a good enterprise for landless rural women as it is grown on

agricultural waste, require less land, and require short span of time to grow. White Button Mushroom (*Agaricus bisporus*) is very popular and alone shares about 95 per cent of the total mushroom production in the state, a large quantity (80%) is consumed as fresh and remaining is canned. It is grown on agriculture wastes like wheat straw, paddy straw etc. and these waste are available in huge amount in Seoni district of MP.

Mushroom cultivation will boost the socio-economic status of SC/ST farmers and farm women and resolve employment problems of both literate and illiterate. To find out the impact of any training programme a evaluation of what is being done is essential, on the basis of what necessary changes can be made to make the training programme more effective (Lal and Tandon, 2011). In vegetarians dominate country like India; attempt should be made to popularize a vegetable protein source like mushroom documented by Bahl (2000). Training programs play a pivotal role for enhancing the competence of extension functionaries' through diffusion of innovations at actual workplace (Meena and Singh, 2012).

Mushrooms are an excellent source of various vitamins like B, C and D, including niacin, riboflavin, thiamine, and folate, and trace minerals including potassium, phosphorus, calcium, magnesium, iron and copper. It has become one among few enterprises which rural women of both district has adopted in big way both at household level and as commercial enterprise as a source of income generation after the right dissemination of technology through KVK (Shahi *et al.*, 2018). A total of 35 migrant labours were selected from Pipariya village of

Table-1: Socio-economic status of mushroom trainees. n=35

Characteristics	Trainees	
	Numbers	%
Age		
Young ones (less than 30 years)	10.00	28.57
Medium (31 to 50 years)	17.00	48.57
Old (more than 50 years)	08.00	22.85
Sex		
Male	26.00	74.28
Female	09.00	25.71
Education		
Illiterate	03.00	8.57
Primary school	05.00	14.28
Middle school	19.00	54.28
High school	06.00	17.14
Higher secondary	02.00	05.71
Land Holding		
Landless	04.00	11.42
Marginal (less than 1 ha)	31.00	88.57
Big (More than 1 ha)	00.00	00.00
Occupation		
Farming	02.00	05.71
Vegetable selling	00.00	00.00
House wife	06.00	17.14
Labourer	24.00	68.57
House wife + Labourer	03.00	08.57

Kurai, Seoni district who have undergone through training on mushroom production techniques for 3 days. A questioner was developed covering background information

Materials and Methods

To find out the knowledge gained by the trainee and effectiveness of the training, a pre- and post evaluation was conducted to understand the knowledge level of the participants. To check the knowledge of the participants, a group of 13 questions associated with mushroom production, nutritive value, value added product from mushroom, harvesting and storage process etc. were prepared. Change in perception level was calculated from the difference of scores obtained in pre and post evaluation of the training. More emphasis would be done on the sensible aspects of production of *Pleurotus species* (Oyster Mushroom) the edible mushroom. And frequent visits to mushroom units were also conducted. Trainees were interacted personally for their feedback with respect to training. The feedbacks were taken from the women farmers after a month of coaching regarding mushroom unit established reception scale and whether the farm women will continue the enterprises. Benefit cost ratio analysis: - To assess the economics of crops/farming system benefit cost ratio analysis is a crucial tool. It's the ratio of Gross return (B) and price of production (A) as mentioned in table 4. $BCR = \text{Gross return (B)} / \text{Cost of production (A)}$. Alongside knowledge of mushroom

production the SMS should even be used as source or input to maximise the use of it.

The major outcome of any training programme were gain in knowledge, gain in skill acquired and ultimately in additional adoption of the technology. A crucial indicator of the impact of the GKRY training programme is that the extent, to which they need, adopted the actual technology i.e. vertical and horizontal spread of the technology. KVKs are being conducting long and short duration training on mushroom production both to rural youth and rural women. Mushroom production has become one among few enterprises which rural women of both the district has adopted as commercial enterprise and as a source of income generation after the right dissemination of technology through KVK.

Results and Discussion

It was studied that nutritional importance of mushroom, sorts of mushroom, staple , mushroom Spawn, importance of Casing, required humidity and temperature for fruiting, harvesting methodology, preservation techniques, marketing channels, awareness and availability of loans and subsidies from the both central and state governments and mushroom recipes. It's going to therefore, be concluded that trainees succeeded in acquiring knowledge after manifestation to training on mushroom production. Thus, it are often inferred that exposure to training had increased the knowledge of respondents regarding all the sub-components of mushroom production.

Socio-economic profile : The participants differed in their socio-economic traits supported education, age, sex, occupation, landholding and annual income etc (Table-1). The results revealed that 25.71 per cent of the participants were female whereas 74.28 percent were male. The age of participants was ranged between 17 to 56 years. Information with reference to caste showed that 62.85 per cent of the participants belong to ST Caste followed by Scheduled caste (37.14%). Assessment of the trainees with reference to education indicated that among the 35 participants 8.57 it had been illiterate, 54.28 per cent studied up to secondary school, 17.17 percent high school level and followed by senior secondary (5.715%). Information in context of occupational background revealed that 5.71 percent of the participants was involved in farming, 17.14 percent was housewife, 68.57 was labourer followed 8.57 percent of trainees belonged to both house wife and labourer background. The socio-economic traits impacting the adoption of mushroom cultivation enterprise weren't according to each other. Age has no significant relationship in adoption of mushroom cultivation.

Table-2 : Gain in knowledge after GKY training.

n=35

S. No.	Parameters	Pre-intervention (%)	Post- intervention (%)	Gap in knowledge
1.	Varieties and types of mushrooms	17.14	100.00	82.86
2.	Knowledge about identification of good quality / edible type of mushrooms	31.42	100.00	68.58
3.	Knowledge about diseases controlled by consumption of mushroom	08.57	98.50	89.93
4.	Nutritive value of mushroom	11.42	98.00	86.58
5.	Diseases/pest of mushrooms and its control	02.85	99.10	96.25
6.	Market price and Profit from mushroom	17.14	95.60	78.46
7.	Method of compost /straw making	22.85	97.50	74.65
8.	Mushroom spawn and inoculation	08.57	96.10	87.53
9.	Method of preparation of casing	02.85	95.60	92.75
10.	Techniques of Storage and harvesting	42.85	100.00	57.15
11.	Processing and Value addition to mushroom	11.42	100.00	88.58
12.	Period of oyster mushroom production	05.71	98.22	92.51
13.	SMS and its use	02.85	98.25	95.40

Table-3 : Suggestions received from trainees.

n=35

S. No.	Suggestions	Frequency	Percentage	Ranks
1.	Much importance to practical classes	27	77.14	III
2.	Regular supply of spawn	30	85.71	I
3.	Supply printed literatures like booklets/guide book	19	54.28	V
4.	Publicity of nutritional benefits of mushroom in rural/urban areas	22	62.85	IV
5.	Linkages with banks and other government specially for financial assistance	31	88.57	II
6.	To increase training days	26	74.28	VII
7.	Conduct training at different out stations for better exposure	29	82.85	VI
8.	Utilization of spent mushroom in different way	11	31.42	VII

Table-4 : B : C Ratio.

Year	Particulars	Yield (Kg/bag)	Cost of production Rs./ 50 Bags (A)	Gross return Rs./unit (B)	Net profit Rs/unit (C)	B : C Ratio
2020	Oyster mushroom cultivation	3.0 Kg fresh mushroom	1400	12200	10800	8.71

Migrant labour got an honest amount of net income of 10000 to 10800 rupees per unit during a season after selling their mushroom against the value of production Rs/ 50 bags viz 1400 and gross return Rs/unit 12200 rupees with B: C Ratio-8.71 at the rate of 200 INRs per kg and 800 INRs per kg (dried form) in local and adjoining markets.

The suggestions offered by the mushroom trainees as feedback for further improvement of the training course were confirmed that more importance must tend to the regular supply of excellent quality spawn (85.71%), Linkages with banks and other government offices engaged in rural development for especially for financial assistance (88.57%), supply of mushroom literature, (54.28%). 74.28 per cent trainees also suggested on increase in duration of coaching , while 82.85 per cent were in favour of organizing training at different out

stations for better exposure. 31.42% of the respondent shown gave the suggestion for utilization of SMS.

Use of Spent mushroom Substrate (SMS) : SMS also had been used for Bioremediation : is that the use of living to get rid of or neutralize unwanted contaminants in air, soil, or water. Pesticides: - The SMS of *Lentinula edodes* has been assessed for degradation of metalaxyl, benalaxyl, penconazole, tebuconazole, pyrimethanil, cyprodinil, iprovalicarb, and azoxystrobin etc.

Crop Production : Spent *Agaricus* compost is often wont to supplement the nutrient requirements of plants.

Greenhouse Crops : SMS has been evaluated for the assembly of varied greenhouse flowers and vegetable. Field Crops: - Large acreage crops are evaluated with *Agaricus bisporus* spent substrate.

Nursery and Landscape : usage in grass seed

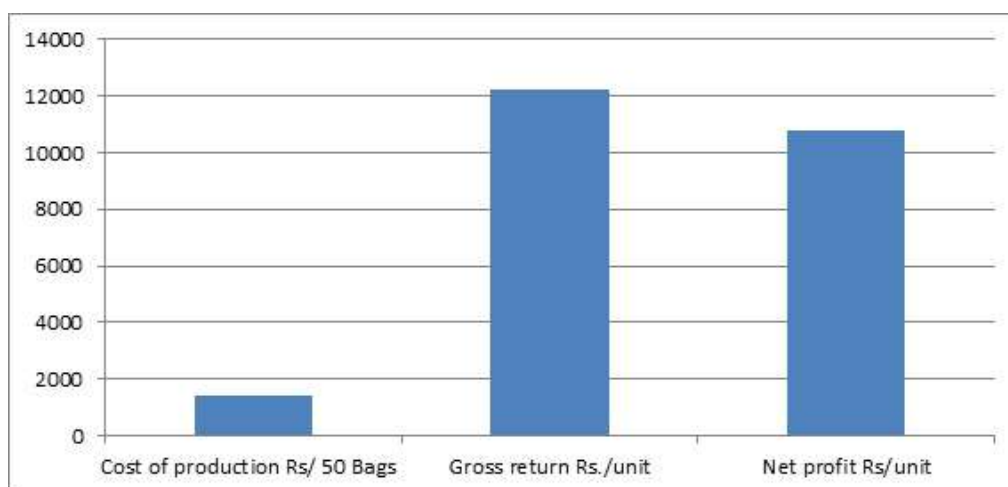


Fig.-1 : B : C Ratio.



Training conducted at village



Spawning during training



Filling bags tying



Filled bags



Bloom of oyster mushroom



Bloom of oyster mushroom

germination or turf also explored the utilization *Pleurotus* spp. spent substrate in nursery crops.

Reuse within the Cultivation of Mushrooms : Food and feed for Animals and Fish : as proteinaceous and therefore the substrate formulations may include cereal straws t are components of animal and carps diets.

Disease Management : including apple scab, damping-off and plant disease of creeping bent *Pythium* Damping-off disease of tomatoes, dry bubble disease in commercial mushrooms, and wilt of tomato.

Miscellaneous Uses : Renewable Energy : SMS has been evaluated as a source of biogas. *Lentinula edodes* spent substrate has been tested as an alternate fuel. *Agaricus bisporus* spent substrate had been used as chars and activated charcoal, airlift bioreactor (Rinker D L. 2017.)

Conclusion

The econometric analyses of the impact of PM-GKY also offer some important insights in terms of both income generation and nutritional security for migrant labours. Mushroom production is such an enterprise during which need of land isn't an enormous issue so even landless farmers. A good amount of net profit of 10000 to 10800 rupees per unit in a season after selling their mushroom against the Cost of production with the B: C Ratio-8.71 now labours of the village are interested to opt out mushroom cultivation as a major income generating activity throughout the year due to its regular demand. The result of this study clearly reflects that the off campus training programme can make available needed information and guidance to the migrant labour, rural unemployed farm women to start and flourish any agricultural enterprise. And combat with the migration of the seasonal labour. It has also been observed that spent mushroom Substrate (SMS) a waste material can be reused in various means.

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Evaluation of Establishment Methods and Nutrient Management Practices on Yield and Economics of Rice

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Abstract

A Field experiment was laid during kharif and rabi seasons of 2011-12 and 2012-13 at Indian Institute of Rice Research, Hyderabad. The treatment consisted of four establishment methods i.e., system of rice intensification (SRI), modified drumseeder (25X25cm spacing), normal drumseeder and normal transplanting in main plots and four nutrient management practices i.e., 100 % RDN (recommended dose of nitrogen) through inorganic, 75 % RDN through inorganic+ 25% RDN through organic, 50 % RDN through inorganic + 50% RDN through organic and 100 % RDN through organic in sub plots. Experimental results revealed that significant increase in grain and straw yield was observed with SRI followed by modified drum seeder, normal drumseeder and normal transplanting. During all the seasons of experiment.SRI registered significantly higher gross returns, net returns and benefit cost ratio over other establishment practicesand it was followed by modified drumseeder during both the years of study.Under different nutrient management practices 50% inorganic + 50% organic treatment registered higher grain and straw yield as compared to all other nutrient management practices during all the seasons of data. The data on economics revealed that 50% inorganic + 50% organic treatment recorded higher gross returns but net returns and benefit cost ratio was higher with 100% inorganic treatment. Sri in combination with 100% inorganic treatment recorded highest net returns.

Key words : SRI, modified drumseeder, INM, B:C ratio, economics

Introduction

Among the cereals, rice (*Oryza sativa* L.) is the major source of calories for 40 % of the world population (Baishya *et al.*, 2015). Rice is the staple food for a large part of the human population and supplies as much as half of the daily calories of the world population (Abbasi *et al.*, 2011). Annually in India, around 120 million tonnes of rice is produced in an area of 44 million hectares with a productivity of over two tonnes per hectare of milled rice.

About 77% of the global rice production in the world is done by conventional transplanting method in puddled soil (Chakraborty *et al.*, 2017) (Xu *et al.*, 2019). Conventional transplanting system of rice crop production requires labour, water, capital, and energy in large amount so that it has become less profitable at present due to the lack of these resources (Guruprem *et al.*, 2017). Transplanting takes roughly 25 per cent of the total labour requirement of the crop. A shortage of labour during peak period causes delayed transplanting, it leads to increasing transplanting shock and lower productivity. Decreased availability and increasing cost of labour have increased the cost of rice cultivation through conventional methods. All these factors demand a major shift from

puddle transplanted rice production to direct seeding of rice.

Direct seeding on puddled soil avoids drudgery of nursery raising and transplanting. It saves time and investment compared to transplanting. Absence of nursery management, rapid and easy sowing, reduced labour requirement, increased water use efficiency, lower methane emission and higher profit are the advantages of wet direct seeding over transplanted rice (Chauhan *et al.*, 2012). Direct seeded rice matures 1-2 weeks before transplanted rice, thus reducing the risk of terminal drought and allowing earlier planting of a following non-rice crop (Rana *et al.*, 2014).

In India after green revolution cultivation of high yielding dwarf varieties took place. These HYVs are responsive to fertilizer. To meet the nutrient needs of these high yielding varieties farmers become depended on application of chemical fertilizers. Rice yield and biomass increased rapidly due to increased use of chemical fertilizers (Ghosh *et al.*, 2013). Excess use of inorganic fertilizers has depleted the inherent soil fertility (Mahmud *et al.*, 2017). The decline or stagnation in yield has been observed in spite of consumption of increased

Table-1 : Grain yield (kg ha⁻¹) as influenced by establishment methods and nutrient management practices.

Treatments	Kharif			Rabi		
MAIN PLOTS	2011	2012	Pooled	2011	2012	Pooled
M1 (SRI)	6140	6535	6338	6438	6645	6541
M2 (Modified Drum seeder)	5356	6244	5800	5859	6287	6073
M3 (Normal Drum Seeder)	5084	5635	5359	5392	6090	5741
M4 (NTP)	4944	5468	5206	5356	6025	5690
S.Em±	137	138	34	112	117	47
C.D. (p=0.05)	475	477	117	388	405	162
SUBPLOTS						
N1 (100% Inorg)	5363	6124	5743	5898	6408	6153
N2 (75% Inorg+25% org)	5300	5827	5563	5591	6203	5897
N3 (50% Inorg+50% org)	5693	6383	6038	6033	6457	6245
N4 (100%org)	5168	5547	5358	5523	5980	5751
S.Em±	107	92	67	108	106	86
C.D. (p=0.05)	311	269	196	316	309	252
GENERAL MEAN	5381	5970	5676	5761	6262	6011
INTERACTIONS						
Sub at same level of Main						
S.Em±	213	185	134	216	211	173
CD (p=0.05)	622	539	391	631	617	505
Main at same level of Sub						
S.Em±	230	211	121	218	217	157
CD (p=0.05)	716	665	358	669	668	465

rate of chemical fertilizers. Results of the long-term experiments all over India revealed that a decrease in rice productivity due to continuous use of chemical fertilizers (Baishya *et al.*, 2015). Organics can improve yield and nutrient use efficiency of rice (Singh and Kumar, 2014). Nutrients demand at the peak period can be met through organics. Organics also provides micro nutrients and modify soil-physical behavior as well as increase the efficiency of applied nutrients. The combination of organic and inorganic fertilizers has been reported not only to meet the nutrients need of the crop but also helps to maintain the sustainability of the system to attain productivity goals (Yadav and Meena, 2014).

Materials and Methods

The present investigation was under taken during kharif and rabi seasons of 2011-12 and 2012-13at Indian Institute of Rice Research (formerly Directorate of Rice Research) farm, Rajendranagar, Hyderabad. The farm is geographically situated at an altitude of 542.7 m above mean sea level on 17° 19' N latitude and 78° 29' E longitudes. According to Troll's climatic classification, it falls under semi-arid tropics (SAT). The soil was clay loam, alkaline in reaction (pH 8.0 -8.2), with 0.48-0.52% of organic matter, 210-223 kg ha⁻¹ of available nitrogen, 39-43 kg ha⁻¹ of available P and 525-542 kg ha⁻¹ of available K. The experiment was laid out in split plot

design with 12 treatment combinations and three replications. The treatment combinations consisted of four establishment methods i.e., system of rice intensification(SRI) (M₁), modified drumseeder (25X25cm spacing)(M₂), normal drumseeder (M₃) and normal transplanting(NTP) (M₄) in mainplots and four nutrient management practices i.e., 100 % RDN (recommended dose of nitrogen) through inorganic(N₁), 75 % RDN through inorganic+ 25% RDN through organic(N₂), 50 % RDN through inorganic + 50% RDN through organic(N₃) and 100 % RDN through organic(N₄) in sub plots. In normal drumseeders, the spacing will be 20 X 5-8 cm. By making some alterations modified drumseeder was fabricated with spacing of 25 X 25 cmfor this study to test the wider spacing efficiency in direct seeding.The high yielding, semi dwarf rice variety Sampadha, having crop duration of 135 days with yield potential of 5.8-6.8 t ha⁻¹was grown in the experimental site. The recommended dose of fertilizer was 120 Kg N: 60 Kg P₂O₅: 40 Kg K₂O ha⁻¹. In case of 100% inorganic treatment nitrogen was applied through urea in three equal splits as ½ as basal, ¼ at maximum tillering and ¼ at panicle initiation stage. In INM treatments inorganic source of nitrogen was applied through urea in three equal splits at basal, 30 DAT (days after transplanting) and at 60 DAT. The organic source of nitrogen was applied based on the nitrogen equivalent of vermicompostas basal. In case of

Table-1a : Interaction of crop establishment methods and nutrient management practices on grain yield (kg ha⁻¹).

Establishment methods	Kharif 2011					Kharif 2012					Kharif pooled mean				
	N ₁	N ₂	N ₃	N ₄	Mean	N ₁	N ₂	N ₃	N ₄	MEAN	N ₁	N ₂	N ₃	N ₄	MEAN
M1-SRI	6292	6092	6762	5414	6140	6974	6821	6523	5822	6535	6556	6307	6868	5618	6337
M2-Modified drum seeder	5482	4942	5749	5249	5356	6643	6625	5872	583	6244	6053	5407	6196	5542	5799
M3-Normal drum seeder	4753	5451	4910	5222	5084	6221	5929	5539	4851	5635	5341	5494	5565	5036	5359
M4-NTP	4923	4714	5351	4787	4944	5695	5121	5375	5681	5468	5022	5044	5522	5233	5205
MEAN	5363	5300	5693	5168		6383	6124	5827	5547		5743	5563	6038	5357	
	S.E.m±					S.E.m±					S.E.m±				
	(p=0.05)					(p=0.05)					(p=0.05)				
Sub at same level of main	213		622			185		539			134		391		
Main at same level of sub	230		716			211		665			121		358		
Contd....															
Establishment methods	Rabi 2011-12					Rabi 2012-13					Rabi pooled mean				
	N ₁	N ₂	N ₃	N ₄	MEAN	N ₁	N ₂	N ₃	N ₄	MEAN	N ₁	N ₂	N ₃	N ₄	MEAN
M1-SRI	6534	6310	7090	5817	6438	7058	6646	7073	5801	6645	6796	6478	7081	5809	6541
M2-Modified drum seeder	6079	6018	6055	5283	5859	6363	6041	6603	6141	6287	6220	6029	6329	5711	6072
M3-Normal drum seeder	5416	4953	5315	5882	5392	6433	5995	6023	5907	6090	5924	5474	5669	5894	5740
M4-NTP	5562	5082	5670	5109	5356	5777	6128	6127	6069	6025	5669	5604	5898	5589	5690
MEAN	5898	5591	6033	5523		6408	6203	6457	5980		6152	5896	6244	5751	
	S.E.m±					S.E.m±					S.E.m±				
	(p=0.05)					(p=0.05)					(p=0.05)				
Sub at same level of main	216		631			211		617			173		505		
Main at same level of sub	218		669			217		668			157		465		

direct seeding sprouted seeds were sown on thoroughly puddled and well leveled main field. On the same day the sprouted seeds were broadcasted uniformly on well prepared nursery bed for NTP and SRI.

Grain yield : The higher grain yield was recorded by SRI method during both the years. Parameswari and Srinivas (2017), Chandankute *et al.*, (2015), Midya *et al.*, (2021), Nahar *et al.*, (2017) observed the same results. Next to SRI method modified drum seeder proved its significant superiority over normal drum seeder and normal transplanting. These results were in accordance with the findings of Upendrarao *et al.*, (2020); Pramod *et al.*, (2021). During 2011 kharif modified drum seeder remained at par with normal drum seeder but was found significantly superior over normal transplanting normal drum seeder (Table-1). The pooled data also indicated the same trend. In terms of percentage increase SRI recorded 12.76%, 4.45%, 9.00% and 5.40% higher grain yield during kharif 2011, kharif 2012, rabi 2011-12 and rabi 2012-13 seasons respectively over modified drum seeder.

The yield advantage due to SRI over conventional planting was mainly due to planting of young seedlings of 12 days in main field with immediate establishment have facilitated early initiation of tillers. It is evident that highest tillers production was observed with SRI planting. Controlled irrigation also augmented the fresh root production till flowering stage and does helped in supplementation of nutrient requires for supporting of filling capacity of panicles.

Among the subplots 50% RDN through inorganic + 50% RDN through organic proved its superiority during all the seasons of experiment. During first kharif season 50% RDN through inorganic+ 50% RDN through organic remained at par with 100% RDN through inorganic. But 2012 kharif data and the kharif pooled data indicated the significant superiority of 50% RDN through inorganic + 50% RDN through organic source. Both the rabi seasons data revealed that 50% RDN through inorganic + 50% RDN through organic was on par with 100% RDN through inorganic and found significantly better over remaining other treatments. The results emphasize the concepts of INM for high grain production and also sustainability of soil fertility. Similar findings have also been reported by Amanullah and Hidayatullah (2016) and Meher Malika *et al.*, (2015). During all the seasons 100% organic treatment recorded lowest grain yield (Howida Elhabe, 2018). The interaction effect of planting methods and nutrient management practices on grain yield (Table-1a) during all the seasons of study was found to be significant. SRI in combination with 50% RDN

Table-2 : Straw yield (kg ha⁻¹) of rice as influenced by establishment methods and nutrient management practices means.

MAIN PLOTS	Kharif			Rabi		
	2011	2012	Pooled	2011	2012	Pooled
M1 (SRI)	7188.08	7542.75	7365.42	7342.08	7652.58	7497.33
M2 (Modified Drum Seeder)	6109.92	6956.08	6533.00	6679.17	7121.67	6900.42
M3 (Normal Drum Seeder)	5793.08	6480.75	6136.92	6083.42	6539.33	6311.38
M4 (NTP)	5278.08	5974.58	5626.33	5759.00	6302.17	6030.58
S.Em±	140.83	185.79	123.59	155.42	195.07	126.46
C.D. (p=0.05)	487.35	642.92	427.68	537.81	675.04	437.62
SUBPLOTS						
N1 (100% Inorg)	6138.33	6922.25	6530.29	6588.42	7044.25	6816.33
N2 (75% Inorg+25% org)	5996.17	6545.25	6270.71	6313.42	6749.17	6531.29
N3 (50% Inorg+50% org)	6617.25	7393.67	7005.46	7026.00	7486.33	7256.17
N4 (100%org)	5617.42	6093.00	5855.21	5935.83	6336.00	6135.92
S.Em±	131.83	158.55	92.02	147.15	170.44	106.65
C.D. (p=0.05)	384.78	462.77	268.58	429.50	497.49	311.28
General Mean	6092.29	6738.54	6415.42	6465.92	6903.94	6684.93
INTERACTIONS						
Sub at same level of Main						
S.Em±	263.66	317.10	184.04	294.30	340.89	213.30
CD (p=0.05)	NS	NS	NS	NS	NS	NS
Main at same level of Sub						
S.Em±	268.28	331.56	201.68	298.52	353.85	223.86
CD (p=0.05)	NS	NS	NS	NS	NS	NS

through inorganic source + 50% RDN through organic source recorded significantly higher grain yield over other establishment and nutrient combinations during all the seasons of experiment.

Straw yield (kg ha⁻¹) : Straw yield of rice was significantly higher in SRI and during kharif and rabi seasons. It is in conformity with Midya *et al.*, (2021). During second year kharif and rabi seasons it was significantly on par with modified drum seeder treatment (Table-2). During all the seasons straw yield recorded by modified drum seeder was statistically on par with normal drum seeder. By observing the data of all the four seasons it was witnessed that wider spacing treatments recorded higher straw yield as compared to closer spacing treatments. It was probably due to more dry matter production per unit area caused by better nutrient absorption from soil, increased rate of metabolic processes, higher rate of light absorption and increased rate of photosynthetic activity that produced higher plant height and leaf area index as compared to normal transplanting. These results are in accordance with the findings of Upendrarao *et al.*, (2020), Pramod *et al.* (2021), Nahar *et al.*, (2017). During all the four seasons and in pooled means highest straw yield was observed with treatment 50% RDN through inorganic source + 50% RDN through organic source. The superiority of this treatment was because of adequate supply of nitrogen throughout crop growth period that led to higher dry matter production (MeherMalika *et al.*, 2015). The lowest straw yield was found with treatment 100% organic during all the seasons. Howida Elhabe, 2018 also recorded similar results.

Gross returns (ha⁻¹) : SRI recorded significantly higher gross returns during both the years of study and in pooled means. This was due to higher grain and straw yield obtained in SRI. These results could be substantiated with the findings of Midya *et al.*, (2021), Chandankute *et al.*, (2015), Jagadish Kumar *et al.*, (2010) and Singh *et al.*, (2009).

Application of 50% RDN through inorganic + 50% RDN through organic treatments recorded significantly higher gross returns as compared to other nitrogen management practices. Higher gross returns with 50% RDN through inorganic source + 50% RDN through organic source attributed to higher grain and straw yield during both the years of study. Midya *et al.*, (2021) also found similar results. The lowest gross return was observed with 100% RDN through organic source.

Net returns (ha⁻¹) : During all the seasons and in pooled means, system of rice intensification recorded significantly higher net returns (32236, 36927, 44447 and 47405 ha⁻¹, during kharif 2011, kharif 2012, rabi 2011-12, rabi 2012-13, respectively) as compared to other establishment methods. This was mainly due to higher grain and straw yield obtained had resulted the higher net returns in SRI over other establishment methods. Similar results were also observed earlier by Midya *et al.*, (2021), Mohanty *et al.*, (2014), Islam and Kalita (2016), Chandankute *et al.*, (2015).

The net returns registered significantly higher in 100% RDN through inorganic practice than other nitrogen management practices during both the years of study. It

Table-3 : Gross income, net income (Rs. ha⁻¹) and Benefit cost ratio as influenced by establishment methods and nutrient management practices.

Treatments	Net income (Rs. ha ⁻¹)				Gross income (Rs. ha ⁻¹)				Benefit cost ratio			
	Kharif		Rabi		Kharif		Rabi		Kharif		Rabi	
	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012	2011	2012
MAIN PLOTS												
M1 (SRI)	32236	36927	34582	44447	47405	45926	74938	79629	77284	89283	92241	90762
M2 (Modified Drum Seeder)	27911	38520	33215	42124	48004	45064	65173	75782	70477	81249	87129	84189
M3 (Normal Drum Seeder)	22818	29590	26204	33701	42974	38338	61860	68632	65246	74695	83968	79331
haM4 (NTP)	17713	24212	20963	29747	38764	34255	59725	66224	62975	73859	82876	78367
S.E.m±	-	-	-	-	-	-	-	-	-	-	-	-
C.D. (p=0.05)	-	-	-	-	-	-	-	-	-	-	-	-
SUBPLOTS												
N1 (100% Inorg)	30906	40069	35488	45533	52453	48993	65283	74446	69864	81628	88548	85088
N2 (75% Inorg+25% org)	26896	33053	29875	37838	46008	41923	64432	70789	67610	77460	85630	81545
N3 (50% Inorg+50% org)	28331	36716	32524	40690	46541	43616	69425	77811	73618	83838	89690	86764
N4 (100%org)	14745	19410	17078	25958	32145	29051	62556	67222	64889	76159	82347	79253
S.E.m±	-	-	-	-	-	-	-	-	-	-	-	-
C.D(p=0.05)	-	-	-	-	-	-	-	-	-	-	-	-
INTERACTIONS												
Sub at same level of Main	-	-	-	-	-	-	-	-	-	-	-	-
S.E.m±	-	-	-	-	-	-	-	-	-	-	-	-
CD (p=0.05)	-	-	-	-	-	-	-	-	-	-	-	-
Main at same level of Sub	-	-	-	-	-	-	-	-	-	-	-	-
S.E.m±	-	-	-	-	-	-	-	-	-	-	-	-
CD (p=0.05)	-	-	-	-	-	-	-	-	-	-	-	-

may be attributed to less input cost and more economic efficiency and was in accordance with results of Jat *et al.*, (2015). The lowest net returns were found with 100% RDN through organic practice (14745, 19410, 25958 and 32145 ha⁻¹ during kharif 2011, kharif 2012, rabi 2011-12, rabi 2012-13, respectively). These findings were in accordance with the Mohanty *et al.*, (2014). This was mainly due to higher cost of cultivation in 100% RDN through inorganic practice.

Benefit cost ratio : Establishment methods differed with respect to benefitcost ratio during both the years of study. The higher values of B:C ratio were observed with SRI (1.79, 1.90, 2.02 and 2.10) and modified drum seeder (1.78, 2.08, 2.12 and 2.27) during kharif 2011, kharif 2012, *rabi* 2011-12 and *rabi* 2012-13, respectively. Both the establishment methods performed equally better with respect to B: C ratio. The higher benefit cost ratio was attributed to higher grain yield and net returns in SRI and modified drum seeder. This was supported by Midya *et al.*, (2021), Manjunatha *et al.*, (2009), Parameswari and Srinivas (2017). Though grain yield is higher in SRI, lesser cost of cultivation in modified drum seeder and higher cost of cultivation in SRI method made SRI equal to modified drum seeder in respect of benefit cost ratio.

Among nitrogen management practices, 100% RDN through inorganic source recorded significantly higher B:C ratio than other nitrogen management practices during both the years of study owing to higher net returns in this practice which resulted higher benefit cost ratio (Lhungdim *et al.*, (2014)). The lowest B:C ratio was observed with 100% RDN through organic source practice owing to higher cost of cultivation (Mohanty, 2014).

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Yield Attributes of Finger Millet (*Eleusine coracana* L.) as Influenced by Compost and Fertilizers

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Abstract

A field experiment was conducted during *rabi*, 2020-21 at Agricultural Research Station, Perumallapalle, ANGRAU, Tirupati to study the effect of compost and fertilizers on yield parameters in finger millet. The experiment was laid out in a randomized block design with eleven treatments and replicated thrice. The results revealed that, conjunctive use fertilizers and compost through biocompost and vermicompost significantly influenced the yield attributes of finger millet. Application of 100 % RDF + Biocompost @ 4 t ha⁻¹ recorded significantly the highest yield attributing characters viz., plant height (125.6 cm), dry matter production (2368 kg ha⁻¹, 6607 kg ha⁻¹ and 9454 kg ha⁻¹ at 30 DAT, 60 DAT and harvest, respectively), number of tillers m⁻² (110), number of ear heads m⁻² (77), number of finger ear head⁻¹ (11) and ear head length (10.26 cm). The lowest plant height (91.83 cm), dry matter production (1346 kg ha⁻¹, 5133 kg ha⁻¹ and 7392 kg ha⁻¹ at 30 DAT, 60 DAT and harvest, respectively), number of tillers m⁻² (93), number of ear heads m⁻² (61), number of finger ear head⁻¹ (8) and ear head length (9.02 cm) were recorded in control (0 % RDF).

Key words : Finger millet, biocompost, vermicompost, yield parameters.

Introduction

Finger millet (*Eleusine coracana* L.) is an important principle staple food crop grown on marginal and sub-marginal soils in India. Finger millet is primarily grown in the states of Karnataka, Andhra Pradesh, Odisha and Tamil Nadu. In India, finger millet is grown in an area of about 1.10 million hectares with an annual production of 1.76 million tonnes and a productivity of 1601 kg ha⁻¹ (Directorate of Economics and Statistics, 2019-20). In Andhra Pradesh, it is cultivated in an area of 34000 hectares with a production of 44000 tonnes and a productivity of 1320 kg ha⁻¹ (Directorate of Economics and Statistics, 2019-20). This crop has much significance in Chittoor district, being grown in an area of 5000 hectares with a production of 9000 tonnes and a productivity of 1580 kg ha⁻¹ (Plant doctors diary, 2017).

Providing complete nutrition to plants is the most important way of achieving good plant growth which leads to higher productivity. Intensive cultivation, growing of exhaustive crop, use of unbalanced and inadequate fertilizers accompanied by restricted use of organic manures have made the soils not only deficient in nutrients, but also deteriorated soil health resulting in decline in crop response to recommended dose of fertilizers. Boosting yield, reducing production cost and improving soil health are three interlinked components of sustainable triangle. Integration of both organic and inorganic nutrient sources holds the greater step towards successful agriculture by maintaining good soil health.

One of the possible ways of increasing the nutrient content of the compost is enrichment technique which may help to arrest depletion of nutrients from soil to a greater extent. Application of chemical fertilizers cannot be avoided completely, since they are the potential source for nutrients in easily available form. However, the increasing fertilizer costs on one hand and the use of inorganic fertilizers alone without proper understanding of balanced application has led to decline in finger millet productivity in many areas of Karnataka, Andhra Pradesh and Tamil Nadu. Hence, there is an urgent need for finding an alternate source for chemical fertilizers. Keeping, the above points in view the present experiment was conducted to evaluate the effect of biocompost and vermicompost in combination with inorganic fertilizers on dry matter production and yield of finger millet.

Materials and Methods

A field experiment was conducted during *rabi*, 2020-21 at Agricultural Research Station, Perumallapalle, ANGRAU, Tirupati to know the influence of compost and fertilizers on yield attributes in finger millet. The experimental soil was sandy clay loam texture with pH 7.30, EC 0.352 dS m⁻¹ and OC (0.47 %). The soil was low in available nitrogen (222 kg ha⁻¹), medium in available phosphorus (30.15 kg ha⁻¹) and high in available potassium (292 kg ha⁻¹). The experiment was laid out in a randomized block design with eleven treatments and replicated thrice. The size of gross plot and net plots were 4.0 m × 3.0 m and 3.55 m × 2.80 m, respectively. The treatments comprises of Control (0 %

RDF) (T_1), 100 % RDF (T_2), 125 % RDF (T_3), 75 % RDF + Biocompost @ 2 t ha⁻¹ (T_4), 75 % RDF + Biocompost @ 4 t ha⁻¹ (T_5), 100 % RDF + Biocompost @ 2 t ha⁻¹ (T_6), 100 % RDF + Biocompost @ 4 t ha⁻¹ (T_7), 75 % RDF + Vermicompost @ 2 t ha⁻¹ (T_8), 75 % RDF + Vermicompost @ 4 t ha⁻¹ (T_9), 100 % RDF + Vermicompost @ 2 t ha⁻¹ (T_{10}), 100 % RDF + Vermicompost @ 4 t ha⁻¹ (T_{11}).

The ragi variety Vakula was used in the present experiment. Ragi seeds were sown in nursery and transplanted to main field by adopting a spacing of 22.5 cm × 10 cm. The recommended dose of fertilizer was 60:30:20 kg N:P₂O₅:K₂O ha⁻¹. Entire phosphorus (Single super phosphate) and potassium (muriate of potash) fertilizer were applied as basal and nitrogen (urea) fertilizer was applied in two equal splits, half as basal and remaining half at 30 DAT. Vermicompost and biocompost were applied as per the treatments and incorporated before transplanting of the crop. Pre emergence herbicide Pendimethalin (30 % EC) @ 1.0 kg ha⁻¹ was sprayed one day after transplanting at optimum soil moisture to prevent the growth of weeds. One hand weeding was done at 40 days after transplanting (DAT) as a common practice in all treatments. The crop was harvested at physiological maturity when all the ear heads turned to brown and seeds were easily detachable. The border rows from each plot were harvested first by leaving the net plot area. Later ear head from each net plot area was harvested after separating those representative hills for recording biometrical observations. The crop was harvested on 20th February, 2021. Biometric observations on the morpho-physiological parameters were taken on tagged five representative plants selected at random from each treatment of net plot and the mean values are presented. The data was analysed by using Analysis of variance.

Results and Discussion

Dry Matter Production : Dry matter production of finger millet recorded at 30 DAT, 60 DAT and harvest differed significantly with the application of compost and fertilizers (Table-1).

Significantly the highest dry matter production was recorded with the application of 100 % RDF + Biocompost @ 4 t ha⁻¹ (T_7) at all stages of crop growth i.e. 30 DAT, 60 DAT and harvest (2368 kg ha⁻¹, 6607 kg ha⁻¹ and 9454 kg ha⁻¹). However it was at par with 100 % RDF + Vermicompost @ 4 t ha⁻¹ (T_{11}). The lowest dry matter production (1346 kg ha⁻¹) of finger millet was recorded in control (0 % RDF) (T_1) (1346 kg ha⁻¹, 5133 kg ha⁻¹ and 7392 kg ha⁻¹ at 30 DAT, 60 DAT and harvest, respectively).

The highest dry matter production recorded with the

combined application of 100 % RDF and biocompost @ 4 t ha⁻¹ (T_7) which might be due to increased availability of nutrients in soil due to mineralization of nutrients from organic sources and inorganic fertilizers. The beneficial effect of biocompost on plant growth may be due to the higher supply of macro and micro nutrients, also due creation of favourable physical and biological environment in the soil leading to better crop growth and nutrient absorption. This might have been responsible for higher dry matter production. Similar results were obtained by Ashwini *et al.* (2015) and Vajantha *et al.* (2012). Raundal *et al.* (1999), also found significant increase in dry matter yield due to application of macronutrients and organic wastes.

Plant Height (cm) : Data pertaining to plant height (cm) at harvest in finger millet was presented in Table 1. Plant height of finger millet was significantly effected by the application of compost along with fertilizers. Significantly the highest plant height (125.6 cm) was observed with the application of 100 % RDF + Biocompost @ 4 t ha⁻¹ (T_7) and the next best treatment was found to be with the application of 100 % RDF + Vermicompost @ 4 t ha⁻¹ (T_{11}) (120.6 cm) which was at par with 75 % RDF + Biocompost @ 4 t ha⁻¹ (T_5) (118.8 cm) and 75 % RDF + Vermicompost @ 4 t ha⁻¹ (T_9) (116.4 cm). The lowest plant height (91.83 cm) was noticed in control (0 % RDF) (T_1). Application of 100 % RDF supplies nutrients in available form at initial stages of plant growth which plays an important role in metabolic process and activation of number of enzymes participating in photosynthesis which inturn increased plant growth. These results are in accordance with Nehra and Hooda, (2002) and Naik and Rao, (2004), who reported increase in plant height of lentil crop due to pressmud application. Increased availability of nutrients to soil with the application of organic sources of nutrients and inorganic fertilizers could have triggered the cell elongation and multiplication resulting in higher growth rate of shoot in turn plant height of finger millet. Similarly, Korai *et al.* (2014) revealed that there were pronounced positive effects of adding biocompost as well as N on plant height and dry weight of maize.

Number of Tillers m⁻² : Number of tillers m⁻² of finger millet as effected by application of compost and fertilizers is presented in Table 1. Number of tillers m⁻² in finger millet was significantly affected by all the treatments. Maximum number of tillers m⁻² (110) was recorded with the application of 100 % RDF + Biocompost @ 4 t ha⁻¹ (T_7) and it was on par with 100 % RDF + Vermicompost @ 4 t ha⁻¹ (T_{11}) (107 cm). The next best treatment is 75 % RDF + Biocompost @ 4 t ha⁻¹ (T_5) (106 cm) which was on par with 75 % RDF + Vermicompost @ 4 t ha⁻¹ (T_9) (105 cm). The lowest number of tillers m⁻² (93) was observed in control (0

Table-1 : Dry matter production and yield attributes of finger millet crop as influenced by application of compost and fertilizers.

Treatments	Dry matter production (kg ha ⁻¹)			Plant height (cm)	No. of tillers m ⁻²	No. of ear head m ⁻²	No. of fingers ear head ⁻¹	Ear head length (cm)
	30 DAT	60 DAT	At harvest					
T ₁ : Control (0% RDF)	1346 ^g	5133 ^g	7392 ^g	91.83 ^f	93 ^g	61 ^g	8 ^d	9.02
T ₂ : 100% RDF	1808 ^e	5651 ^{de}	8000 ^{ef}	105.7 ^e	99 ^{ef}	67 ^{ef}	9 ^c	9.70
T ₃ : 125% RDF	2119 ^c	5698 ^{de}	8015 ^{ef}	107.3 ^e	102 ^{de}	66 ^{ef}	9 ^c	9.64
T ₄ : 75% RDF + Biocompost @ 2 t ha ⁻¹	1764 ^e	5573 ^{ef}	7827 ^f	110.1 ^e	98 ^{ef}	66 ^{ef}	9 ^c	9.55
T ₅ : 75% RDF + Biocompost @ 4 t ha ⁻¹	2108 ^c	6104 ^b	8653 ^b	118.8 ^{bc}	106 ^b	73 ^c	10 ^b	10.1
T ₆ : 100% RDF + Biocompost @ 2 t ha ⁻¹	1986 ^d	5852 ^c	8405 ^c	115.2 ^d	104 ^c	69 ^{de}	9 ^c	9.88
T ₇ : 100% RDF + Biocompost @ 4 t ha ⁻¹	2368 ^a	6607 ^a	9454 ^a	125.6 ^a	110 ^a	84 ^a	11 ^a	10.3
T ₈ : 75% RDF + Vermicompost @ 2 t ha ⁻¹	1684 ^f	5497 ^f	7769 ^f	105.5 ^e	97 ^g	65 ^f	9 ^c	9.42
T ₉ : 75% RDF + Vermicompost @ 4 t ha ⁻¹	1846 ^e	6089 ^b	8513 ^b	116.4 ^{bc}	105 ^b	71 ^c	10 ^b	10.1
T ₁₀ : 100% RDF + Vermicompost @ 2 t ha ⁻¹	1954 ^d	5820 ^c	8217 ^{cd}	114.2 ^d	103 ^d	68 ^{def}	10 ^b	9.78
T ₁₁ : 100% RDF + Vermicompost @ 4 t ha ⁻¹	2286 ^b	6440 ^a	9382 ^a	120.6 ^b	107 ^a	77 ^b	10 ^b	10.15
F-value	11.72 ^{**}	25.77 ^{**}	29.48 ^{**}	28.47 ^{**}	11.51 ^{**}	40.45 ^{**}	36.33 ^{**}	6.716
p-value	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.060

*Significant at p=0.05 level

**Significant at p=0.01 level

Note : Same set of alphabets indicates no significant difference or at par with each other (DMRT)

RDF : 60:30:20 kg of N:P₂O₅ : K₂O ha⁻¹

% RDF) (T₁). The results were in accordance with the findings of Rai *et al.* (2004), who reported that organic wastes enhanced plant growth and tillers favourably due to supply of nutrients from bio compost. Similar results were also reported by Nawaz *et al.* (2016) and Kejiya *et al.* (2019).

Number of Ear heads m⁻² : Application of compost along with fertilizers exerted significant influence on number of ear heads m⁻² at harvest in finger millet (Table-1). Significantly the highest number of ear heads m⁻² (84) in finger millet was registered with the application of 100 % RDF + Biocompost @ 4 t ha⁻¹ (T₇) followed by 100 % RDF + Vermicompost @ 4 t ha⁻¹ (T₁₁) (77). The next best treatment is 75 % RDF + Biocompost @ 4 t ha⁻¹ (T₅) (73) which was on par with 75 % RDF + Vermicompost @ 4 t ha⁻¹ (T₉) (71). The lowest number of ear heads m⁻² (61) was noticed in control (0 % RDF) (T₁). Significantly the highest number of ear heads m⁻² of finger millet was recorded with combined application of 100 % RDF + Biocompost @ 4 t ha⁻¹ (T₇) might be due to application of inorganic fertilizers along with compost resulted in production of higher photosynthates and its subsequent partitioning towards sink. Integrated nutrient supply had continuous favourable effect on yield attributes like ear head. This finding confirms that of Divya *et al.* (2017) and Patil *et al.* (2018). Increased plant height and number of tillers resulted in increases in productive ear heads. This was mainly due to higher photosynthetic efficiency and net assimilation, which helped in increasing the overall growth of the plant.

Number of Fingers Ear head⁻¹ : Significant difference was found on the number of fingers earhead⁻¹ due to combined application of compost and fertilizers (Table 1).

At harvest, significantly the highest number of fingers ear head⁻¹ (11) was recorded with the application of 100 % RDF + Biocompost @ 4 t ha⁻¹ (T₇) followed by 100 % RDF + Vermicompost @ 4 t ha⁻¹ (T₁₁) (10) which was on par with 75 % RDF + Biocompost @ 4 t ha⁻¹ (T₅) (10), 75 % RDF + Vermicompost @ 4 t ha⁻¹ (T₉) (10) and 75 % RDF + Vermicompost @ 2 t ha⁻¹ (T₁₀) (10). The lowest number of fingers earheads⁻¹ (8) was recorded with control (T₁). Similarly, Gangadhar Nanda (2015) reported that the combined application of organic matter and chemical fertilizers increased number of fingers per ear head and finger length of finger millet.

Ear head length (cm) : Data pertaining to ear head length in finger millet was presented in Table-1. Application of compost with fertilizers showed non-significant effect on ear head length at harvest. Maximum ear head length (10.26 cm) was recorded with 100 % RDF + Biocompost @ 4 t ha⁻¹ (T₇) while the lower ear head length (9.02 cm) was recorded with control (T₁).

Conclusion

From the above results it could be concluded that the application of 100 % RDF + Biocompost @ 4 t ha⁻¹ to finger millet is the most efficient nutrient management practice to obtain better growth of finger millet. Hence, it is best practice to be recommended to sustain higher productivity and to achieve economic profitability in Southern Agroclimatic Zone of Andhra Pradesh.

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Bioactive Compounds from Rice By-Products : A New Hope for the Pharmaceutical Industry

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Abstract

Rice by-products, such as straw, husk, and bran, are produced during the rice cultivation and milling operations and are abundant in bioactive components such vital amino acids, phenolics, flavonoids, vitamin E, and $\bar{\alpha}$ -oryzanol. These compounds are attracting attention because of their potential health benefits as well as their antioxidant properties for increasing food storage durability. However, a significant amount of rice by-products is not effectively utilised, resulting in economic waste and environmental issues.

Introduction

Rice (*Oryza sativa* L.) is the most significant staple food crop on the world. According to the Food and Agriculture Organization of the United Nations (FAO), over 740 million tonnes of rice are harvested worldwide each year, with 90 percent (roughly 670 million tonnes) produced and consumed in Asia, particularly in the eastern, southern, and south-eastern regions. Farmers in Asian emerging countries such as Thailand, Vietnam, Philippines, Indonesia, India, and Bangladesh, on the other hand, are poor. Straw, husk, and bran are the most common by-products of rice agriculture and commercial rice processing (combined with germ). One kilogramme of rice grain yields 1.5 kilogrammes of straw, implying that around 1,100 tonnes of rice straw are produced year from paddy fields around the world. Furthermore, low-value goods such as husk (20% of the total weight of whole rice) and bran (10% of the total weight of whole rice) are produced by industrial rice processing (Butsat & Siriamornpun, 2010). Many recent research have found that these by-products contain bioactive components like amino acids, phenolic acids, flavonoids, vitamin E, $\bar{\alpha}$ -oryzanol, and pigmented compounds, all of which have the potential to improve human health (Butsat & Siriamornpun, 2010).

However, the majority of rice cultivation and processing by-products are now used as animal feed, and there is a significant amount that is not being used efficiently. Furthermore, the disposal of these by-products has become a major issue (Daifullah *et al.*, 2003). Unused by products are typically burned in the field, resulting in both economic waste and environmental issues such as air pollution, smog development, and soil moisture loss (Chaudhary *et al.*, 2016). As a result, the focus of this review is on the extraction and creation of novel bioactive compounds from these underutilised wastes and

by-products, as well as their utilisation in the food and pharmaceutical industries. Farmers would be able to take advantage of new markets for waste materials and earn more profit from their crop leftovers, while also reducing pollution caused by their disposal, thanks to the valuable exploitation of rice cultivation and rice processing by-products.

By-products of rice cultivation and rice processing

Rice straw : Rice straw, the most prevalent agro-residue from paddy fields around the world, is used as animal feed, household fuel, and boiler fuel (Sarkar *et al.*, 2012). Rice straw is used as a feeding source for livestock in Southeast Asian nations such as Thailand, Vietnam, and Indonesia. Every kilogramme of rice grain produces 1–1.5 kilogrammes of straw, with a considerable amount of this being discarded as waste each year (Sarkar *et al.*, 2012). The open burning of straw for disposal and to prepare the field for the next crop is a common practise. However, this approach emits toxic air pollutants that can have serious health consequences (Gadde *et al.*, 2009).

Rice straw has been found to contain a variety of bioactive chemicals, according to several studies. Karimi *et al.* (2014) used high-performance liquid chromatography to identify bioactive chemicals in rice straw types (Hashemi, Khazar, Ali Kazemi, Neda, Shiroodi, and Binam) (HPLC). Rice straw included phenolic substances such as gallic acid, caffeic acid, pyrogallol, and salicylic acid, as well as flavonoids such as kaempferol, apigenin, rutin, daidzein, genistein, and myricetin, according to the researchers. According to DPPH and nitric oxide free radical scavenging activity experiments, the extract from the Hashemi variety included phenolic compounds, flavonoids, and antioxidant activity. Li *et al.* (2015) used nanofiltration to remove significant amounts of hydroxycinnamic acids from alkaline hydrolyzate from Chinese rice straw,

including ferulic acid, p-coumaric acid, vanillic acid, syringaldehyde, p-hydroxybenzaldehyde, and vanillin.

Rice husk : Rice husk is a significant byproduct of the rice milling process. Rice husk accounts for about 20% of the total weight of whole rice (545 million tonnes produced worldwide) (Feng *et al.*, 2004). However, due to its unfavourable qualities, such as resistance to degradation, high ash and lignin concentration (Chandrasekhar *et al.*, 2003), and inedibility, rice husk use and economic interest are exceedingly low (Butsat & Siriamornpun, 2010). For these reasons, it is frequently disposed of by open burning, which pollutes the environment. Rice husk, on the other hand, has a nutritional advantage in that it provides antioxidant effects that protect the rice seed from oxidative stress. Butsat and Siriamornpun (2010) investigated the chemical composition of rice husk (KDML 105 variety), including the content of phenolic acid, α -oryzanol, and tocopherols, as well as the antioxidant capacity, and discovered that the phenolic acid content, specifically vanillic acid and p-coumaric acid, was high. According to the DPPH radical scavenging activity and ferric reducing antioxidant power (FRAP) assays, rice husk has a strong antioxidant activity. Furthermore, pyrogallol and caffeic acid were discovered in five Iranian rice husk varieties (Hashemi, Khazar, Ali Kazemi, Neda, Shiroodi, and Binam) (Karimi *et al.*, 2014).

Rice bran : Rice bran is one of the most common by-products of the whole grain rice milling process, accounting for around 10% of the total weight of the rice (Zullaikah *et al.*, 2005). Commercial rice bran is typically a blend of rice bran layer and rice germ. Bioactive substances found in rice bran include phenolic acids, flavonoids, vitamin E, and α -oryzanol (Min *et al.*, 2011). It is, nevertheless, underutilised as a human diet and is frequently used as animal feed. Butsat and Siriamornpun (2010) looked at the bioactive chemicals found in Thai rice's husk, bran, and grain. Bioactive substances such as α -oryzanol, tocopherols, and phenolic acids were detected in higher concentrations in the bran and husk fractions, according to the researchers. Furthermore, the bran and husk fractions have stronger antioxidant activity than the grain fraction. Wanyo *et al.* (2014) found high levels of α -oryzanol, vitamin E (including α -tocopherol, β -tocopherol, and γ -tocopherol), phenolic acids (including gallic acid, protocatechuic acid, p-hydroxybenzoic acid, vanillic acid, chlorogenic acid, caffeic acid, syringic acid, p-coumaric acid, ferulic acid, and sinapic acid) and flavonoids (including kaempferol). The anthocyanin components of glutinous and non-glutinous Thai black rice extracts were determined by Pitija *et al.* (2013). Two anthocyanin peaks were discovered using HPLC analysis. Using liquid chromatography-electrospray ionisation

mass spectrometry (LC-ESI-MS), these peaks were identified as cyanidin 3-O-glucoside and peonidin 3-O-glucoside, respectively.

Conclusion

Due to their high nutritional value and possible health advantages, creative utilisation of bioactive chemicals found in waste/by-products from rice farming and rice processing has expanded to numerous domains in recent years, particularly the food and pharmaceutical industries. In addition, many recent studies have established and enhanced extraction methodologies and extraction conditions for extracting bioactive chemicals from rice straw, rice husk, and rice bran, which is required for their further application. Food colourants, food enrichment, food preservatives, anti-cancer drugs, and anti-inflammatory agents could all be used with the extracted bioactive chemicals. They can also be used to lower the amounts of synthetic food additives or drugs. The extraction cost of bioactive chemicals and the toxicity of extractant solvents are the most important aspects to consider from the perspective of the industry.

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Doubling Farmers' Income through Soil and Water Management Practices in Tribal Areas of Katol Taluka in Nagpur District of Maharashtra State, India

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Abstract

The present study was carried out during 2017-18 to 2019-20 in five tribal villages namely Mhasada, Miniwada, Malkapur, Kawdimet and Ghubadi village of Katol taluka in Nagpur district of Maharashtra state where more than 50% of farmers are tribal. Primary data were collected from 160 tribal farmers and analyzed by capital budgeting technique along-with descriptive statistics tools has been used. The study revealed that the area specific soil and water management practices adopted by farmers helped them to increase the productivity and profitability. A total of 160 tribal farmers benefitted and adopted the improved the soil and water suitability crop plans from the STC programme. The study further revealed that about 64.75 ha (160 acreage) area covered under the project resulted the resources use efficiency enhanced in terms of increase of per hectare yields by 35%, net return by 55%, cultivated area increased by 2%, employment increased by 2% and water use efficiency increased by 6% in the study area. In a nut shell, on the path of doubling the farmer's income, area specific soil and water management interventions created remarkable improvement in crop productivity and farmers' income that translated into better lives of tribal farmers in study area.

Key words : Income, productivity, profitability soil and water management, tribal.

Introduction

To fulfill the demand of food, energy, human and livestock requirements, natural resources are most important inputs on the planet. Due to increasing population and changing climate of the world, immense pressure on available limited natural resources were observed in recent years. Soil and water are fundamental natural resources for the agricultural production system. Degradation of these natural resources are the serious threats for increasing productivity and doubling farmers' income especially in rain-fed areas of India. Therefore it is important to adopt sustainable management practices, conservation technologies and judicious uses of these resources are exceptionally important for food and nutritional security, sustainable livelihood and doubling the farmer's income in country (Kumawat, A. *et al*, 2020). Doubling farmer's real income till 2022–23 over the base year 2015–16 is requires annual growth of 10.41% in farmers' income. In this regard government of India has developed technological initiatives and policies such as Pradhan mantri krishi sinchayee yojana, Soil health card scheme, Paramparagat krishi vikas yojana and provision of insurance against failure of crop and income loss, Pradhan mantri fasal bima yojana, PM-Kisan yojana and E-Nam etc. (Kotadiya, 2021).

At the behest of Indian Council of Agricultural Research (ICAR), National Bureau of Soil Survey and Land Use Planning (NBSS & LUP), Nagpur has also

implemented the Schedule Tribe Component (STC) for enhancement of livelihood and doubling the income of tribal farmers. The scheduled tribes (STs) population (104.5 million) constitutes about 8.6% of India's total population (Census, 2011). Due to the remoteness of location of most of the ST population, the degree of benefit from general developmental programmes is limited therefore there is need for special programmes. Kumar and Chahal (2018), in their study concluded that 70% of the farmers in India have annual per capita income less than Rs. 15,000 and only 10% of them earn more than Rs. 30,000. Choudhary *et al*, 2019 also identified that the land size and income are significantly associated with each other. Kamble *et al*. (2015) mentioned that government has made special programmes and policies to promote the socioeconomic development among backward tribes. On this background, ICAR- NBSS & LUP, Nagpur introduced appropriate area based soil management practices and sustainable land use and water management plans to improve crop productivity and income of tribal farmers of Katol taluka with the following objectives :

To work out the cost, profit and benefit cost ratio of technology intervention.

To work out the crop productivity after technology intervention

To work out the overall impact of technology intervention.

Materials and Methods

The Study Area : With the objective of enhancement of productivity and farm income in the identified five tribal villages namely Mhasada, Miniwada, Malkapur, Kawdimet and Ghubadi village of Katol taluka (Located at 21.27°N 78.58°E) in Nagpur district of Maharashtra state where more than 50% of farmers are tribal with total population of 43267 (Wikipedia.org) was selected for the study where farmers are doing agriculture in traditional way. On the basis of farm surveys, farmer's scientist-expert's meetings and participatory rural appraisal (PRA) conducted in the area, identified distinguished field level problems accounted for low agricultural productivity. The study was carried out during 2017-18 to 2019-20 (three years) and primary data were collected on agricultural practices of farmers, inputs used, production and cost of cultivation etc. from 160 tribal farmers.

Analytical Tools : Capital budgeting technique along-with descriptive statistics tools has been used to analyze the data. Benefit Cost Ratio (BCR) was calculated as Gross Returns accrued divided by Total Cost of cultivation, which was actually incurred by farms. This may be expressed as BCR is equals to GR/TC, where, GR is Gross Returns and TC is Total Cost of cultivation. The data analyzed under three categories in shallow black and deep to medium deep black soils under rain-fed and irrigated conditions as following three treatments :

Farmer's traditional practice under shallow black soils,

Demonstrated crops under deep to medium deep black soils in rain fed conditions

Demonstrated crops under deep to medium deep black soils using sprinkler irrigation.

Results and Discussion

Demonstrated crop varieties as per the suitability criteria : The agriculture in Katol reflected a dismal performance predominantly due to outdated agricultural production technologies. Tribal farmers live at subsistence levels and prevalence of rain fed agriculture. Unsuitable soil crop selection resulting in depletion of soil productivity. Small and fragmented land holdings (NABARD Monograph 2016), water scarcity and absence of organized efforts for natural resource management based livelihoods due to remoteness resulted low levels of income in study area. Most of the farmers have no knowledge of soil suitability measures and management practices for various crops and they were doing agriculture with their own ability.

The soils identified as heavy deep black soils are

predominant followed by medium and light soils. Since the study area identified as rain fed area therefore low biomass producing and water conserving varieties (Bashir *et al.* 2017) were selected as per the suitability parameters identified in study area (Table1). Demonstrations of *kharif* (cotton, pigeonpea and sorghum) and *rabi* (wheat and chickpea) crops among the 160 tribal farmers has been conducted during 2017-18 to 2019-20 (three years). It was found that irregular or insufficient rainfall was serious problem causing low yields and even crop failure in dry land areas (Singh *et al.* 2015). Therefore, envisaged the soil and water management strategies such as intercropping, micro-irrigation system and integrated nutrient management with the complete package of practice in the study area.

Treatment wise economic comparison of demonstrated crops : Economics of demonstrated crops has been compared with the farmer's traditional practice in different soils such as shallow black and deep to medium deep black soils under rain-fed and irrigated conditions in three treatments as below:

(i) T1 : Farmer's traditional practice under shallow black soils in rain fed conditions.

(ii) T2 : Demonstrated crops under deep to medium deep black soils in rain fed conditions.

(iii) T3 : Demonstrated crops under deep to medium deep black soils using sprinkler irrigation.

As shown in table-2, yields of different crops were enhanced in treatment no. 3 (demonstrated crops under deep to medium deep black soils using sprinkler irrigation). Net returns to the farmers also increased followed by treatment no. 2 (demonstrated crops under deep to medium deep black soils in rain fed conditions) and treatment no. 1 (farmer's traditional practice under shallow black soils). The study further revealed that, by increasing the cost of cultivation to some extent for technological interventions, farmers can gain more profit due to increased in productivity. The performance of all crops in terms of yield and water productivity were found much higher since use of modern technology of sprinkler irrigation in suitable soils such as deep to medium deep black soils.

It was also showed that sorghum was performed better in medium deep soils as compare to shallow soils without any irrigation facilities. The average net profit realized by farmers was higher in cotton with BC ratio 2.1 in third treatment as compare to second (BCR 1.9) and first (BCR 1.5) treatment. In pigeonpea, the average net profit of Rs. 31 thousand per hectare realized by farmers with BC ratio 2.2 in third treatment as compare to

Table-1 : Demonstrated crop varieties and suitable parameters in study area. (n=160)

Crop	Variety	Duration days	Suitability parameters			
			Climate and irrigation		Soil type	Tolerance/ Resistance
Cotton	Ajit 199	150-170	Irrigated and conditions	rain-fed	Deep black to medium black soils	Highly tolerant to leaf reddening, sucking pests and diseases.
Pigeon pea	ICPL 8863	150-160	Light irrigations at flowering and pod formation stage		All types of soils with good drainage. Saline soils are not suitable	Wilt resistant
Sorghum	CST 9	110-115	Withstand high temperature and drought		clayey loam soil rich in humus and efficient drainage facilities	resistant to shoot fly and stem borer
Wheat	Lok-1	126-134	Irrigated and conditions	rain-fed	clayey loam soil, moderate water holding capacity, Heavy soil with good drainage	Resistant to shattering & lodging, black and brown rust
Chick pea	Vijay	105-110	Irrigated and conditions	rain-fed	sandy loam to clay loam soils, Black cotton soils with well drainage	Resistant to Wilt, blight and rust Tolerant to terminal moisture stress.

Table-2 : Treatment-wise economic comparison of kharif and rabi crops in study area. (n=160)

Crops	Treatment number	Av. total cost (000Rs.)	Av. yield (q/ha)	Av. gross return (000Rs.)	Av. net return (000Rs.)	BC ratio
Cotton	T1	22.6	6.42	35.3	12.7	1.5
	T2	26.2	9.37	51.5	25.3	1.9
	T3	26.7	10.23	56.3	29.5	2.1
Pigeon-pea	T1	20.4	8.26	38.8	18.3	1.9
	T2	25.04	11.32	53.2	28.1	2.1
	T3	25.8	12.18	57.2	31.3	2.2
Sorghum	T1	10.5	9.21	20.2	9.71	1.9
	T2	12.3	11.73	25.8	13.4	2.1
Chickpea	T1	16.2	6.57	24.9	8.77	1.5
	T2	18.03	8.38	31.8	13.8	1.7
	T3	18.5	9.74	37.01	18.4	1.9
Wheat	T1	11.1	7.13	12.4	1.27	1.1
	T2	11.4	10.71	18.6	7.26	1.6
	T3	11.9	12.46	21.7	9.827	1.8

second (BCR 2.1) and first (BCR 1.9) treatment. The average net profit of chickpea was higher with BC ratio 1.9 in third treatment as compare to second (BCR 1.7) and first (BCR 1.5) treatment. Per hectare average net profit in wheat was Rs. 9 thousand with BC ratio 1.8 in third treatment as compare to second (BCR 1.6) and first (BCR 1.1) treatment

Impact of demonstrations over the farmer's own practice in study area : Technological interventions in soil and water management practices in study area resulted to increase the yields of demonstrated crops and reinforce the cropping system by improving drought resilience, boosting resistance to pests and diseases and also by capturing new market opportunities (Choudhary et al. 2019). Figure 2 revealed that the per hectare cost of cultivation increased by 15.82% in cotton and farmers were able to increase their yields by 45.96% and 59.35% in second and third treatment respectively. In pigeon-pea

cultivation it was found that the cost of cultivation increased by 22.5 percent and yield increased by 37% with net profit of Rs. 28.15 thousand per hectare with BC ratio 2.12 in second treatment. In third treatment, due to the infrastructural development such as adoption of sprinkler irrigation system, the cost of cultivation increased by 26.46% and average yield increased by 47.46% and farmers gained average net profit of Rs 31.38 thousand per hectare with BC ratio 2.21. In second treatment of sorghum cultivation average net profit of Rs. 13488.20 per hectare realized by farmers which is 38 percent higher than farmers own practice. By increasing the cost of cultivation by 11.41% in second treatment, farmers were increased their yields of chickpea by 27.55% and net profit increased by 57.34%.

It was also revealed that the area specific change in soil and water management practices required additional capital and it boost production, productivity and the

The study area: Katol taluka of Nagpur district, India

North
↑

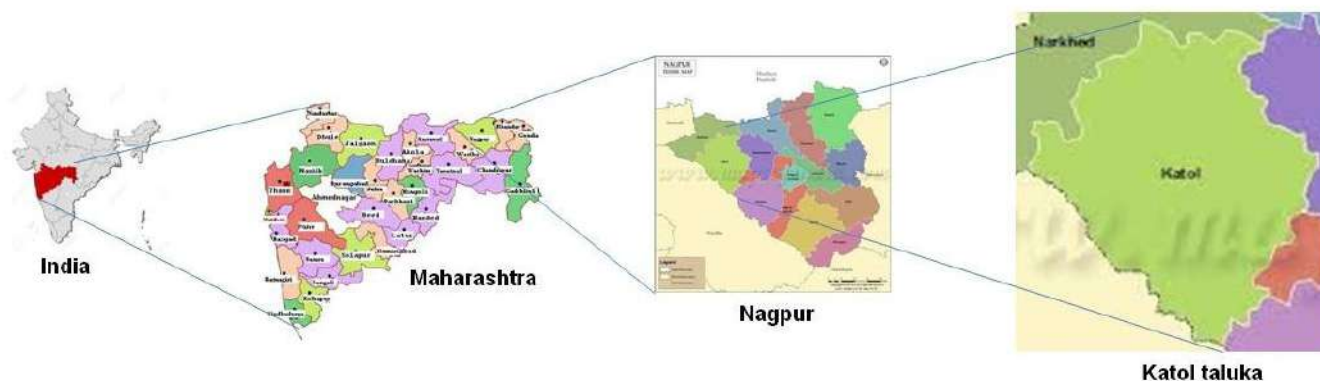


Figure-1 : The study area, Katol taluka of Nagpur district in India.

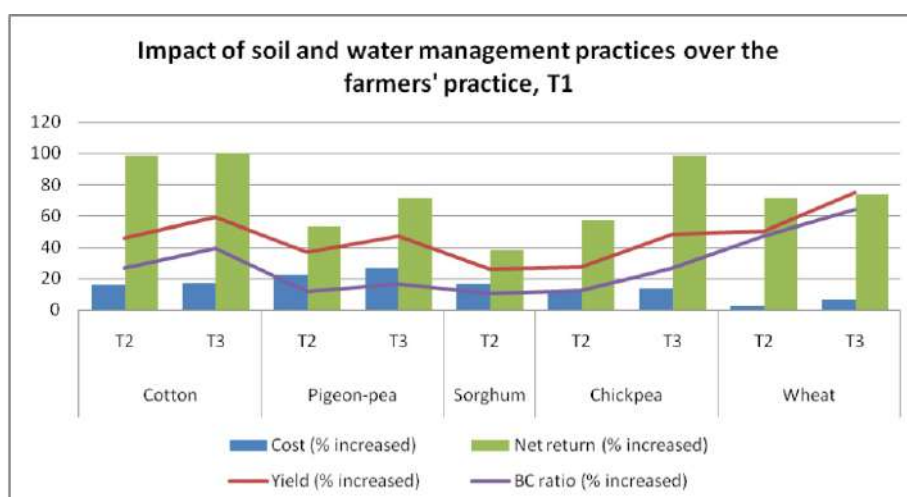


Figure-2 : Graphical presentation of impact of soil and water management practices.

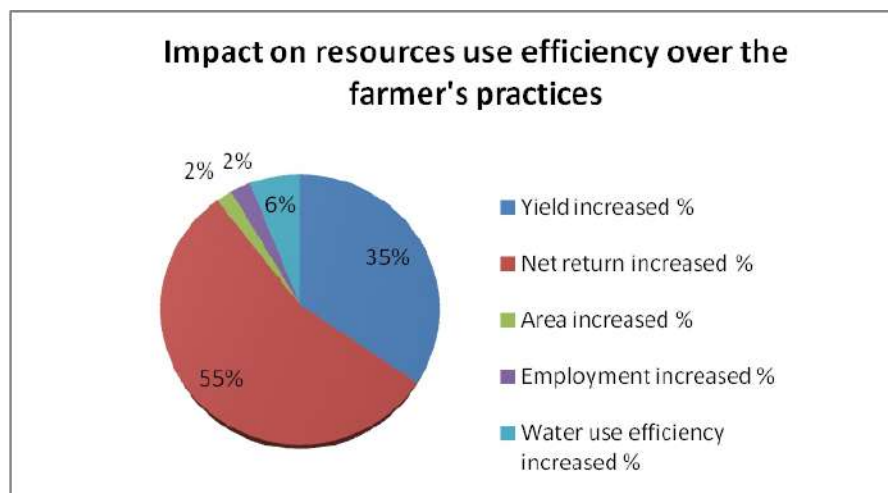


Figure-3 : Impact on resources use efficiency of farmers over the farmer's practices.

profitability of the farmers in study area. Malve *et al*, 2018 concluded that, higher benefit cost ratio specified the economic viability of technological interventions and farmers can easily adopt the technology. In case of third

treatment of chickpea cultivation, farmers increased yields by 48.25%. In wheat cultivation it was found that the cost of cultivation increased by 2.36% and yield increased by 50.21% with net profit of Rs. 7261.94 per

hectare with BC ratio 1.63 increased by 46.85% in second treatment. In third treatment, expenses made on sprinkler irrigation by farmers and total cost increased by 6.75%. The average yield increased by 74.75% and farmers made average net profit of Rs 9827.01 per hectare with BC ratio 1.82 increased by 63.96%. Farmers experienced that the soil depth and sprinkler irrigation facilities played a crucial role to enhance the per hectare yield of all the kharif and rabi crops in rain fed conditions.

Impact on resources use efficiency of farmers over the farmer's practices : Report of the Committee on Doubling Farmers' Income revealed that the optimal use of scarce resources makes value to agriculture and efficient use of material inputs such as labour and water brings long term positive impact on agricultural productivity and farmers' income. It was observed that the area specific soil and water management practices adopted by farmers helped them to increase the resources use efficiency in terms of increase of per hectare yields by 35%, net return by 55%, cultivated area increased by 2%, employment increased by 2% and water use efficiency increased by 6% in the study area.

Conclusions

In a nut shell, on the path of doubling the farmer's income, the STC programme created awareness among the farmers to select crops based on soil suitability, optimize nutrient application based on soil and crop requirement, conserve water, thereby realizing higher incomes translating into better lives of tribal farmers. With area specific soil and water management interventions, a remarkable improvement in crop productivity and farmers' income were observed. A total of 160 tribal farmers benefitted and adopted the improved the soil and water suitability crop plans from the STC programme in the five villages. About 64.75 ha (160 acreage) area covered under the project resulted the soil based cultivation of *kharif* and *rabi* crop's average yield increased by 27% to 74% and profit increased by 38% to 132% as compare to farmers' practices.

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***In Vivo* Evaluation of New Combi Fungicides Against Early Blight of Tomato Caused by *Alternaria solani* (Ellis and Martin) Gones and Grout**

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Abstract

Early blight of tomato caused by *Alternaria solani* (Ellis and Martin) Jones and Grout is a soil inhabiting and air-borne pathogen responsible for considerable loss in tomato production. In the absence of resistant cultivars, the use of fungicides to control the disease is one exercise training. When there is an epidemic outbreak for some reason, perhaps the use of fungicides are one of the best options available. It requires the evaluation of new combi fungicides to know its effectiveness against early blight of tomato under *in vivo* conditions. For this purpose a study was conducted at the experimental field of Krishi Vigyan Kendra, Satna (M.P.) during *rabi* season of 2019-20 to control *Alternaria solani*. Seven treatments including control with three replications were taken up by using RCBD. The treatments viz., Tebuconazole 50 % + Trifloxystrobin 25 % (Nativo 75% WG) @ 0.1 % (T1), Azoxystrobin 18.2 % + Difenconazole 11.4 % (Amistar top) @ 0.13 % (T2), Metiram 55 % + Pyraclostrobin 5 % (Cabrio top 60 % WG) @ 0.4 % (T3), Hexaconazole 5 % + Captan 70 % (Taqat 75 % WP) @ 0.2 % (T4), Zineb 68 % + Hexaconazole 4 % (Avtar 72 % WP) @ 0.25 % (T5), Carbendazim 12 % + Mancozeb 63 % (Saaf 75 % WP) @ 0.2 % (T6) and Untreated control (Spray of plain water) (T7) were applied at first initiation of disease symptoms and second at 15 days after the first spray. The data were recorded at 7 days after the two consecutive sprays of fungicides. Analysis of the data revealed that all fungicidal treatments reduce the disease intensity as compared to untreated control. The lowest per cent disease intensity (PDI) was observed in Tebuconazole 50 % + Trifloxystrobin 25 % WG @ 0.1 % (12.77 %) throughout the growing period of the crop, followed by Metiram 55 % + Pyraclostrobin 5 % WG @ 0.4 % (14.59 %). Similarly, the highest yield of tomato fruits was recorded with Tebuconazole 50 % + Trifloxystrobin 25 % WG @ 0.1 % (351.58 q/ha), followed by Metiram 55 % + Pyraclostrobin 5 % WG @ 0.4 % (323.79 q/ha).

Key words : *In vivo*, evaluation, combi fungicides, tomato, *Alternaria solani*, *Rabi*, PDI

Introduction

Tomato (*Lycopersicon esculentum* Mill.) is an important crop grown worldwide and the second most important remunerable solanaceous vegetable crop after potato (Pritesh and Subramanian, 2011; Sahu *et al.*, 2013). It is native to South America and is widely cultivated in 140 countries of the world. In India, it has an annual production of 18732 thousand mt with 774 thousand ha area (Anonymous, 2017). China is the rank first in production of tomato, followed by India and USA respectively. In India, tomato cover about 760 thousand hectares with production of 18399 thousand metric tons, mainly grow in Uttar Pradesh, Karnataka, Maharashtra, Haryana, Punjab, Bihar and Himachal Pradesh. It can be grown in a wide range of climates from tropical to temperate region. With high nutritional value, it provides a balance source of Vitamin A, C, E and good source of antioxidant and contains 95.3 % of water and 0.07 % calcium needed to maintain good human health (Olaniyi *et al.*, 2010). Tomato crop is vulnerable to bacterial, viral, nematode and fungal diseases. Among the fungal diseases, alternaria blight of tomato caused by *Alternaria solani* (Ellis and Martin) Jones and Grout, is a soil inhabiting air-borne pathogen responsible for leaf blight, collar and fruit rot of tomato

disseminated by fungal spores (Abada *et al.*, 2008). The pathogen causes infection on leaves, stem, petiole, twig and fruits as well as leads to the defoliation, drying of twigs and premature fruit drop which ultimately reduce the yield 30 to 65 % in various states (Kamble *et al.*, 2009; Saha and Das, 2013). Crowded plantation, high rainfall and extended period of leaf wetness are responsible factors to induce disease development (Gondal *et al.*, 2012) and plants are more susceptible to the blight infection during fruiting period (Momel and Pemezny, 2006). All above ground parts of the plants can have symptoms of this disease. Initial symptoms on leaves appear as small 1-2 mm black or brown lesions and under favorable environmental conditions the lesions will enlarge and are often surrounded by a yellow halo. Lesions greater than 10 mm in diameter often have dark pigmented concentric rings. This so-called "bull's eye" type lesion is highly characteristic of early blight. As lesions expand and new lesions develop entire leaves may turn chlorotic and dehisce, leading to significant defoliation. On young tomato seedlings lesions may completely girdle the stem, a phase of the disease known as "collar rot," which may lead to reduced plant vigor or death (Kemmitt, 2012). *Alternaria solani* contains enzymes such as cellulases

which degrade the host cell wall and also contain pectin methyl galacturonase which facilitate host colonization (Shahbazi *et al.*, 2011). Preventive fungicides inhibit the spore germination and penetration but pathogen can derive resistance against fungicide application so repeated application of fungicides at proper dose and interval of time is mandatory (Hossain and Hossain, 2009; Kumara *et al.*, 2010). It needs to develop new effective fungicides with better mode of action which will be helpful for increase in quality and quantity of tomato production (Sahu *et al.*, 2013). However, this investigation was designed to evaluate of six combi fungicides against the menace of early blight of tomato under *in vivo* conditions.



Fig.-1 : Necrotic spots with concentric rings like symptoms on tomato leaf and fruit.

Materials and Methods

The present study was carried out at the experimental field of Krishi Vigyan Kendra, Satna (M.P.), during rabi season of 2019-20 in RCBD with 3 replications and 7 treatments including control with plot size of 3x2 m² to know the effect of 0.4 % (T₃), Hexaconazole 5 % + Captan 70 % (Taqat 75 % WP) @ 0.2 % (T₄), Zineb 68 % + Hexaconazole 4 % (Avtar 72 % WP) @ 0.25 % (T₅), Carbendazim 12 % + Mancozeb 63 % (Saaf 75 % WP) @ 0.2 % (T₆) and Untreated control (Spray of plain water) (T₇). Seeds of tomato variety Kashi Aman were procured from Indian Institute of Vegetable Research (IIVR) Varanasi (U.P.). The plot size for each treatment was 32 m² and distance between row to row and plant to plant was 4530 cm. 25 days' old seedlings were transplanted in the main field. Recommended cultural practices were uniformly followed to raise the crop successfully. The crop was fertilized with basal dose of 100:60:60 kg ha⁻¹ N, P and K, respectively. Timely hoeing and weeding operations were carried out to ensure soil moisture and remove weeds. Two sprays of each fungicide with their prefixed concentration were applied at an interval of 15 days after the first appearance of disease symptoms in the leaves, control plots were sprayed with plain water. The per cent disease intensity was recorded after 7 days interval as per two consecutive sprays of fungicides. The disease intensity of early blight of tomato was recorded by

using 0-5 scale (Table 2). Five infected plants were selected randomly from each plot and five leaves were selected from each selected plant for scoring the disease intensity data (Singh, 2004).

Per cent Disease Intensity (PDI) : The per cent disease intensity (PDI) was calculated by using the following formula given by (Pandey *et al.*, 2002).

$$\text{PDI} = \frac{\text{Sum of all disease ratings}}{\text{Total no. of observations (sample)} \times \text{Maximal disease rating grade}} \times 100$$

Statistical analysis : Based on these observations, percent disease intensity (PDI) of early blight of tomato was recorded. The per cent disease intensity data was arcsine transformed before analysis of variance (ANOVA). Statistical analysis was done with using the standard procedure described by (Gomez and Gomez, 1986).

Results and Discussion

The diseases scoring before spray were varied from 0 to 1 and the per cent disease intensity (PDI) was recorded 2.10 % to 3.29 %. After 7 days of 1st foliar spray of fungicide in all the fungicide sprayed plots the disease score varied from 0 to 2. But in the case of untreated control plot the maximum disease score recorded was 5. The per cent disease intensity calculated from the disease score was found to be highest in case of untreated control plot (24.78 %). Tebuconazole 50 % + Trifloxystrobin 25 % (WG) was found to be most effective in controlling the disease by recording the minimum per cent disease intensity as (2.62 %), followed by Metiram 55 % + Pyraclostrobin 5 % (WG) having PDI with 5.23 % (Table 3). It was also found that there was no disease spread in that plot after the first spray, where the chemical Tebuconazole 50 % + Trifloxystrobin 25 % (WG) was sprayed, as the per cent disease intensity was 2.62 % before the spray. After 7 days of 2nd spray of fungicide data revealed that all the tested fungicides were found to be significantly superior over control. The maximum per cent disease intensity was recorded with control plot (28.01 %). Tebuconazole 50 % + Trifloxystrobin 25 % (WG) was found to be most effective in controlling the disease by recording the minimum per cent disease intensity as (3.32 %), followed by Metiram 55 % + Pyraclostrobin 5 % (WG) having PDI with 6.11 % (Table 3). At the time of harvest, maximum per cent disease intensity was recorded in the control plot i.e. 45.33 %. The plants treated with Tebuconazole 50 % + Trifloxystrobin 25 % (WG) had 8.11 % and was found the most effective fungicide for controlling the early blight disease, followed by the PDI of 12.59 %, 13.33 % and 14.62 % in the plots sprayed with Metiram 55 % + Pyraclostrobin 5 % (WG),

Table-1 : List of combi fungicides used in experiment.

S. No.	Chemical name	Trade name	Concentration (%)
1.	Tebuconazole 50% + Trifloxystrobin 25% (WG)	Nativo	0.1
2.	Azoxystrobin 18.2% + Difenconazole 11.4% (SC)	Amistar Top	0.13
3.	Metiram 55% + Pyraclostrobin 5% (WG)	Cabrio Top	0.4
4.	Hexaconazole 5% + Captan 70% (WP)	Taqat	0.2
5.	Zineb 68% + Hexaconazole 4% (WP)	Avtar	0.25
6.	Carbendazim 12% + Mancozeb 63% (WP)	Saaf	0.2
7.	Untreated Control	Plain Water	-

Table-2 : Disease rating scales.

Disease score	Disease severity
0	No infection
1	0.1-1.0 Per cent leaf area affected
2	1.1-10.0 Per cent leaf area affected
3	10.1-25.0 Per cent leaf area affected
4	25.1-50.0 Per cent leaf area affected
5	< 50.1 Per cent leaf area affected

Table-3 : In vivo evaluation of new combi fungicides against early blight disease and fruit yield of tomato.

Sl. No.	Name of fungicides	PDI before spray (%)	PDI at 7 days after the 1 st spray (%)	PDI at 7 days after the 2 nd spray (%)	PDI at harvest (%)	Fruit yield (t/ha)	% Increase in yield over control
1.	T1-Tebuconazole 50 % + Trifloxystrobin 25 % (WG)	2.62	2.62	3.32	8.11	35.06	117.22
2.	T2-Azoxystrobin 18.2% + Difenconazole 11.4% (SC)	2.67	8.12	8.66	13.33	28.15	74.41
3.	T3-Metiram 55 % + Pyraclostrobin 5 % (WG)	2.10	5.23	6.11	12.59	31.68	96.28
4.	T4-Hexaconazole 5 % Captan 70 % (WP)	2.67	9.38	10.12	14.62	28.11	74.16
5.	T5-Zineb 68 % + Hexaconazole 4 % (WP)	3.29	11.31	12.64	16.67	27.59	70.94
6.	T6-Carbendazim 12 % + Mancozeb 63 % (WP)	2.68	14.56	18.49	21.32	22.10	36.93
7.	T7-Control	2.67	24.78	28.01	45.33	16.14	-
	Overall mean	2.67	10.86	12.48	18.85	26.98	78.34
	F-test	S	S	S	S	S	
	SEm+	NS	0.144	0.147	0.86	0.91	
	CD at 5%	NS	0.44	0.45	2.65	2.80	

Azoxystrobin 18.2 % + Difenconazole 11.4 % (SC) and Hexaconazole 5 % + Captan 70 % (WP), respectively (Table 3). Least control of disease was recorded in Carbendazim 12 % + Mancozeb 63 % WP (21.32 %) treated plots. Total fruit yield was significantly higher in all the treatments i.e. sprayed with chemicals as compared to control. However, the maximum fruit yield (35.06 t/ha) was obtained in plots sprayed with Tebuconazole 50 % + Trifloxystrobin 25 % (WG) and least yield (22.10 t/ha) was recorded in Carbendazim 12 % + Mancozeb 63 % (WP) (Table 3). However, Carbendazim 12 % + Mancozeb 63 % (WP) had significantly higher fruit yield as compared to untreated control plots (16.14 t/ha). Among the fungal diseases early blight caused by *Alternaria solani* (Ellis and Martin) Jones and Grout, is one of the most destructive disease of tomato in tropical and subtropical regions (Raina et al., 2018 and Thippeswami et al., 2017). *Alternaria solani* is a soil inhabiting air-borne pathogen responsible for leaf blight, collar and fruit rot of tomato (Abada et al., 2008). To effectively control of early blight disease, chemical management is the only way to reduce

the disease severity. In this study we found that, the minimum per cent disease intensity (8.11 %) of early blight and maximum fruit yield (35.06 t/ha) was recorder with the sprayed of Tebuconazole 50 % + Trifloxystrobin 25 % (WG) @ 0.1 % plot as compared to other treatments. The probable reason for such finding may be that, Tebuconazole 50 % + Trifloxystrobin 25 % (WG) would have affected the early blight disease intensity. This resulted in better overall growth and good health of tomato plants. This was also supported by the findings of (Tiwari et al., 2004; Yadav and Dabbas, 2012) against early blight of potato.

Conclusion

From the present investigation it was found that, application of strobilurin groups of fungicides (Azoxystrobin and Trifloxystrobin) combined with triazole groups of fungicides (Tebuconazole and Difenconazole) had better control on the early blight disease of tomato and gave higher fruit yield under *in vivo* conditions.

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Socio-Economic Analysis of Different Agroforestry Systems in Nayagarh District, Odisha

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Abstract

Agroforestry is known to offer a wide range of livelihood benefits to farmers viz higher crop yields and incomes, greater food security and better resilience to climate change. The purpose and role of why agroforestry should be adopted are better explained by the farmers who adopt agroforestry as land management option. Hence this study was carried out with a purpose to know the socioeconomic status of farmers practicing agroforestry in Nayagarh, Odisha in 2019-20 and through stratified random sampling technique, 100 numbers of household were surveyed. Majority of the households had an annual income of Rs. 50,000 – Rs.1 lakh per annum. The present research was designed to examine the significance of agroforestry through agroforestry interventions for the socio-economic upliftment of rural households. The data was collected through a structured interview schedule by personal interviews of the respondents. In the study area, the majority of respondents were middle-aged, illiterate, unemployed and low-income. Most of them belonged to the Scheduled Tribe. Agriculture was the primary occupation for their livelihood and revenue generation, followed by agroforestry. Eight major agroforestry practices were widespread in the area, including; bund plantation, block plantation, homestead, aquaforestry, agrisilviculture, silvihorti, silvipasture and others. Bund plantation, homestead and agrisilviculture are major agroforestry practices adopted and Agroforestry were primary occupation for (68%) farmers, secondary occupation (17%) and tertiary occupation (12%) of farmers. Under bund plantation the crops occupy 18.77 ha, Trees 14.5 ha fruit trees 10.69ha. In block plantation crops were 1.05 ha, Trees 12.23ha, Fruit trees 9.91ha and highest crops area comes under bund plantation, highest trees area comes under Agrisilviculture system and highest fruit trees area comes under Silvihorti system. The data revealed that total crops area under different systems was 52.9 ha, total trees areas were 77.54ha and total fruit trees areas were 54.94ha. In others some flowers and trees were cultivated which occupied total area of 2.42ha. The finding of the present study suggests to consider socio-economic factor while designing agroforestry models for the study area. The existing agroforestry practices also need improvement by incorporating important fruit, fodder and timber trees as per farmers' choice and objectives. The study concluded that the socioeconomic status of the farmers was satisfactory due to improvement brought out by adoption of agroforestry.

Key words : Agroforestry system, bund plantation and socioeconomic analysis.

Introduction

Agroforestry is described as “a collective name for land use systems and technologies in which woody perennials are purposely combined with herbaceous crops and or animals in the same land management unit” (Nair *et al.*, 2008). Agroforestry is an eco-friendly and sustainable modern farming land use practice that maintains overall farm productivity by combining herbaceous food crops with woody perennial trees and livestock on the same piece of land, either alternately or at the same time, using scientific management practices that improve the socioeconomic condition of people. It is an effective and alternative management system to meet the target of increasing forest cover to 33 % as given by the national forest policy. In agroforestry systems, the trees grown on different farmlands in the same locality when aggregated can bring about improved wooded situation thereby enhancing environmental protection (Otegbeye, 2002). Socio-economic appraisal is the way citizens, individuals, communities or organisations can think about social and

economic circumstances (Abdrabo and Hassan, 2003). Socio-economic research in the fields of farmers and their link to agroforestry is significant (Irshad *et al.*, 2011). In such management methods, such as field management and agroforestry practices, the socio-economic position of farmers plays an important role in relation to the economic potential of agroforestry practices adopted by farmers. Agroforestry has both protective and social-economic benefit. Kang (1993) reported that besides direct agricultural benefit, trees exhibit socio-economic values. The benefit of the tree components derived by farmers from agroforestry was evaluated from a social- economic and ecological perspective (Anderson and Sinclair, 1993). The social-economic benefits of agroforestry can be evaluated in terms of productivity, stability and sustainability. Socio-economic study of farmer and their relationship to agroforestry is highly important. This word helps as certain opportunities for development of agroforestry system in our country. Analyzing the household and farm characteristics can help the process of effective planning system farm forestry. Sinclair and

Walker (1999) indicated the lack of quantitative and predictive understanding about traditional agroforestry practices and its importance in making them more adoptable developing new strategies for encouraging farmer to grow tree and improvement in existing agroforestry system can be designed.

Nayagarh district mainly depends on agriculture, forest produce and seasonal migration to different parts of the country. An understanding of socioeconomic status of agroforestry farmers and their relationship to the agroforestry is highly important. This would help to ascertain the opportunities for the development of the system (Irshad *et al.*, 2011). Hence this study was carried out with a purpose to know the socioeconomic status of farmers practicing different agroforestry in the study area.

Materials and Methods

The study site is located in Daspatha and Nayagarh block of Nayagarh District, Odisha State, 5 villages from each of two blocks of district Nayagarh were included in surveys. Hence, 10 villages from two blocks had been selected. 10 of each village were further selected randomly from each sample village for detailed survey.

The study area was surveyed through household survey with the help of questionnaire using stratified random sampling technique. Different methods were adopted in this case study house hold interviews, focus group discussions and participatory rural appraisal and agroforestry surveys. This study utilizes both primary and secondary sources for collecting quantitative and qualitative data. The main method of collecting primary data was from the household survey with all categories of farmers. Quantitative data were collected mainly by administering questionnaires followed by observation, interview-discussion, group discussion, whenever happened with key informants while qualitative data were collected through questionnaire execution and field visits. For data collection on socio-economic status, household survey through well structured questionnaires, the information collected from them regarding their socio economic status, general awareness with respect to various agroforestry activities, participation in to various agroforestry activities and people's participation in agroforestry programmes. Data collected on ecological characteristics, socio-economic characteristics, land use characteristics and resources/ supporting services. The selection criteria for study of villages were their geographical distribution under districts and presence of agroforestry in that area using random sampling. Thus 100 random households in the selected villages were surveyed to determine average land holding size, area under different land uses, crops, trees and shrubs used for various purposes and management practices.

Results and Discussion

Socioeconomic profile : The Socioeconomic study of the area is shown in Table 1. The table indicated that maximum respondents were in the age group of 30 to 40 years (36%) followed by the age group of 40 to 50 years (23%) and age group 20 to 30 years (22%). The least respondents of 19% were found in the age group of >50 years. 79% Percentage of male farmers and only 21% female farmers and majority of households (40%) belongs to ST category followed by 27% belongs General category, 17% belongs to OBC and minimum 16% belongs to SC category found in the area. It was found that married farmers were reported maximum (91%). unmarried farmers, widow and divorce were reported 7%, 1% and 1% respectively. 71 percent households were illiterate. In literate categories 17 % households were educated at primary level, around 7 % households study at intermediate level. Highly educated viz graduate level household were only 1 % and any other like vocational/ITI were 4 %. Nuclear family was found to be the highest (85%) whereas joint family was the lowest (15%). Found that the majority of households were having family members 4 to 8 (48%) followed by up to four (37%). Households having 8 to 12 members are (9%) and above 12 members were quite low (6%). among land holding, landless farmers were 8%, percentage of farmers having marginal land-holding were 24 %, having small land-holding were 38 %, having medium land-holding was 16 % and having large land-holding were 13 % of total land holding. It was observed from figure 4.9., that maximum number of respondents i.e. (90%) followed by leased in (8%). Among total land holding leased out & owner and leased out are (1%) each. Among the different types of land like irrigated and non- irrigated almost all land (100%) came under irrigated condition while Farmers owning thatched houses were more (45%) while farmers having kutchha houses were (38%). Farmers owning semi pucca and pucca were (13%) and (4%) respectively. Most of the farmers were unemployed (54%) and 38% were self employed that means they depend on agriculture and agroforestry practices. 1% farmers were under others category. Integrating agroforestry systems into the ongoing agricultural system would raise the revenue of households by rising on-farm production. Salam *et al.* (2000) found that tree planting on the farm resulted in increased average household income and rural poverty alleviation.

It is revealed from the table-2, that only two socio-economic attributes i.e. age and employment status are contributing to systems. Though they are highly correlated with each other and the model summary table

Table-1 : Socio-economic characters of farmers.

Details of the Household		Total % (N=100)
Age (yrs)	20-30	22
	30-40	36
	40-50	23
	>50	19
Gender	Male	79
	Female	21
Caste	SC	16
	ST	40
	OBC	17
	General	27
Marital status	Single	07
	Married	91
	Widow	01
	Divorce	01
Literacy	Illiterate	71
	Primary	17
	Intermediate	07
	Graduate and other	01
	Anyother (vocational/ITI)	04
Types of family	Nuclear	85
	Joint	15
Family member	Upto 4 members	37
	4-8 members	48
	8-12 members	09
	>12 members	06
Land holding	Landless	08
	Marginal (<1 ha)	24
	Small (1-2 ha)	38
	Medium(2-4 ha)	16
	Large (>4ha)	13
Type of owner-ship of land	Owner	90
	Leased in	08
	Leased out	01
	Owner and leased out	01
Types of land	Irrigated	100
	Non irrigated	-
Types of house-hold	Pucca	04
	Semi pucca	13
	Kutchra	38
	Thatched house	45
Employment status	Fulltime employed	03
	Parttime employed	04
	Self employed	38
	Unemployed	54
	Others	01

describes that the R^2 value is 0.235 indicating that the overall contribution is 23.5% of the systems.

Occupational profile of households : The occupation profile of the household is divided into three groups i.e. Primary, Secondary and Tertiary. The occupation has been divided into following group like Agriculture, Agroforestry, Labour, Cattle rearing, private service, govt. service, , Employment and others. A perusal of the table no. 3 indicated that in all villages almost all households (100%) were engaged in agriculture which is their primary

occupation. The data shows that Agroforestry were primary occupation for (68%) farmers, secondary occupation (17%) and tertiary occupation (12%) of farmers. Cattle rearing were one of the important component of occupation as it was the primary occupation for (50%) farmers, secondary occupation for (35%) and tertiary for (15%) farmers, Among other Primary occupations Govt. service (4%) and rest like Labour, Private service, Business, family occupation which we can say almost nil. Households with a higher social status and more capital can more readily handle the burden of embracing innovation and are thus innovators or early adopters (Kragten *et al.* 2001). Higher household income is thus projected to increase the risk of the decision of farmers to produce more trees per household. Similar study by Himshikha (2016) reported that the agriculture 99.45% of farmers do agriculture in Haridwar, Uttarakhand.

Annual Income : It was found from the table-4 that majority of the household i.e.34% had an annual income of Rs. 50,000 – Rs.1 lakh followed by 23% have Rs. 25,000 – Rs. 50,000, 22% had more than 1lakh, 12% had Rs. 10,000 – Rs. 25,000 and least i.e.10% had less than Rs10,000.

It could be inferred from above table that majority of the households had an annual income of Rs. 50,000 – Rs.1 lakh per annum. This may be due to the fact that most of the people have small land holding and they mostly depend on farming for income generation.

Land distribution under Agroforestry practices : While studying the degree of the adoption of agroforestry practice, land distribution under agroforestry practice types was significant as it demonstrates the desire of farmers to broaden agroforestry practices in their sector. In the study region, Table no. 5. showed land distribution under recorded agroforestry activities.

It was clear that maximum land (43.5 ha) had been utilized under Bund plantation (23.11%), followed by 42.3 ha in Agrisilviculture (22.47%) and 39.4 ha in Homestead practices (20.93%). Rest of land had been distributed in Silvihorti 24.9 ha (13.23%), Block plantation 23.2 ha (12.32%), Aquaforestry.8 ha land under other practices (0.42%). In the study sites the area of different plants area under different systems were like Bund plantation, Block plantation, Homestead, Aquaforestry, Agrisilviculture, Silvihorti, Silvipasture and others are in the following table no. 6.

Under bund plantation the crops occupy 18.77 ha, Trees 14.5 ha fruit trees 10.69ha. In block plantation crops were 1.05 ha, Trees 12.23ha, Fruit trees 9.91ha. Likewise different plants were known from table. The

Table-2 : Multiple regression analysis.

Coefficients ^a						
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1.	(Constant)	13.137	26.064	-	0.504	0.616
	Age	-19.036	7.811	-0.855	-2.437	0.017*
	Gender	6.328	12.443	0.112	0.509	0.612
	Caste	10.663	8.761	0.490	1.217	0.227
	Marital Status	-15.977	13.756	-0.240	-1.161	0.249
	Literacy	-4.784	7.671	-0.201	-0.624	0.535
	Type of family	11.469	14.834	0.179	0.773	0.442
	Family member	0.494	8.445	0.018	0.058	0.954
	Land holding	-5.390	7.138	-0.266	-0.755	0.452
	Ownership	6.257	12.544	0.120	0.499	0.619
	Types of land	9.981	23.345	0.074	0.428	0.670
	Types of household	-6.559	9.622	-0.236	-0.682	0.497
	Employment Status	16.034	8.151	0.509	1.967	0.052*

a. Dependent Variable : Systems

Model	R	R ²	Model Summary	Adjusted R ²	Std. Error of the Estimate
1	.485a	.235		.130	21.47897

a. Predictors : (Constant), employment status, types of land, gender, marital status, type of family, types of household, ownership, family member, literacy, age, land holding, caste.

Table-3 : Occupation of the respondents.

Sl. No.	Type	Category	Total (%)
1.	Agriculture	Primary	100
		Secondary	-
		Tertiary	-
2.	Agroforestry	Primary	68
		Secondary	17
		Tertiary	12
3.	Labour	Primary	-
		Secondary	27
		Tertiary	73
4.	Cattle rearing	Primary	50
		Secondary	35
		Tertiary	15
5.	Private service	Primary	-
		Secondary	4
		Tertiary	6
6.	Govt. Service	Primary	4
		Secondary	-
		Tertiary	-
7.	Unemployment	Primary	85
		Secondary	12
		Tertiary	3

Table-4 : Annual income (Rs) of the respondents.

Sl. No.	Annual Income (Rs)	Total (%)
1.	<10,000	10
2.	10,000-25,000	12
3.	25,000-50,000	23
4.	50,000-1lakh	34
5.	>1 lakh	22

Conclusions

The major motivating factor for adoption of commercial agroforestry in Nayagarh was assured income obtained from bund plantation. From the study it is found that majority of respondent/farmers and surveyed households were male-headed; majority of farmers' families fell under ST and general categories; the majority of farmers were middle age but Illiterate more. The farmers were largely dependent on agriculture, agroforestry and horticulture for income generation for their livelihood and maximum are self employed .Most of the farmers were from nuclear size families. Approximately more than one third of the total agroforestry farmers considered farming as their primary occupation and most of them considered agriculture as their major source of income. There is a major correlation between individual and social influences, such as age, education, profession, annual income, family size, house sizes, family size, land ownership, livestock properties, land use system, standard timber, small wood, fuel wood, fruit and vegetables, crops, and agroforestry system adoption, among various socioeconomic characteristics. Study shown that the socioeconomic status of the farmers in the study area was satisfactory as adoption of

results showed that highest crops area comes under bund plantation, highest trees area comes under Agrisilviculture system and highest fruit trees area comes under Silvihorti system. The data revealed that total crops areas under different systems were 52.9 ha, total tress area were 77.54ha and total fruit trees area were 54.94ha. In others some flowers and trees were cultivated which occupied total area of 2.42ha.

Table-5 : Land distribution under Agroforestry practices.

System	Land (ha) under agroforestry	Land covered (%)	Rank
Bund Plantation	43.5	23.11	1
Block Plantation	23.2	12.32	5
Homestead	39.4	20.93	3
Aquaforestry	11.4	6.05	6
Agrisilviculture	42.3	22.47	2
Silvihorti	24.9	13.23	4
Silvipasture	2.7	1.43	7
Others	0.8	0.42	8
Total	188.2	100	-

Table-6 : Total area of plants under different Agroforestry systems in the villages.

Systems	Total area (ha) of plants under different systems			
	Crops	Trees	Fruit Trees	Others
Bund Plantation	18.77	14.5	10.69	-
Block Plantation	1.05	12.23	9.91	-
Homestead	12.41	13.4	12.58	0.99
Aquaforestry	-	4.2	6.71	0.48
Agrisilviculture	20.67	20.67	-	0.95
Silvihorti	-	9.84	15.05	-
Silvipasture	-	2.7	-	-
Others	-	-	-	-
Total	52.9	77.54	54.94	2.42

agroforestry had improved it. It is concluded that eight major agroforestry practices are widespread in the area, including; bund plantation, block plantation, homestead, aquaforestry, agrisilviculture, silvihorti, silvipasture and others. Bund plantation, homestead and agrisilviculture are major agroforestry practices adopted. From the findings, there is evidence of a strong correlation between socio- economic factors studied and agroforestry adoption, which also leads to their important role in the adoption of agroforestry activities. Finally the study concluded that the socioeconomic status of the farmers in the study area was satisfactory because of the adoption of various agroforestry systems.

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Mitigating the Dry Spell Effect through Foliar Application of Nutrients and Chemicals on Maize in Dryland Areas of South-East Rajasthan

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Abstract

A field experiment was conducted at Dryland Farming Research Station, Arjia, Bhilwara (Maharana Pratap University of Agriculture and Technology, Udaipur), Rajasthan during kharif for three years (2012 - 2015) to study the effect of foliar spray of different nutrients and chemicals on maize crop under rainfed environment. The experiment consisted of nine treatments and was laid out in a randomized block design with three replications. The treatments are as follows: T₁-Control, T₂-Water spray, T₃-Soluble NPK (19:19:19) @ 2 percent concentration, T₄-ZnSO₄ 0.5 percent concentration, T₅-Soluble NPK (19:19:19) @ 2.0 percent + ZnSO₄ @ 0.5 percent concentration, T₆-Selenium @ 20g ha⁻¹ and T₇-KNO₃ @ 2 percent concentration. Foliar application of nutrients was applied twice as per treatment during the dry spell before knee high stage and grain filling stage with RDF (50:30:0). Foliar application of soluble NPK @ percent + ZnSO₄ @ 0.5 percent recorded significantly 32 percent higher maize grain yield (2683 kg/ha) followed by soluble complex fertilizer NPK (19:19:19) @ 2 percent (2473 kg/ha), zinck sulphate @ 0.5 percent (2473 kg/ha), potassium nitrate @ 2 percent (2400 kg/ha) and selenium @ 20g/ha (2363 kg/ha) as compared to control (2032 kg/ha). The plant height, cob placement, 1000 grain weight (g) were also recorded higher under foliar application of soluble complex fertilizer NPK (19:19:19) @ 2 percent + zinck sulphate @ 0.5 percent followed by soluble complex fertilizer NPK (19:19:19) @ 2%, zinck sulphate @ 0.5 percent, potassium nitrate @2% and Selenium @ 20g/ha as compared to control, respectively due to foliar application during the dry spells (>10 days) before knee high and grain filling stage. Further, spray of soluble NPK (19:19:19) @ 2 percent + zinc sulphate @ 0.5 percent before at knee high stage and tasseling stage during dry spell obtained highest net return (Rs. 60990/- per ha), benefit cost ratio (3.41) and RWUE (rainwater use efficiency (4.74 kg grain/ ha/ mm rainfall) in comparison to control (Rs. 43331/- per ha, B:C ratio (2.66) and RWUE 3.59), respectively.

Key words : Foliar spray; potassium; zinc sulphate; crop growth rate; dryland; tasseling.

Introduction

Maize (*Zea mays* L.) ranks 3rd as a food-grain crop after wheat and rice and it is not only as a cereal but also as vegetable and fodder crop. In dryland areas, during dry spell period crops exposed to the drought and farmers are not aware to spray of chemical/nutrient during dry spells and maize crop adversely affected under long dry spell due lack of moisture and less uptake of plant nutrients, under these situation maize crop growth was adversely affected and crop yield is reduced drastically. Drought stress during the early vegetative phase limits shoot elongation, leaf area and tillering, possibly by decreased CO₂ assimilation in the leaf and slow nutrient mobilization to growing tissues due to decreased stomatal conductance, transpiration and low relative water content (Barnabas et al., 2008; Lipiec et al., 2013; Aslam et al., 2013). Drought stress during the early reproductive stage, coinciding with the young microspore stage, leads to pollen the spikelet abortion, thus decreasing grain numbers in rice and wheat (Dolferus et al., 2011; Kato et al., 2008). Even a mild drought stress during pre-anthesis led to a 70% decrease in secondary branches and a 45 percent decrease in spikelet/panicle number in rice (Kato

et al., 2008). Similarly, extended anthesis-silking interval under drought stress decreased sink size and final grain number in maize (Barnabas et al., 2008; Aslam et al., 2013). At anthesis, drought stress increases pollen and ovary abortion, induces poor anther dehiscence and restricts panicle exertion due to shortened peduncle length, resulting in higher spikelet sterility in rice, wheat and maize (Liu et al., 2006; Praba et al., 2009; Rang et al., 2011; Powell et al., 2012). Moreover, high abscisic acid accumulation under drought represses the sucrose supply to pollen, resulting in low pollen viability in rice, wheat and other cereals (Powell et al., 2012). Parenthesis water-limited conditions alter flowering time depending upon the duration and intensity of drought stress and asynchronous; advanced or delayed flowering has been observed in wheat (Foulkes et al. 2007 and Cattivelli et al., 2008). At grain filling, terminal drought results in early senescence with shorter grain-filling, duration and low green flag-leaf area persistence in wheat and barley (Samarah, 2005; Foulkes et al., 2007). Moreover, assimilate limitation under server drought can lower grain number and 1000-grain weight in rice, wheat and barley (Samarah, 2005; Praba et al., 2009; Powell et al., 2012).

In recent years on demonstrative fields complex fertilizers and deficient micro nutrient were used as foliar spray for mitigating the dry spell stress in different crops to improve the water balance in the plant which ultimately increases productivity of crop under dryland conditions. The major primary nutrients i.e. N, P and K, micronutrients i.e. zinc has been recognized as essential inputs for sustained the maize productivity and enhancement in its quality in dryland areas. Nitrogen (N) is a vital plant nutrient and a major determining factor required for maize production (Shanti et al., 1997). Nitrogen is a component of protein and nucleic acids and when N is suboptimal, growth is reduced. Its availability in sufficient quantity throughout the growing season is essential for optimum maize growth (Haque et al., 2001). Phosphorus, as a constituent of ADP and ATP, plays a key role in energy transformation. It also helps in assimilation of photosynthates into other metabolites and hence acts as an activity zone for CO₂ assimilation. It is important for seed and fruit formation and crop maturation. Phosphorus hastens ripening of fruits thus counteracting the effect of excess nitrogen application to the soil. Moreover, as an integral part of chromosomes, it stimulates cell division and is necessary for meristematic growth. Likewise, potassium is an essential nutrient and is also the most abundant cation in plants. It plays essential roles in enzyme activation, protein synthesis, photosynthesis, osmoregulation, stomatal movement, energy transfer, phloem transport, cation-anion balance, and stress resistance (Gul et al., 2015). As well as zinc also have great influence on basic plant life processes, such as nitrogen metabolism, uptake of nitrogen and protein quality, photosynthesis and chlorophyll synthesis, carbon anhydrase activity, resistance to abiotic and biotic stresses protection against oxidative damage (Cakmak 2008). Therefore, keeping the above facts in view, the present investigation was undertaken to examine the impact with objectives to assess the effect of foliar sprays of nutrients and chemicals for combating dry spell effect on plant growth, yield and economics and also find out the best economic and viable treatment to enhance the productivity of maize in dryland areas.

Methods and Materials

A field experiment was conducted at Dryland Farming Research Station, Arjia, Bhilwara (Maharana Pratap University of Agriculture and Technology, Udaipur), Rajasthan during kharif for three years (2012-2015) to study the effect of foliar spray of different nutrients and chemicals on maize crop under rainfed environment. Soil of the site were Inceptosols with pH 7.8, EC 0.32 and organic carbon 0.43, low in available nitrogen (200.72 kg/ha), high in available phosphorus (38.16 kg/ha) and

high in available potassium (423.0 kg/ha). The experiment consisted of nine treatments, and was laid out in a randomized block design with three replications. The treatments are as follows: T₁-Control, T₂-Water spray, T₃-Soluble NPK (19:19:19) @ 2 percent concentration, T₄-ZnSO₄ 0.5 percent concentration, T₅-Soluble NPK (19:19:19) @ 2.0 percent + ZnSO₄ @ 0.5 percent concentration, T₆-Selenium @ 20g ha⁻¹ and T₇-KNO₃ @ 2 percent concentration. The Experiment was sown at the onset of monsoon, maize seeds were sown in lines with row to row spacing 60 cm and plant to plant spacing 25 cm apart. Nutrients were applied as per recommended dose of fertilizer in the agroclimatic zone IV-a Rajasthan. Application of half dose of N and full dose of P₂O₅ at the time of sowing and remaining half dose of N was top dressed at knee high stage in sufficient moisture conditions. Foliar application of nutrients was applied twice as per treatment during the dry spell before knee high stage and grain filling stage.

Result and Discussion

Effect on Growth : Data in table-3. reveals that under different treatment application of foliar application of nutrient and chemicals during dry spell (>10 days) before knee high and grain filling stage in maize crop, application of foliar application of soluble complex fertilizer NPK (19:19:19) @ 2% + zink sulphate @ 0.5 % the plant height was recorded significantly higher (204.6 cm/plant) which was 8.83 percent higher as compared to control (188.0 cm/plant). Mahdi *et al.*, (2012) reported that increasing levels of zinc application up to 10 kg Zn ha⁻¹ recorded significantly taller plants and higher leaf area index of fodder maize. Similarly, Meena *et al.*, (2013) reported that in maize application of 5 kg Zn ha⁻¹ produced significantly taller plants and more dry matter plant⁻¹ than 2.5 kg Zn ha⁻¹ but it remained at par with 7.5 kg Zn ha⁻¹. Further, foliar application of nutrient and chemicals during dry spell (>10 days) in maize crop could not significantly affect the plant population and crop placement over control. However, foliar application of soluble NPK (19:19:19) of @ 2% + Zinc sulphate @ 0.5 percent during dry spell significantly increase dry weight of plant (202.0 g/plant) followed by Potassium nitrate @ 2.0 percent (196.33 g/plant), soluble NPK @ (19:19:19) of @ 2% 2.0 percent (196.11 g/plant), Zinc sulphate @ 0.5 percent (193.66 g/plant), urea @ 2.0 percent (191.89 g/plant) over control (196.33 g/plant), respectively. The increase in dry weight per plant of maize in tune of 12.12, 17.72, 17.00, 16.12, and 15.06 percent higher as compared to control (166.78 g/plant), respectively. Balyan *et al.*, (2006) reported that integrated nutrient management in maize improve all growth parameters significantly, plant height, dry matter accumulation g/plant, CGR, NAR in maize crop.

Table-1 : Effect of foliar spray of nutrients/chemicals for mitigating the dry spell on mean yield and economics (2012-15).

Treatment	Yield (kg/ha)		Cost of cultivation (Rs/ha)	Gross return (Rs/ha)	Net return (Rs/ha)	B:C ratio	RWUE (kg grain/ha/mm)
	Grain	Stover					
T ₁ -Absolute Control	2032	5278	16285	59616	43331	2.66	3.59
T ₂ -Water spray	2067	5467	16545	61084	44539	2.69	3.65
T ₃ -soluble NPK (19:19:19) @ 2%	2473	6664	16697	73636	56939	3.41	4.37
T ₄ -ZnSO ₄ 0.5%	2461	6314	16697	71850	55153	3.30	4.35
T ₅ -soluble NPK (19:19:19) @ 2% + ZnSO ₄ 0.5%	2683	7009	17905	78895	60990	3.41	4.74
T ₆ -Selenium@20g/ha	2363	6320	17125	70147	53022	3.10	4.18
T ₈ -KNO ₃ 2%	2400	6336	16905	70872	53967	3.19	4.24
S. Em+	86	311					
C.D. (P=0.05)	256	923					
C.V.%	11.7	8.66					

Table-2 : Effect of foliar spray of nutrients/chemicals to mitigating the dry spell effect on yield of maize crop (mean of three years).

Treatments	Grain yield (kg/ha)				Stover yield (kg/ha)			
	2012	2014	2015	Mean	2012	2014	2015	Mean
T ₁ -Ab. Control	2944	2001	1152	2032	6888	3852	5094	5278
T ₂ -Water spray	3010	2013	1179	2067	6938	4048	5414	5467
T ₃ -NPK 2%	3556	2441	1424	2473	8589	5032	6372	6664
T ₄ -ZnSO ₄ 0.5%	3530	2336	1515	2461	8545	4395	6003	6314
T ₅ -T ₃ +T ₄	3765	2510	1775	2683	8773	5263	6992	7009
T ₆ -Selenium@20g/ha	3092	2394	1603	2363	7249	4708	7002	6320
T ₇ -KNO ₃ 2%	3314	2302	1585	2400	7998	4384	6628	6336
S.Em+	162	110	86		374	309	311	
C.D. at 5%	481	326	256		1112	918	923	
C.V.%	8.48	9.51	11.70		8.29	1182	8.66	
Rainfall (mm)	518.2	673.2	506.2					

*During 2013 crop was failed due 31 days long dry spell (16th Aug. to maturity) from tasselling to maturity of maize crop.

Table-3 : Effect of foliar spray of nutrients/chemicals during dry spell on growth parameters of maize (2012-15).

Treatment	Plant height (cm)	Plant population 000'/ha	Cob placement (cm)	Dry wt./Plant (g)
T ₁ -Absolute Control	188.0	64.17	85.67	166.78
T ₂ -Water spray	190.2	66.67	85.67	168.89
T ₃ -NPK 2%	195.2	64.86	86.00	195.11
T ₄ -ZnSO ₄ 0.5%	195.1	66.11	82.78	193.66
T ₅ -T ₃ +T ₄	204.6	66.53	80.89	202.00
T ₆ -Selenium@20g/ha	192.3	66.25	85.33	182.89
T ₇ -Urea 2%	190.1	66.53	84.22	191.89
T ₈ -KNO ₃ 2%	192.2	66.39	80.44	196.33
S. Em+	5.3	1.61	3.67	7.35
C.D. (P=0.05)	15.68	NS	NS	22.25

Effect on yield attributing characters : Data in table-4. reveals that under different treatment application of foliar application of nutrient and chemicals during dry spell in maize crop could not significantly affect the number of cob/plant over control. Further, foliar application of soluble NPK (19:19:19) of @ 2% + Zinc sulphate @ 0.5 % during dry spell significantly increase number of grain/cob (365.67 grain/cob) which was 17.96 percent higher in comparison to control (31.0 grain/cob) but rest of the treatment were found at par in comparison to control.

Similarly, data reveals that foliar application of soluble NPK (19:19:19) @ 2% + Zinc sulphate @ 0.5 % during dry spell significantly increase of grain yield/cob

(201.56 g/cob) followed by soluble NPK (19:19:19) of @ 2% (195.22 g/cob) but rest of the treatment were found at par in comparison to control (188.0 g/cob), respectively. Mohsin *et al.*, (2014) results showed that maize hybrid Pioneer 30-Y-87, combined application of Zn as seed priming (2%) and foliar spray (2%) significantly increased the cob length, cob diameter, 1000- grain weight, grain yield, biological yield and harvest index. The increase in dry weight per plant of maize under foliar application of soluble NPK (19:19:19) @ 2% + Zinc sulphate @ 0.5% and soluble NPK (19:19:19) @ 2 % were 7.21 and 3.84 percent higher as compared to control (188.0 g/cob), respectively.

Table-4 : Effect of foliar spray of nutrients/chemicals during dry spell on yield attributes characters of maize (2012-15).

Treatment	No. of grains/ cob	Grain yield/ cob (g)	1000-grain weight (g)	No. of cobs/plant
T ₁ -Absolute Control	310.00	188.00	181.08	1.00
T ₂ -Water spray	312.00	190.22	181.41	1.00
T ₃ -NPK 2%	332.33	195.22	197.97	1.11
T ₄ -ZnSO ₄ 0.5%	324.67	193.11	195.73	1.11
T ₅ -T ₃ +T ₄	365.67	201.56	202.50	1.22
T ₆ -Selenium@20g/ha	315.00	192.33	194.60	1.11
T ₇ -Urea 2%	347.33	190.11	193.10	1.11
T ₈ -KNO ₃ 2%	352.33	192.22	196.59	1.11
S. Em+	37.20	5.17	5.22	0.10
C.D. (P=0.05)	NS	15.35	15.45	NS

Table-5 : Effect of foliar spray of nutrients/chemicals on soil moisture regimes under different treatments in maize crop at harvest (2012-15).

Treatment	Depth (cm)	Soil moisture (%)At harvest			
		2012	2014	2015	Mean
T ₁ -Absolute Control	0-15	6.01	6.21	5.21	5.81
	15-30	7.40	8.76	7.06	7.74
	30-45	9.04	10.58	9.58	9.73
	Average	7.48	8.52	7.28	7.76
T ₂ -Water spray	0-15	7.40	6.42	5.42	6.41
	15-30	8.19	8.45	7.45	8.03
	30-45	9.59	10.24	9.24	9.69
	Average	8.39	8.37	7.37	8.04
T ₃ -Soluble NPK(19:19:19) @ 2%	0-15	6.74	5.64	5.64	6.01
	15-30	8.56	8.58	8.58	8.57
	30-45	10.67	10.32	10.32	10.44
	Average	8.66	8.18	8.18	8.34
T ₄ -ZnSO ₄ @ 0.5%	0-15	7.69	7.11	6.11	6.97
	15-30	9.75	8.79	8.79	9.11
	30-45	10.18	10.09	9.09	9.79
	Average	9.21	8.66	8.00	8.62
T ₅ -Soluble NPK(19:19:19) @ 2% + ZnSO ₄ @ 0.5%	0-15	5.87	6.04	6.04	5.98
	15-30	7.13	8.19	8.19	7.84
	30-45	10.05	10.11	10.11	10.09
	Average	7.68	8.11	8.11	7.97
T ₆ -Selenium @ 20 g/ha	0-15	6.17	5.20	5.20	5.52
	15-30	9.59	7.94	7.94	8.49
	30-45	10.19	9.33	9.33	9.62
	Average	8.65	7.49	7.49	7.88
T ₇ -Urea @ 2%	0-15	5.95	6.52	5.36	5.94
	15-30	7.58	8.56	7.01	7.72
	30-45	10.14	9.85	9.14	9.71
	Average	7.89	8.31	7.17	7.79
T ₈ -KNO ₃ @ 2%	0-15	5.48	6.43	6.43	6.11
	15-30	8.06	8.13	8.13	8.11
	30-45	9.34	10.19	10.19	9.91
	Average	7.63	8.25	8.25	8.04
At sowing	0-15	12.51	10.22	11.47	11.40
	15-30	13.78	12.09	12.61	12.83
	30-45	15.32	12.94	13.08	13.78
	Average	13.870	11.75	12.38	12.67

However, data reveals that foliar application of soluble NPK (19:19:19) @ 2% + Zinc sulphate @ 0.5 % during dry spell significantly increase of test weight of maize grain (202.50 g) followed by soluble NPK (19:19:19) of @ 2% (197.97 g) but rest of the treatment were found at par in comparison to control (181.08 g),

respectively. The increase in test weight of maize grain under foliar application of soluble NPK (19:19:19) @ 2% + Zinc sulphate @ 0.5% and soluble NPK (19:19:19) @ 2 % were 11.82 and 9.33 percent higher as compared to control (181.08 g), respectively. Similarly, Balyan, and Kumpawat (2008) reported that dry matter /plant

significantly increased by recommended dose of fertilizer and 5t FYM/ha in maize.

Effect on yield and economics : To mitigating the dry spell stress and improving the production of maize crop under dryland conditions by the use of different nutrient/chemicals used as foliar spray. Data presented in table-1. among all foliar treatments, foliar application of soluble complex fertilizer NPK (19:19:19) @ 2% and zink sulphate @ 0.5 % with 0.25% calcium hydroxide during the dry spells (>10 days) before knee high and grain filling stage recorded significantly 32 percent higher maize grain yield (2683 kg/ha) followed by soluble complex fertilizer NPK (19:19:19) @ 2% (2473 kg/ha), zink sulphate @ 0.5 % (2473 kg/ha), potassium nitrate @2% (2400 kg/ha) and Selenium@20g/ha (2363 kg/ha) as compared to control (2032 kg/ha). Similar trend were reported by Meena *et al.*, 2013. Further, Kumar and Bohra (2014) observed that application of 125% RDF + 10 kg Zn⁻¹ha gave the maximum baby cob (9.24 t/ha), baby corn (2.1 t ha⁻¹) and green fodder yield (30.49 t ha⁻¹) with a net profit (138.81×10³ Rs.ha⁻¹) over control but it remained at par with application of 25 kg S ha⁻¹. Further, spray of soluble NPK (19:19:19) @ 2% + zinc sulphate @ 0.5% before at knee high stage and tasseling stage during dry spell obtained highest net return (Rs. 60990/- per ha), benefit cost ratio (3.41) and RWUE (rainwater use efficiency (4.74 kg grain/ ha/ mm rainfall) in comparison to control (Rs. 43331/- per ha, B:C ratio 2.66 and RWUE 3.59), respectively. similar findings were observed by Azab (2015) reported that combined application of Zn (1.5%) and NPK fertilizer significantly improved cob length, no. of rows, cob girth, 1000-grain weight, grain yield and harvest index as compared to the treatment fertilized only with NPK. Liu *et al.*, (2016) reported that Zn application of 30 kg ZnSO₄ 7H₂O increased grain yield of summer maize. Amanullah *et al.*, (2016) and Balyan *et al.*, (2006) reported that integrated nutrient management on maize recorded higher 1000- grain weight, Number of grains ear⁻¹, grain yield and harvest index were obtained with 0.2% Zn. similar findings were also recorded by Kumar *et al.*, (2015)

Effect on soil moisture : Data presented in table 5 reveals that average soil moisture at sowing was 12.79 percent. Further, data show that maximum mean soil moisture in all depth at harvest under the treatment soluble complex fertilizer NPK (19:19:19) @ 2% (10.44 percent) followed by soluble complex fertilizer NPK (19:19:19) @ 2% + zink sulphate @ 0.5 % (10.09 percent) in comparison to other treatment.

Conclusion

To mitigating the dry spell stress and improving the production of maize crop under dryland conditions by the use of different nutrient/ chemicals used as foliar spray.

Among all foliar treatments, foliar application of soluble complex fertilizer NPK (19:19:19) @ 2% and zink sulphate @ 0.5 % with 0.25% calcium hydroxide during the dry spells (>10 days) before knee high and grain filling stage recorded significantly 32 percent higher maize grain yield (2683 kg/ha) in comparison to control (2032 kg/ha). Further, spray of soluble NPK (19:19:19) @ 2% + zinc sulphate @ 0.5% also obtained highest net return (Rs. 60990/- per ha), benefit cost ratio (3.41) and RWUE (rainwater use efficiency (4.74 kg grain/ ha/ mm rainfall) in comparison to control.

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In Vitro Assessment of Moringa oleifera Leaves as a Source of Non Conventional Livestock Feed

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Abstract

This investigation aims to evaluate the beneficial properties and optimum level of incorporation of *Moringa oleifera* leaves in the diet of livestock by using *in vitro* analysis technique. Six treatment groups of complete feeds T₁, T₂, T₃, T₄, T₅ and T₆, considered in the study were composed with 0, 3, 6, 9, 12 and 15% of *Moringa oleifera* leaves respectively by replacing equal proportions of cotton seed cake present in feed. The results indicated a significant ($p < 0.01$) linear increase in the values of *in vitro* digestibilities and gas production with increasing levels of Moringa leaves in the complete feed. Highest *in vitro* digestibility values and total gas production were observed in T₆ group. The observations concluded that *Moringa oleifera* leaves might be used as non conventional protein source in livestock ration. Supplementation of Moringa leaves at 15% level of complete feed was selected as optimum level of incorporation.

Key words : *Moringa oleifera*, *in vitro*, digestibility, gas production.

Introduction

Scarcity of animal feeds and high price of available feed resources in India is the major issue responsible for low productivity of animals. Incorporation of low cost feed ingredients, with high nutritive value, in animal feed can serve as a helpful approach to overcome this problem. One such feed ingredient is the leaves of *Moringa oleifera* which can be used as a cheap protein supplement for livestock. *Moringa* tree is adaptive to dry climatic conditions of the arid or semi-arid zones. It can also survive in the humid parts during summer. The tree can be cultivated in exceptionally arid regions along with limited rainfall. It is also adaptive to a large variety of soils. Thus it can be considered to ensure green fodder availability round the year without extra efforts. The high nutritional quality and better biomass production of *Moringa oleifera*, especially in dry periods, support its significance as livestock fodder (Nouman *et al.*, 2014). *Moringa* leaves contain 8 important essential amino acids (leucine, iso leucine, methionine, lysine, phenylalanine, tryptophan, threonine, valine), 46 anti-oxidant compounds, 36 anti-inflammatory compounds, phytochemicals, minerals (calcium, chloride, copper, chromium, fluorine, iron, magnesium, manganese, molybdenum, phosphorus, potassium, sodium, sulphur, selenium, zinc) and vitamins (A, B complex, C, D, E, K, H, Folic acid etc). The nutritive value of *Moringa oleifera* as compared to other feed resources indicates that it provides calcium more than 17 times the calcium present in milk. The protein content found in *Moringa* is nine times of the protein present in

yogurt. It contains 25 times higher iron content in comparison to spinach and 15 times higher potassium than bananas. The vitamin C and vitamin A concentration in *Moringa* is 7 times higher than oranges and 10 times higher than carrots, respectively (Rockwood *et al.*, 2013). Keeping in view the above qualities of *Moringa* leaves and scarcity of livestock feed particularly protein sources, the present study has been planned to assess the potential use of *Moringa oleifera* tree leaves and to determine their optimum level of incorporation in livestock feed.

Materials and Methods

Collection of rumen liquor : Rumen fluid was collected from donor animals before feeding with the help of stomach tube. A suction pump was used for creating negative pressure. After collection rumen liquor was strained through muslin cloth and referred as strained rumen liquor (SRL). The rumen liquor was brought to the laboratory in a pre-warmed (39°C) thermos flask. Carbon dioxide was flushed through rumen liquor for 1 minute to maintain anaerobic conditions.

Experimental Feed : Experimental complete feed was prepared by taking roughage and concentrate mixture in the ratio of 60:40. Ground nut straw was used as sole source of roughage while concentrate mixture was prepared by mixing barley, de oiled rice bran, guar korma, cotton seed cake, mineral mixture and salt. The *Moringa oleifera* leaves were incorporated in the complete feed, in mesh form after drying and by replacing cotton seed cake at 0, 3, 6, 9, 12 and 15% levels.

Table : IVDMD, IVOMD and IVTGP of complete feed containing different levels of *Moringa oleifera* leaves (%DM basis).

Parameters	T ₁ (0%)	T ₂ (3%)	T ₃ (6%)	T ₄ (9%)	T ₅ (12%)	T ₆ (15%)	SEM	Significance
IVDMD (At 48 h incubation)	61.35 ^a	64.07 ^{ab}	67.20 ^{bc}	69.59 ^{cd}	70.5 ^{cd}	71.71 ^d	1.153	**
IVDMD (At 72 h incubation)	64.06 ^a	66.26 ^{ab}	70.21 ^{bc}	72.07 ^c	72.74 ^c	74.06 ^c	1.309	**
IVOMD (At 48 h incubation)	65.37 ^a	66.06 ^{ab}	68.68 ^{abc}	69.86 ^{bc}	71.64 ^c	72.59 ^c	1.314	**
IVOMD (At 72 h incubation)	67.38 ^a	68.44 ^a	71.69 ^b	72.24 ^b	73.74 ^b	74.62 ^b	0.957	**
IVTGP (At 24 h incubation)	26.44 ^a	27.5a ^b	28.0 ^b	28.67 ^{bc}	30.1 ^c	31.99 ^d	0.468	**

Mean superscripted with any one different letters within a row differ significantly from each other

** = Significant at 1% (p<0.01)

Experimental procedure : *In vitro* dry matter digestibility (IVDMD) and *in vitro* organic matter digestibility (IVOMD) values were estimated by the method described by Tilley and Terry (1963). *In vitro* total gas production (IVTGP) was determined by method described by Menke *et al.* (1979).

Results and Discussion

***In vitro* dry matter digestibility (IVDMD) :** The results showed a linear increase in IVDMD at 48 h with the increase in level of *Moringa oleifera* leaves in the feed. The IVDMD at 72 h incubation were significantly (p<0.01) higher for T₄, T₅ and T₆ groups as compared to T₁, T₂ and T₃ groups. The results obtained in the present study are similar to the previous findings of Nouala *et al.* (2006) as they observed significantly higher *in vitro* digestibility with *Moringa oleifera* as compared to concentrate. Similarly, Sarkar *et al.* (2015) also reported significant (p<0.05) increase in *in vitro* total digestible dry matter at 10% and 15% levels of *Moringa oleifera* leaves in the ration as compared to control. In contrary to present findings Zinger *et al.* (2015) reported that the *in vitro* DM digestibility of *Moringa oleifera* silage was lower than wheat silage.

***In vitro* organic matter digestibility (IVOMD) :** Average values of IVOMD at 48 h and 72 h of incubation, differed significantly (p<0.01) among all treatment groups. At 48 h of incubation higher IVOMD values were observed in T₅ and T₆ groups in comparison to T₁, T₂, T₃ and T₄ groups. At 72 h of incubation groups T₃, T₄, T₅ and T₆ showed higher IVOMD than T₁ and T₂ groups. Present findings were similar to Makkar *et al.* (1996) as they observed that organic matter digestibility of *Moringa* leaves by *in vitro* incubation was 75.7% for extracted leaves and 74.1% for unextracted leaves. Kakengi *et al.* (2003) compared *in vitro* organic matter digestibility of different parts of *Moringa oleifera* and *Leucaena leucocephala* in which *Moringa oleifera* showed higher organic matter digestibility than *Leucaena leucocephala*. Sarkar *et al.* (2015) reported significant (p<0.05) increase in organic

matter digestibility values at 10% and 15% level of *Moringa* leaves in complete feed.

***In vitro* total gas production (IVTGP) :** Total gas production in 24 h of incubation, differed significantly (p<0.01) among treatment groups with a highest value for T₆ group. The results indicated a linear increase in gas production with the increasing levels of *Moringa oleifera* leaves in complete feed. The findings obtained in the present study for *in vitro* total gas production are similar to findings of Kakengi *et al.* (2003) as they reported higher gas production values for *Moringa oleifera* sources in comparison to *Leucaena leucocephala* and findings of Nouala *et al.* (2006) in which total gas production significantly increased with *Moringa oleifera* diets in comparison to concentrate feed. Sarkar *et al.* (2015) also reported that total gas production (ml/g DM) increased significantly (P<0.05) and linearly with the inclusion of *Moringa oleifera* leaves at 0, 5, 10 and 15% levels of feed. Findings obtained by Nouala *et al.* (2006) was in disagreement with present findings as they observed no significant difference in total gas production when concentrate feed was replaced by *Moringa oleifera* at 25% and 50% levels.

Conclusion

The study concluded that the supplementation of *Moringa oleifera* leaves improved IVDMD, IVOMD and IVTGP of complete feed. Thus the leaves of *Moringa oleifera* may be used as a source of non conventional livestock feed. Highest values of *in vitro* dry matter digestibility at 42 h of incubation and total gas production were obtained in T₆ group containing 15% level of *Moringa* leaves which indicated 15% level as optimum level of incorporation of *Moringa oleifera* leaves in complete feed.

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Yield and Quality of Fodder Maize as Influenced by Manures and Levels of Phosphorus Grown on Calcareous Soils

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Abstract

A Pot culture experiment was conducted to study the effect of manures and levels of phosphorus on yield and quality of fodder maize grown on calcareous soils at Division of Soil Science and Agricultural Chemistry, College of Agriculture, Pune, during *kharif* 2019. The experiments consisted of eleven treatments i.e. control, RDF and combination of three organic manures (FYM, Vermicompost and PMC) and three levels of phosphorus (25, 50 and 75 kg P₂O₅ ha⁻¹) through DAP replicated thrice in Factorial Completely Randomized Design. In pot culture experiment it was observed that combined application of vermicompost @ 2.5 t ha⁻¹ along with 75 kg P₂O₅ ha⁻¹ recorded maximum fodder maize (705.33 g pot⁻¹) yield and it was on par with application of FYM @ 10 t ha⁻¹ along with 75 kg P₂O₅ ha⁻¹ over recommended dose of fertilizer and control treatment. Quality parameters such as crude protein, crude fiber, ADF and NDF were also influenced significantly by the application of organic manures, P₂O₅ levels and there combinations. Among the organic manures vermicompost @ 2.5 t ha⁻¹ and P₂O₅ levels @ 75 kg ha⁻¹ recorded significantly higher value for crude protein in the fodder maize. On the contrary the crude fiber, ADF and NDF significantly decreased. Combined application of vermicompost @ 2.5 t ha⁻¹ along with 75 kg P₂O₅ ha⁻¹ significantly recorded higher value for crude protein (8.12%). On the contrary the crude fiber (29.64%) recorded significantly higher value with combined application of PMC @ 5 t ha⁻¹ along with 25 kg P₂O₅ ha⁻¹. The interaction between organic manures and levels of phosphorus found non-significant in respect of ADF and NDF content of fodder maize.

Key words : Yield, quality parameter, fodder maize, manures, calcareous soil.

Introduction

Maize (*Zea Mays*) is one of the main *kharif* crops in India including many Asian countries. Its cultivation is popular for grain as well as for livestock fodder. This crop can be grown under irrigated areas with wide range of climate throughout the year for fodder purpose. Forage maize can also be grown in winter which had a significant role in livestock production, particularly in the tropical zone where feed stuffs could not meet animal requirements due to many factors such as poor soil fertility, drought and others (Eltelib *et al.*, 2006). Being an indispensable and most important constituent of animal ration, it provides energy and protein to the animals. The production of quality fodder is very important for keeping the livestock healthy and it plays important role in dairy industry. Productivity of especially milch animals in India is very low as compared to developed countries due to lack of availability of quality fodder to the animals. The production of maize fodder could be increased by the application of balanced fertilizers in particular with the use of phosphorus fertilizer as its quality can be considerably improved with this nutrient.

Calcareous soils are common in arid and semiarid climate and occur as inclusions in more humid regions, affecting over 1.5 billion acres of soils worldwide and comprising more than 13 per cent of soil. Calcareous soils

are identified for presence of mineral calcium carbonate in parent material. The pH of this soil is above 7 and may be as high as 8.5. In some soils, CaCO₃ can concentrate into very hard layers that are impermeable to water and plant roots. The calcareousness is unique properties of soil, which affects the physico-chemical properties of soil, availability of phosphorus, zinc and iron in soil and plant growth. Such soils are difficult to manage from fertility point of view. Calcareous soils are extremely productive for agricultural use when they are managed properly.

Hydrous oxides of Fe and Al are enveloped by humus thus protecting orthophosphate from reacting with them. Orthophosphate adsorbed on soil particles is desorbed by humate anion, thus increasing orthophosphate ion concentration in soil solution. CO₂ produced during microbial decomposition forms H₂CO₃ with soil water, this carbonic acid dissolves previously precipitated calcium phosphate in calcareous soils. The mineral acids like HNO₃ and H₂SO₄ produced during microbial activities dissolve previously fixed calcium phosphates.

Materials and Methods

The present investigation entitled "yield and quality of fodder maize as influenced by manures and levels of phosphorus grown on calcareous soils" was undertaken in *kharif* 2019 at Division of Soil Science and Agricultural

Table-1 : Organic manures analysis.

Sr. No.	Manures	FYM	Vermicom post	Press mud cake
1.	pH (1:10)	8.15	7.45	7.9
2.	EC (dS m ⁻¹)	2.27	2.53	1.5
3.	O.C. (%)	18.75	24.46	12.89
4.	Total Nitrogen (%)	0.98	1.82	1.12
1.	Total Phosphorus (%)	0.29	1.42	0.60
2.	Total Potassium (%)	0.48	1.25	0.32
3.	Total Fe (mg kg ⁻¹)	2567	2726	2318
4.	Total Mn (mg kg ⁻¹)	241	418	298
5.	Total Zn (mg kg ⁻¹)	261.7	475.5	309.8
6.	Total Cu (mg kg ⁻¹)	96.8	189.3	108.9
7.	C : N Ratio	19.13	13.44	11.51

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The surface soil sample (0-22.5 cm depth) was obtained from Agronomy Farm, Division of Agronomy, College of Agriculture Pune. Each pot was filled with processed 15 kg soil which was highly calcareous. Seed rate used was 75 kg ha⁻¹. The recommended dose of fertilizers @ 100:50:50 N: P₂O₅: K₂O kg ha⁻¹ was applied to fodder maize.

As per the treatments, based on quantity of soil, quantity of each fertilizer was calculated on the basis of recommended dose. Similarly, the quantity of manures and phosphatic fertilizer was calculated as per treatments and nutrient content present in materials. The required quantity of NPK fertilizers were weighed before sowing of fodder maize. The pots were fertilized with entire dose of potash (50 kg K₂O ha⁻¹) through muriate of potash and 50 per cent nitrogen (50 kg N ha⁻¹) through DAP and Urea at sowing while remaining 50 per cent of nitrogen (50 kg N ha⁻¹) was applied after 30 days of sowing as per the standard recommendations. FYM, vermicompost and PMC (press mud cake) was applied @ 10, 2.5 and 5 Mg ha⁻¹, respectively, to the pots as per treatments under study. Since the soil was low in Fe and Zn, iron and zinc were applied to all the treatments @ 25 kg ferrous sulphate and 20 kg zinc sulphate ha⁻¹, respectively. Chemical properties of organic manures were stated in Table 1.

The experimental soil was clay in texture and having field capacity 36.69% , pH 8.3, EC 0.18 dS m⁻¹, organic carbon 0.45%, CaCO₃ equivalent 13.5%, available nitrogen 132.5 kg ha⁻¹, available phosphorus 6.36 kg ha⁻¹, available potassium 470.88 kg ha⁻¹, DTPA extractable Zn, Fe, Mn, Cu was 0.54 mg kg⁻¹, 3.3 mg kg⁻¹, 10.59 mg kg⁻¹, 6.48 mg kg⁻¹ respectively. The organic manures, soil and plant samples were analysed as per standard analytical methods. The experiment consisted of 11 treatments with 3 replications. The experiment was led out in factorial completely randomized design (FCRD).

Treatment Details

Factor A : Sources of organic manures

1. FYM @ 10 t ha⁻¹
2. Vermicompost @ 2.5 t ha⁻¹
3. PMC @ 5 t ha⁻¹

Factor B : Levels of phosphorus

1. 25 kg P₂O₅ ha⁻¹
2. 50 kg P₂O₅ ha⁻¹
3. 75 kg P₂O₅ ha⁻¹

Additional treatments :

1. Absolute control
2. Recommended dose of fertilizer (100:50:50 N: P₂O₅: K₂O kg ha⁻¹)

The results were statistically analyzed and appropriately interpreted as per the method given by Panse and Sukhatme (1985).

Results and Discussion

Effect of Organic Manures and Phosphorus Levels on

Yield of Fodder Maize : The data on influence of different organic manures and levels of phosphorus on yield of fodder maize are presented in Table-2. Among different organic manures application of vermicompost registered significantly higher fresh fodder maize yield (625 g pot⁻¹) over FYM (592.33 g pot⁻¹) and press mud cake (548 g pot⁻¹) application to fodder maize crop. Application of 75 kg P₂O₅ ha⁻¹ registered significantly higher fresh yield (663.44 g pot⁻¹) of fodder maize crop over application of 25 kg P₂O₅ ha⁻¹ (506.56 g pot⁻¹) and application of 50 kg P₂O₅ ha⁻¹ (594.89 g pot⁻¹) to fodder maize crop. Among all the interaction, application of vermicompost along with 75 kg P₂O₅ ha⁻¹ recorded significantly higher fresh yield (705.33 g pot⁻¹) of fodder maize crop and it was on par with application of FYM @ 10 t ha⁻¹ along with 75 kg P₂O₅ ha⁻¹. Both the treatments were significantly superior over rest of interactions.

It was also observed from data that fresh yield of fodder maize crop was significantly increased over control (156.67 g pot⁻¹) and RDF (429.33 g pot⁻¹) treatment.

The increase in fodder yield is due to timely nutrient availability from organic manures to the maize crop. In addition to that organic manures application may also stimulate root growth by the presence of humic substances released by the decomposing organic matter. These substances exhibit a beneficial effect on root proliferation and on over all plant growth (Nardi *et al.*, 2002). Increasing levels of phosphorus increased the fresh yield of fodder maize might be appreciated to

Table-2 : Effect of organic manures and levels of phosphorus on fresh yield of fodder maize.

Levels of phosphorus	Fresh yield of plant (g pot ⁻¹)			Mean
	25 kg	50 kg	75 kg	
Organic Manures				
FYM	511.33	587.67	678.00	592.33
Vermicompost	558.67	611.00	705.33	625.00
PMC	450.00	586.67	607.33	548.00
Mean	506.56	594.89	663.44	
	Organic Manures	Levels of Phosphorus	Organic Manures x levels of Phosphorus	
SEm +	11.07	11.07	19.17	
C.D. (0.05)	33.14	33.14	57.40	

Absolute control : 156.67

Recommended dose of fertilizer (100:50:50 N: P₂O₅: K₂O kg ha⁻¹) : 429.33

Table-3 : Effect of organic manures and levels of phosphorus on fresh yield of fodder maize crop.

Levels of phosphorus	Crude Protein (%)			Mean
	25 kg	50 kg	75 kg	
Organic Manures				
FYM	5.31	7.25	7.46	6.67
Vermicompost	5.17	7.92	8.12	7.07
PMC	4.97	5.54	5.89	5.47
Mean	5.15	6.90	7.14	
	Organic Manures	Levels of Phosphorus	Organic Manures x levels of Phosphorus	
SEm +	0.17	0.17	0.29	
C.D. (0.05)	0.50	0.50	0.87	

Absolute control : 3.35

Recommended dose of fertilizer (100:50:50 N: P₂O₅: K₂O kg ha⁻¹) : 4.65

Table-4 : Effect of organic manures and levels of phosphorus on crude fiber content of fodder maize crop.

Levels of phosphorus	Crude Fiber (%)			Mean
	25 kg	50 kg	75 kg	
Organic Manures				
FYM	27.50	22.07	19.25	22.94
Vermicompost	27.33	21.83	18.27	22.71
PMC	29.64	23.83	20.22	24.56
Mean	28.16	22.58	19.48	
	Organic Manures	Levels of Phosphorus	Organic Manures x levels of Phosphorus	
SEm +	0.011	0.011	0.020	
C.D. (0.05)	0.034	0.034	0.059	

Absolute control : 31.04

Recommended dose of fertilizer (100:50:50 N: P₂O₅: K₂O kg ha⁻¹) : 18.67

fulfilment of phosphorus requirement of fodder maize crop.

This finding was found in line with the work of Rashid and Iqbal (2012) who conducted field experiment to evaluate the effect of phosphorus fertilizer on the yield and quality of maize fodder on a clay loam (calcareous) soil. He observed that yield of fodder maize were improved significantly over control with all the phosphorus application rates.

Effect of Organic Manures and Levels of Phosphorus on Quality Parameters of Fodder Maize : The data related to quality parameters of fodder maize crop as

influenced by different organic manures and levels of phosphorus are presented in Table 3 to 7.

Crude protein : The maximum protein content (7.07%) was found due to application of vermicompost @ 2.5 t ha⁻¹. Among different levels of phosphorus, 75 kg P₂O₅ ha⁻¹ showed higher crude protein content (7.14%) and closely followed by 50 kg P₂O₅ ha⁻¹ treatment. Further it was also observed that, application of vermicompost @ 2.5 t ha⁻¹ along with 75 kg P₂O₅ ha⁻¹ recorded maximum crude protein (8.12%) content and it was on par with 75 and 50 kg P₂O₅ ha⁻¹ along with FYM @ 10 t ha⁻¹.

The result indicated better utilization of nitrogen with

Table-5 : Effect of organic manures and levels of phosphorus on ADF (acid detergent fiber) content of fodder maize crop.

Levels of phosphorus	ADF (%)			Mean
	25 kg	50 kg	75 kg	
Organic Manures				
FYM	36.55	36.32	36.15	36.34
Vermicompost	36.48	36.29	36.08	36.28
PMC	36.67	36.48	36.17	36.44
Mean	36.57	36.36	36.13	
	Organic Manures	Levels of Phosphorus	Organic Manures x levels of Phosphorus	
SEm +	0.014	0.014	0.025	
C.D. (0.05)	0.43	0.043	NS	

Absolute control : 37.08

Recommended dose of fertilizer (100:50:50 N: P₂O₅: K₂O kg ha⁻¹) : 36.27

Table-6 : Effect of organic manures and levels of phosphorus on NDF (neutral detergent fiber) content of fodder maize crop.

Levels of phosphorus	NDF (%)			Mean
	25 kg	50 kg	75 kg	
Organic Manures				
FYM	57.64	57.34	57.34	57.44
Vermicompost	57.34	57.39	57.30	57.34
PMC	57.89	57.40	57.45	57.41
Mean	57.62	57.41	57.36	
	Organic Manures	Levels of Phosphorus	Organic Manures x levels of Phosphorus	
SEm +	0.010	0.010	0.018	
C.D. (0.05)	0.031	0.031	0.NS	

Absolute control : 58.00

Recommended dose of fertilizer (100:50:50 N: P₂O₅: K₂O kg ha⁻¹) : 57.38

increasing phosphorus input. Increase in crude protein content was due to fact that phosphorus is an important structural component of DNA and RNA. The phosphate group in nucleic acid bridges the RNA or DNA. DNA is carrier of genetic information and RNAs function in protein synthesis (Mengel and Kirkby 2001). Similarly (Hussain 1991) reported that crude protein content in sorghum fodder was increased with phosphorus application.

Crude fiber : It was observed that levels of phosphorus showed significant effect on crude fiber content of fodder maize crop. Among different levels of phosphorus, application of 75 kg P₂O₅ ha⁻¹ to fodder maize crop registered significantly lower crude fiber content (19.48%) as compared with 25 kg P₂O₅ ha⁻¹ (28.16%) and 50 kg P₂O₅ ha⁻¹ (22.58%) application to fodder maize crop. Among different organic manures, application of vermicompost @ 2.5 t ha⁻¹ registered significantly lower crude fiber content (22.71%) and it was on par with application of FYM @ 10 t ha⁻¹. Application of vermicompost along with 75 kg P₂O₅ ha⁻¹, recorded significantly lower values of crude protein (18.97%).

Crude fiber content showed declining trend with increase in fertility levels and it was noted maximum in control treatment (31.04%). The result could be attributed to the fact that higher fertility doses resulted in higher

protein synthesis and lowered the soluble carbohydrates which could be responsible for lower content of crude fiber in fodder of corn (Almodares *et al.*, 2009).

ADF (Acid Detergent Fiber) and NDF (Neutral Detergent Fiber) : The data clearly indicated that there was significant influence of different organic manures on ADF and NDF content of fodder maize crop. Among different organic manure applications, vermicompost registered significantly lower value of ADF (36.28%) and NDF (57.34%) and it was significantly superior over rest of organic sources. Application of 75 kg P₂O₅ ha⁻¹ to fodder maize registered significantly lower ADF (36.13%) and NDF (57.36%) value than 25 and 50 kg P₂O₅ ha⁻¹ application to fodder maize crop.

The interaction between organic manures and levels of phosphorus found non-significant in case of ADF and NDF content. These results were also supportive with the finding of Pholsen and Sukseri (2007) who reported that P and K fertilizer application had no effect on ADF and NDF contents in forage sorghum. Similar finding is given by Rashid and Iqbal (2012) by conducting field trial to evaluate the effect of phosphorus fertilizer on the yield and quality of maize fodder on a clay loam (calcareous) soil. It was observed that phosphorus application showed non-significant affect on NDF and ADF contents (%).

It was also observed that there was small numerical decrease in ADF and NDF content of fodder maize crop. The decrease in ADF and NDF value is an indication in improvement of the quality of fodders. This result coincides with the result of Soest (1985) who reported that ADF and NDF are composed of cellulose + lignin and cellulose + hemicellulose + lignin, respectively and are the structural carbohydrates in plants, which play an important role in the digestibility of forage. The decrease in ADF and NDF (cell wall components) is an indication in improvement of the quality of fodders. On the other hand high values of both the parameters indicate poor digestibility due to more lignifications.

Conclusion

Maize fodder yield and crude protein content was significantly influenced by the application of vermicompost @ 2.5 t ha⁻¹ along with different levels of phosphorus over application of FYM and PMC to fodder maize crop on calcareous soil. The crude fiber content showed declining trend with increase in levels of phosphorus and organic manures application. There was non-significant effect of interaction of different organic manures and levels of phosphorus on ADF and NDF content of fodder maize crop.

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Nutritional Composition and Sensory Characteristics of Wheat Based *Kulcha* and Buns Supplemented with Spinach Leaves Powder

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Abstract

The study investigated the effect of supplementation of the spinach leaves powder on the nutritional composition and the sensory quality of wheat based *kulcha* and buns. *Kulcha* and buns supplemented with spinach leaves powder at 4%, 6%, 8%, 10% and 12% during preparation and evaluated for their sensory characteristics and nutritional composition. The addition of spinach leaves powder significantly increased the crude protein, crude fibre, crude fat and ash content in both *kulcha* and buns. Supplementation with vegetable powder caused significant increase in mineral content, dietary fibre, and antioxidant activity. Addition of spinach leaves powder increased the nutrient density of the products. Sensory results showed that there was significant decrease in sensory characteristics with increasing supplementation level. *Kulcha* and buns were acceptable up to 8% level of spinach leaves powder. Therefore, these value added products should be included in the diet of vulnerable groups in order to improve their nutritional status.

Key words : Supplementation, nutritional composition, sensory quality, antioxidant activity, value added.

Introduction

Green leafy vegetables serve as good sources of water soluble vitamins and vitamin A as well as minerals such as calcium, phosphorus and iron. They contain sufficient amounts of β -carotene and other provitamin A carotenoids that can be absorbed and converted to vitamin A in the human body (Van den berg et al. 2000). They also contain an immense variety of bioactive, non-nutritive health enhancing factors such as antioxidants, phytochemicals, essential fatty acids and dietary fibers. They contain a variety of powerful natural antioxidants such as vitamin C and β -carotene (Umma Khair et al. 2012; Kavitha & Ramadas 2013; Longvah et al. 2017). Phenolic agents are a major class of antioxidants that are found in plant foods at very high concentration (Umma Khair et al. 2012).

Food based strategies are one of the means that are used for combating vitamin A and iron deficiencies in developing countries. The benefits of such food based strategies are manifold- cost effective, sustainable, culturally acceptable, income-generating, feasible to implement and availability of various micronutrient-rich foods for improving the micronutrient status of not only individuals but also for the community (Pritwani & Mathur 2015; Gupta & Verma 2016; Singh et al. 2018).

Value added baked food products can be prepared by using commonly consumed inexpensive, locally available ingredients. Cereals or millets can be mixed with pulses in different proportions, reason being cereals are deficient in lysine and rich in methionine, while pulses are

deficient in methionine and rich in lysine. Hence, mutual supplementation improves the protein quality by balancing the amino acid profile. Use of cereals and pulses as basic ingredients and nutrient rich foods for value addition can become a strategy for development of nutritious food products (Lohekar 2014; Noorfarazilah et al. 2014; Gonzales et al. 2016).

Thus, this study aimed to evaluate the effect of the supplementation of spinach leaves powder on the proximate composition, mineral content, antioxidant activity, and sensory properties of *kulcha* and buns.

Materials and Methods

Procurement of materials : Grain samples of a wheat variety (WH-1105) and a bengal gram variety (HC-1) were procured from the Department of Genetics and Plant Breeding, CCS Haryana Agricultural University, Hisar. The grain samples were cleaned bengal gram seeds were dehulled and ground into flour. The ground samples were stored in plastic container till further use.

Spinach leaves (*Spinacia oleracea* L.) were procured in a single lot from local market of Hisar. Healthy mature and disease-free leaves were selected and washed under running tap water followed by distilled water. Excess water was wiped off with muslin cloth. Then the leaves were dried in the shade for 6 to 8 h to remove excess moisture followed by oven drying at 40-45°C till complete drying. The dried leaves were ground in an electric grinder to obtain a fine powder. The ground powder was stored in low density polyethylene (LDPE) bags for further use.

Preparation of spinach leaves powder

- Fresh spinach leaves
- Wash under tap water
- Rinse with distilled water
- Whip off excess water
- Dry in the shade for 6 to 8 h
- Dry in oven at 40-45°C till complete drying
- Fine powder in grinder
- Stored in low density polyethylene (LDPE) bags

Results and Discussion

Organoleptic characteristics : Most acceptable *kulcha* and buns were selected for nutritional evaluation. Their organoleptic characteristics were determined by a panel of 10 judges for colour, appearance, aroma, texture, taste and overall acceptability using a nine point Hedonic Rating Scale ranging from like extremely (9) to dislike extremely (1) for each organoleptic characteristics.

Nutritional evaluation of acceptable *kulcha* and buns : On the basis of organoleptic acceptability, 8% supplemented *kulcha* and buns were selected for further nutritional analysis. Proximate composition was estimated by using the standard method of analysis (AOAC, 2000). For mineral estimation, the samples were wet acid digested, using a nitric acid and perchloric acid mixture (HNO₃:HClO₄, 5:1 w/v). The total amounts of Ca, Mg, P, Fe and Zn in the digested samples were determined by Atomic Absorption Spectrophotometry (Lindsey and Norwell, 1969). Antioxidant activity was estimated by the method of Prieto *et al.*, 1999; AOAC 2000.

Statistical analysis : The data were statistically analysed in complete randomized design for analysis of variance according to the standard method (Sheoran and Pannu, 1999).

Results and Discussion

Organoleptic characteristics : The replacement of wheat flour with different levels of spinach leaves powder resulted in considerable changes in the sensory properties of *kulcha* and buns (Table-1 and 2).

Control *kulcha* and buns received highest mean score for aroma, taste and for texture which fell in the category of “liked moderately”. Whereas, aroma and taste of supplemented *kulcha* and buns reduced on increasing the level of spinach leaves powder supplementation. Buns and *kulcha* were rated as ‘liked moderately’ to ‘liked slightly’ by the panelists up to 8 per cent level. These results are also found similar with earlier reported results in muffins incorporated with moringa leaves powder up to 8 per cent level (Srinivasamurthy *et al.* 2017).

Further increase in the incorporation level caused significant reduction in colour, appearance and taste with regard to results of organoleptic acceptability of traditional products like *matthi*, *matar*, *sev* and *burfi* are also found similar as reported earlier by various workers in traditional products with incorporation of green leafy vegetables powder up to 10 per cent level (Lakshmi & Radhapriya 2004; Singh *et al.* 2007; Kaur & Kochar 2009; Gupta & Prakash 2011; Verma & Jain 2012; Singh & Grover 2014; Singh *et al.* 2018).

Among the supplemented *kulcha* and buns 8% spinach leaves powder supplemented *kulcha* and buns had highest overall acceptability score in terms of colour, appearance, aroma, texture and taste. This was found in category of “liked slightly” therefore these were selected for nutritional studies.

Nutritional characteristics of acceptable products : Proximate composition of control and supplemented buns and *kulcha* are presented in Table-3 and 4.

Moisture, crude protein, crude fat, crude fibre and ash contents of buns and *kulcha* made from wheat flour (control) were found to be significantly increased on addition of spinach leaves powder and bengal gram flour in wheat flour. The increase in crude protein content up to 8 per cent level i.e Type-III buns and *kulcha* were observed as 16.15 and 16.23 per cent, respectively. It might be due to fortification of wheat flour with bengal gram flour and spinach leaves powder. Crude fat and crude fibre content were also found higher in supplemented *kulcha* and buns. The increase in fat content with incorporation of spinach leaves powder may be due to the increased absorption of fat because of high fibre content in composite flour. These results are supported by other workers who developed value added biscuits, *matthi*, *namakpara* and *pakora* by incorporating green leafy vegetable powder (Brar 2009; Mittal 2011; Pant *et al.* 2012; Verma & Jain 2012; Ajibola *et al.* 2015). Ajibola *et al.* (2015) and Singh *et al.* (2018) reported that increase in moisture, crude protein, crude fibre, crude fat and ash content of biscuits, *matthi*, *namakpara* and *kurmura* with increase in the level of moringa leaves

Table-1: Mean scores of organoleptic characteristics of buns.

Types of Buns	Colour	Appearance	Aroma	Texture	Taste	Overall acceptability
Control	7.80±0.09	7.70±0.01	7.50±0.04	7.40±0.10	7.40±0.02	7.56±0.03
Type-I	7.40±0.02	7.30±0.16	7.10±0.11	7.10±0.05	6.80±0.05	7.14±0.03
Type-II	7.30±0.15	7.20±0.09	7.07±0.07	6.70±0.11	6.60±0.10	6.97±0.65
Type-III	7.30±0.11	7.10±0.14	7.06±0.17	6.80±0.03	6.38±0.03	6.93±0.11
Type-IV	6.00±0.03	5.80±0.10	5.40±0.13	5.00±0.11	4.70±0.07	5.38±0.10
Type-V	5.70±0.03	5.40±0.07	4.90±0.03	4.70±0.02	4.30±0.09	5.00±0.13
CD (P=0.05)	0.23	0.36	0.36	0.28	0.22	0.29

Values are mean ±SE of ten panelists

Control: WF (100%)

Type-I: WF: BGF: SP (48:48:4)

Type-II: WF: BGF: SP (47:47:6)

Type-III: WF: BGF: SP (46:46:8)

Type-IV: WF: BGF: SP (45:45:10)

Type-V: WF:BGF:SP (44:44:12)

WF: Wheat flour

BGF: Bengal gram flour

SP: Spinach powder

Table-2 : Mean scores of organoleptic characteristics of kulcha.

Types of Kulcha	Colour	Appearance	Aroma	Texture	Taste	Overall Acceptability
Control	7.90±0.11	7.80±0.04	7.90±0.10	8.00±0.02	8.00±0.05	7.92±0.18
Type-I	7.40±0.02	7.40±0.09	7.50±0.14	7.20±0.10	7.00±0.13	7.30±0.17
Type-II	7.20±0.09	7.20±0.14	7.10±0.08	7.10±0.07	6.80±0.04	7.08±0.12
Type-III	6.60±0.15	6.80±0.14	6.40±0.15	6.20±0.14	6.01±0.07	6.40±0.16
Type-IV	5.70±0.14	5.60±0.08	5.60±0.12	4.90±0.01	4.90±0.12	5.34±0.12
Type-V	5.30±0.03	5.20±0.09	5.40±0.08	4.30±0.07	4.20±0.04	4.88±0.09
CD(P=0.05)	0.34	0.35	0.33	0.28	0.19	0.47

Values are mean ±SE of ten panelists

Control: WF (100%)

Type-I: WF: BGF: SP (48:48:4)

Type-II: WF: BGF: SP (47:47:6)

Type-III: WF: BGF: SP (46:46:8)

Type-IV: WF: BGF: SP (45:45:10)

Type-V: WF: BGF: SP (44:44:12)

WF: Wheat flour

BGF: Bengal gram flour

SP: Spinach powder

Table-3 : Proximate composition of buns supplemented with spinach powder (% , on dry matter basis)

Buns	Moisture*	Crude protein	Crude fat	Crude fibre	Ash
Control (WF 100%)	21.78±0.80	11.03±0.26	13.51±0.28	1.23±0.03	2.77±0.03
Type-I	22.98±0.22	14.45±0.05	14.45±0.08	2.15±0.03	3.39±0.02
Type-II	23.07±0.38	15.58±0.09	15.03±0.15	2.55±0.01	3.76±0.02
Type-III	24.03±0.34	16.15±0.16	15.76±0.28	3.05±0.04	4.27±0.01
CD (P=0.05)	1.20	0.63	0.66	0.10	0.07

*On wet matter basis

Values are mean ± SE of three independent determinations

Type-I: WF: BGF: SP (48:48:4)

Type-II: WF: BGF: SP (47:47:6)

Type-III: WF: BGF: SP (46:46:8)

WF: Wheat flour

BGF: Bengal gram flour

SP: Spinach powder

Table-4: Proximate composition of kulcha supplemented with spinach powder (% , on dry matter basis).

Kulcha	Moisture*	Crude protein	Crude fat	Crude fibre	Ash
Control (WF 100%)	13.46±0.31	11.71±0.09	14.32±0.02	1.05±0.02	2.49±0.03
Type-I	14.66±0.18	14.56±0.18	15.54±0.18	1.46±0.02	3.64±0.02
Type-II	15.32±0.21	15.86±0.05	15.78±0.40	1.76±0.01	4.32±0.07
Type-III	16.76±0.13	16.23±0.11	16.21±0.37	2.01±0.02	4.78±0.09
CD (P=0.05)	0.85	0.45	0.93	0.08	0.19

*On wet matter basis

Values are mean ± SE of three independent determinations

Type-I: WF: BGF: SP (48:48:4)

Type-II: WF: BGF: SP (47:47:6)

Type-III: WF: BGF: SP (46:46:8)

WF: Wheat flour

BGF: Bengal gram flour

SP: Spinach powder

powder, spinach leaves powder and cauliflower leaves powder up to 10 to 15 per cent levels.

Total minerals : Data in respect to total iron, calcium, zinc and phosphorus contents of buns and *kulcha* are presented in Table-5 and 6.

Total iron, calcium, zinc and phosphorus content of control buns and kulcha varied from 2.76 to 3.46, 37.67 to

38.67, 1.89 to 1.98 and 292.45 to 301.53 mg/100g, respectively. As these contents were found to be improved significantly with increase in the level of incorporation of spinach leaves in wheat-bengal gram flour blends. Total iron, calcium, zinc and phosphorus content in Type-II and Type-III supplemented buns and *kulcha* were in the range of 6.28 to 7.08, 83.55 to 97.56,

Table-5 : Total mineral content of buns supplemented with spinach powder (mg/100g, on dry matter basis).

Buns	Iron	Calcium	Zinc	Phosphorus
Control (WF 100%)	2.76±0.02	37.67±0.56	1.98±0.01	301.53±1.27
Type-I	5.16±0.10	79.45±0.62	2.56±0.02	310.23±0.76
Type-II	6.28±0.06	83.55±0.21	2.86±0.01	315.38±0.23
Type-III	7.08±0.06	97.56±1.12	3.14±0.02	322.14±0.21
C.D (P=0.05)	1.26	2.58	0.86	2.84

Values are mean ± SE of three independent determinations

Type-I: WF: BGF: SP (48:48:4) Type-II: WF: BGF: SP (47:47:6)

Type-III: WF: BGF: SP (46:46:8)

WF: Wheat flour

BGF: Bengal gram flour

SP: Spinach powder

Table-6 : Total mineral content of kulcha supplemented with spinach powder (mg/100g, on dry matter basis).

Kulcha	Iron	Calcium	Zinc	Phosphorus
Control (WF 100%)	3.46±0.01	38.67±0.54	1.89±0.04	292.45±1.26
Type-I	5.71±0.08	77.78±0.04	2.03±0.01	298.13±0.14
Type-II	6.48±0.11	85.76±1.74	2.45±0.04	303.85±1.00
Type-III	7.03±0.12	89.90±1.02	2.89±0.04	307.46±0.71
C.D (P=0.05)	0.29	3.42	0.06	2.86

Values are mean ± SE of three independent determinations

Type-I: WF: BGF: SP (48:48:4) Type-II: WF: BGF: SP (47:47:6) Type-III: WF: BGF: SP (46:46:8)

WF: Wheat flour

BGF: Bengal gram flour

SP: Spinach powder

Table-7 : Anti-oxidant activity of buns supplemented with spinach powder (on dry matter basis).

Buns	Anti-oxidant activity (%)
Control (WF 100%)	21.35±0.13
Type-I	23.07±0.36
Type-II	25.42±0.63
Type-III	27.67±0.25
CD (P=0.05)	0.88

Values are mean ± SE of three independent determinations

Type-I: WF: BGF: SP (48:48:4)

Type-II: WF: BGF: SP (47:47:6)

Type-III: WF: BGF: SP (46:46:8)

WF: Wheat flour BGF: Bengal gram flour

SP: Spinach powder

Table-8 : Anti-oxidant activity of kulcha supplemented with spinach powder (on dry matter basis).

Kulcha	Anti-oxidant activity (%)
Control (WF 100%)	18.45±0.12
Type-I	23.67±0.50
Type-II	25.06±0.45
Type-III	28.45±0.40
CD (P=0.05)	1.30

Values are mean ± SE of three independent determinations

Type-I: WF: BGF: SP (48:48:4)

Type-II: WF: BGF: SP (47:47:6)

Type-III: WF: BGF: SP (46:46:8)

WF: Wheat flour BGF: Bengal gram flour

SP: Spinach powder

2.86 to 3.14 and 315.38 to 322.14 mg/100g, in buns and 6.48 to 7.03, 85.76 to 89.90, 2.45 to 2.89 and 303.85 to 307.46 mg/100, in *kulcha* respectively. As spinach is rich source of all minerals (Singh & Kawatra 2006; Khan *et al.* 2015; Galla *et al.* 2017). These results are also supported by the earlier reports (Pant *et al.* 2012; Singh & Grover 2014; Alijoba *et al.* 2015; Singh *et al.* 2018). Pant *et al.* (2012) reported iron content of control *matthi* was 2.1

mg/100g which increased to 2.3 and 2.5 mg/100g on supplemented with 25 per cent spinach leaves powder and drumstick leaves powder, respectively. Brar (2009) reported high iron and calcium content in colocasia supplemented *matthi*, Verma & Jain (2012) reported 14.7 mg/100g total iron in 7.5 per cent level of bengal gram leaves supplemented *chapatti* while Srinivasamurthy *et al.* (2017) reported 55.06 mg/100g calcium, 3.55 mg/100g iron, 275.0 mg/100g phosphorus in muffin incorporated with 10 per cent level of moringa leaves powder.

Anti-oxidant activity : The result of anti-oxidant activity of buns and *kulcha* are presented in Table-7 and 8.

Anti-oxidant activity of control buns and *kulcha* were in the range of 18.45 to 21.35 per cent, respectively which found to be significantly increased in all the spinach leaves powder supplemented products i.e Type-I, Type-II and Type-III buns and *kulcha*. This increase might be due to addition of spinach powder (4, 6, 8, 10 and 12 % levels) which has high anti-oxidant activity (Ajibola *et al.* 2015). Umma Khair *et al.* (2012) also reported higher anti-oxidant activity in spinach leaves powder supplemented products in comparison to control products. As these results are in line with the present results reported in spinach leaves powder supplemented products.

Conclusion

The enrichment of *kulcha* and buns with spinach leaves powder resulted increase in proximate, mineral, and antioxidant contents. *Kulcha* and buns enriched with spinach powder was acceptable at low inclusion levels (8%). The acceptability of *kulcha* and buns samples with higher inclusion level would only be possible with a lot of

awareness creation about the health potentials. This work emphasized the possibility of enriching baked products with green leafy vegetables highlighted.

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Effect of the Roofing Materials on Heat Stress in Magra Lambs in Arid Region

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Abstract

The present study was carried out to observe the effect of different roofing materials on the growth performance of lambs at Livestock Research station Bikaner. Eighteen Magra lambs of 3-4 months of age were randomly divided into three groups T₀ (Control group having tree shed), T₁ (Thatch roof shed), and T₂ (Tin roof shed). All three groups of lambs were managed under a similar system of feeding and other management systems. Daily temperature and relative humidity of macroclimate and microclimate was recorded during experiment. The result showed that Mean temperature of microclimate was significantly (P<0.01) lower in group T₁ followed by T₂ and T₀ whereas mean relative humidity non significantly differed in all groups. Temperature humidity index (THI) was significantly lower (P<0.01) in T₁.

Key words : Thatch roof, respiration, rectal temperature, Magra lambs.

Introduction

The housing system is an important factor that affects animals' performance in terms of growth, health, production, and reproduction. Animal housing should prevent the animal from climate extremes to reduce stress. In animals, housing roof plays a significant role in the protection of animals as well as protecting them from adverse climatic conditions. Productivity of livestock is substantially increased through shelter management by mitigating environmental stress (Nienaber and Hahn, 2007). Sheep in India are mostly raised in open spaces not having suitable housing facilities under an unhygienic and stressful state. Also, no prior planning and designing is done before the construction of sheep shelters. Faulty housing and management practices can be a cause of discomfort leading to poor productivity. Roofs have an important role in the determination of the thermal exchanges of the animals (Liberati and Zappavigna, 2004). A shade reduces the amount of solar radiation falling on the animal body. Sheep exposed to heat stress produce changes such as lower living body weight and decreased feed intake efficiency (Maraia *et al.*, 2008).

Materials and Methods

The present research study was carried out at Livestock Research Station, Kodemdesar, Bikaner situated at an altitude of 201 meters above the mean sea level in the Thar Desert, about 32 km away from the city of Bikaner in Rajasthan, falling between co-ordinates of 28°3'0" North latitude and 73°4'0" East longitude. For the study, Eighteen Magra lambs (male and female) aged about 3 to 4 months, were selected and randomly distributed into 3

experimental groups and provided the following housing condition: T₀ Control having an open area under tree shade with a sand floor. The shaded area was protected by wire fences. T₁ (Thatch roofed shed) Thatch roof shed was constructed with locally available dry grass (Khim) fixed on a bamboo frame with a Sand floor. T₂ (Tin roofed shed) has a tin sheet roofed shed with a sand floor. The work was carried out for 3 months and lambs were kept for an adaptation period of one week. All three groups of lambs were managed under similar systems of feeding and other management systems. All the lambs were free from any kind of physiological, anatomical and infectious diseases. Lambs were on grazing for 6 hours daily, along with grazing dry fodder (groundnut straw) was fed ad lib and commercial concentrate pellet feed (Saras Gold) having 19.8% CP, 70% TDN, and 2500 kcal/kg metabolic energy was fed to meet the requirement of nutrient @ 200gms /lamb/day. During the experimental trial metrological variables i.e temperature (°C) and relative humidity (%) of both macro and microclimate were recorded by using digital thermo hygrometer at 9am and 3pm on daily basis. THI of macroclimate and microclimate was calculated from recorded metrological variables by using formula given by Tucker *et al.* (2008).

$$THI = (1.8 \times T + 32) - [(0.55 - 0.0055 \times RH) \times (1.8 \times T - 26)]$$

Statistical analysis : The data for all measured variables were analysed using one way ANOVA procedure of SPSS version 20 (SPSS for window, V 20.0; SPSS Inc, Chicago, IL, USA.). "Duncan multiple range" test was conducted to test the significance of difference between mean value.

Table-1 : Average values of Different Climatic Variables in Macro Climate.

Metrological variables	Morning (9:00 AM)	Evening (3:00 PM)
Ambient Temperature (°C)	29.77±0.63	35.73±0.69
Relative humidity (%)	56.62±2.24	45.31±3.23
Temperature humidity index (THI)	78.92±2.82	84.58±1.89

Table-2 : Average values of climatic variables in different experimental sheds (Micro climate) during experiment period.

Metrological variables	Time	Tree shade (T ₀)	Thatch roof (T ₁)	Tin roof (T ₂)
Temperature (°C)	Morning (9:00 AM)	27.26 ^b ± 0.45	23.70 ^a ± 0.32	24.97 ^a ± 0.23
	Evening (3:00 PM)	33.67 ^b ± 0.59	30.41 ^a ± 0.46	32.13 ^{ab} ± 0.36
Relative humidity (%)	Morning (9:00 AM)	62.84 ± 1.61	58.84 ± 1.80	62.15 ± 1.71
	Evening (3:00 PM)	46.15 ± 2.05	46.46 ± 2.52	45.92 ± 1.29
Temperature humidity index (THI)	Morning (9:00 AM)	76.33 ^c ± 0.61	70.88 ^a ± 0.43	72.98 ^b ± 0.26
	Evening (3:00 PM)	82.23 ^c ± 0.48	78.18 ^a ± 0.45	80.29 ^b ± 0.26

Means bearing different superscript in a row differ significantly (P<0.05).

Result and Discussion

Macro climate : The data of temperature (°C) and relative humidity (%) of macroclimate were recorded at 9am and 3pm on daily basis and presented in table 1. The overall mean value of maximum temperature (°C) and minimum temperature (°C) of macro climate were 35.73±0.69, 29.77±0.63, respectively. Average value of RH (%) in morning and evening were 56.62±2.24, 45.31±3.23, respectively.

Temperature humidity index of macroclimate : Results revealed that the THI values were numerically high in evening hours than morning hours because of high ambient temperature which indicated stressful climatic condition during experimental period.

Microclimate in experimental sheds : Different meteorological variables viz. Temperature (°C) and relative humidity (%) were measured daily in different experimental sheds during research period to observe the effect of thermal stress on experimental lambs.

Temperature (°C) : The data of temperature (°C) inside the sheds were recorded at 9am and 3pm on daily basis and presented in table 2. The overall mean value of maximum temperature (°C) in group T₀, T₁, and T₂ was 33.67±0.59, 30.41±0.46, 32.13±0.36, respectively. The average maximum temperature in thatch roof was significantly (P<0.01) lower than tin sheet roof and tree (control). The mean minimum temperature (°C) was 27.26±0.45, 23.70±0.32, 24.97±0.23 for T₀, T₁, and T₂, respectively. Results revealed that average minimum temperature was least in T₁ group followed by T₂ and T₀ group. The mean minimum temperature value of T₁ group differed significantly (P<0.01) with T₀ group but the difference was non significant in case of T₂. The lower temperature under thatch roof was due to protection from direct solar radiation inside the shed which created more comfortable microclimate to the experimental lambs.

The present findings of experiment were in

agreement with the finding of Jat (2002) who reported lower maximum and minimum temperature under thatch roof and mud plaster roof. Patil *et al.* (2008)⁽¹¹⁾ reported that tin roof was insufficient to lower the heat load falling on it. Similar trend of observation were reported in the experiment of Yazdani and Gupta (2000)⁽¹⁶⁾, Kamal (2013)⁽⁴⁾ in calves. Patil *et al.* (2014)⁽¹²⁾ reported significantly lower maximum temperature in thatch roof as compare to asbestos sheet and white painted roof shade.

Relative humidity (%) : The data of relative humidity (%) inside the sheds were recorded at 9am and 3pm on daily basis and presented in table 2. The mean values of RH (%) at 9 am were 62.84±1.61, 58.84±1.80, 62.15±1.71 for group T₀, T₁, T₂ group, respectively. Average values of RH (%) at 3 pm were 46.15±2.05, 46.46±2.52, 45.92±1.29 for T₀, T₁ and T₂ group, respectively. There was numerically high value of RH % (62.84) was observed in control group (tree) in morning but the difference between groups was non significant. However there was higher value of RH % was recorded under thatch roof in evening. The mean RH% of thatch roof in morning was lower than tin shed and tree.

Similar trend of observation were reported in the study of Jat (2002)⁽³⁾ in calves, Rahman (2008)⁽¹³⁾ in goats. Present findings were in agreement with Patil *et.al* (2014)⁽¹²⁾ reported low RH in thatch roof shed.

Temperature humidity index of microclimate (THI) : The data of overall mean value of THI at 9am and 3 pm were recorded daily and presented in table-2. Average THI values at 9am were 76.33±0.61, 70.88±0.43, 72.98±0.26 in group T₀, T₁ and T₂, respectively. Results revealed that group T₁ had lowest THI value followed by T₂ and T₀. The value of THI differed significantly in all three groups. Lower value of mean THI under thatch roof (T₁) might be due to low ambient temperature during morning hours.

THI value 70 or less are considered as comfortable condition of animal Silanikove (2000)⁽¹⁴⁾. However there

was numerically higher value of THI (>72) recorded under tin sheet roof (T_2), tree (T_0). Tree had maximum mean THI at 9 am that indicated mild thermal stress condition in experimental lambs kept under tree shade.

The average THI values at 3 pm were 82.23 ± 0.48 , 78.18 ± 0.45 , 80.29 ± 0.26 for group T_0 , T_1 , T_2 , respectively. Results revealed that group T_1 had significantly ($P < 0.01$) lower THI value followed by T_2 and T_0 . Results indicated that experimental lambs kept under thatch roof were in mild heat stress condition while lambs kept under tree (T_0), tin roof (T_2) were exposed to more thermal stress ($\text{THI} > 78$) than thatch roofing. Tin sheet roof was not able to inhibit the penetration of solar radiation inside the shed. Heat stress is measured by the temperature-humidity index (LPHSI 1990, ⁽⁷⁾ Marai *et al.* 2001⁽⁹⁾).

High ambient temperature, wind speed and relative humidity cause the heat stress in animals (Hayes *et al.* 2003, ⁽²⁾ Kaya 2011⁽⁵⁾). Present findings of study were found similar with Jat (2002) ⁽³⁾ in calves, Patil *et al.* (2014) ⁽¹²⁾, Raman (2008) ⁽¹³⁾ in goats.

Conclusion

Therefore it can be concluded that in arid region heat has extreme effect on health of animals which produces the heat stress in animals. Excessive heat load can also impair the physiological responses among the animals. Present study revealed that, thatch roof can be used as beneficial and economic roofing material as it protected lambs from extreme heat stress in harsh climatic condition of arid zone during the summer season. Thatch roof prevented direct and indirect solar radiations and created more comfortable micro environment inside the shed which results in better growth performance as compared to tin sheet and tree. Tin sheet roofing was insufficient to reflect back the heat radiations during summer season. By adopting modified roofing such as white painted metal sheet on roof top can increase the efficiency of tin sheet during summer season. Therefore appropriate interventions in housing should be done to provide optimal environmental conditions so that animal can express their full genetic potential.

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Spatial Distribution of Maize Stem Borer, *Chilo partellus* (Swinhoe)

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Abstract

The present investigation on "Spatial distribution of maize stem borer, *Chilo partellus* (Swinhoe)" was carried out at Agronomy farm, Rajasthan College of Agriculture, MPUAT, Udaipur during *Kharif*, 2019 and 2020. The spatial distribution parameters viz., variance to mean ratio, Clumping Index (IDM), Mean Density, Lloyd's Patchiness Index, Iwao's patchiness regression and Taylor's Power law were computed and result revealed that larvae of maize stem borer, *C. partellus* showed clumped or contagious type of distribution during both the year.

Key words : Distribution, maize, stem borer, clumped, contagious.

Introduction

Maize (*Zea mays* L.) is an important cereal crop grown all over the world as food for human consumption, animal feed, and fodder and as an industrial product. It is an important crop next to rice and wheat grown over a wide range of geographical and environmental conditions in India as compared to other cereal crops (Anonymous, 2013). Maize is being grown in more than 166 countries in about 163 M ha area with 823 million tons production across the globe including tropical, sub-tropical and temperate regions (Anonymous, 2012). The average maize yield in the developed countries is more than 8 t/ha, while in the developing countries it is around 3 t/ha (Zaidi and Singh, 2005). This low average yield is due to poor adoption of hybrid varieties, unbalanced fertilizer application, less irrigation and high infestation of insect pests.

In spite of taking due care of the production components, at times insect pests take a heavy toll of the crop thus bringing down crop yields. Among various biotic factors responsible for low production of maize, the damage caused by insect pests forms an important limiting factor for its profitable cultivation. As many as 141 insect pests cause varying degrees of damage to the crop right from sowing till harvest (Reddy and Trivedi, 2008). Major limiting factors are maize stem borer, *Chilo partellus* (Swinhoe), pink stem borer, *Sesamia inferens* (Walker), two species of shoot fly, *Atherigona nuquii* Steyskal and *Atherigona soccata* Rund, armyworm, *Mythimna seprata* (Walker), maize cob borer, *Helicoverpa armigera* and maize aphid, *Rhopalosiphum maidis* Fitch which cause economic yield losses during different seasons all over the country (Siddiqui and Marwaha, 1994). Chavan *et al.* (2006) observed stem borer (*C. partellus*) and grasshopper incidence on seedlings at 15

days after germination. *C. partellus* is widely distributed and is considered as a pest of *kharif* maize, while *S. inferens* occurs occasionally during the rainy season in Northern India; however, it is reported to remain active during *rabi* season in Southern states (Chouraddi *et al.* 2012). Patra *et al.* (2013) recorded total twenty four insect pests in maize.

The study about the spatial distribution of maize stem borer, *C. partellus* is an important to determine the distribution patterns and growth rates of this pest population. Further information is needed as a basis for developing a sampling plan and the strategy to control this pest in order to reduce the risk of damage and loss of maize yields. Therefore, this study aimed to determine the spatial distribution pattern of *C. partellus* at Udaipur, Rajasthan.

Materials and Methods

The field experiment to investigate the "Spatial distribution of maize stem borer, *Chilo partellus* (Swinhoe)" was conducted during *Kharif*, 2019 and 2020 at Agronomy farm, Rajasthan College of Agriculture, MPUAT, Udaipur, India. The experiment was laid out in plots of size 4.8 x 4.0 m replicated four times. Maize variety Pratap Makka-3 was sown in the prepared field on the 5th July, 2019 and 2nd July, 2020 with row to row and plant to plant spacing of 60 cm x 25 cm, respectively. The larval population of *C. partellus* was observed on 15 randomly selected plants in each replication (four replications). Though, total 60 plants were observed for the population of *C. partellus* at weekly interval. The population dynamics data of stem borer (*C. partellus*) was used to determined spatial distribution for each date of sampling. The data from original counts were arranged in frequency tables for fitting the different statistical parameters. Variance to mean ratio (Southwood, 1978), exponent – K (Lloyd, 1967),

Table-1 : Distribution pattern of stem borer, *C. partellus* on maize during *Kharif*, 2019.

SMW	Mean density ($\bar{x}$)	Variance (S^2)	Variance to mean ratio ($S^2/\bar{x}$)	Dispersion pattern (K)	Co-efficient of variation (CV)	Mean crowding index (X)	Lloyd's patchiness index ($X/\bar{x}$)	Index of clumping (IDM)	Mean colony size (C)	Pattern of distribution
32	0.30	0.42	1.39	0.77	2.15	0.69	2.30	0.39	1.69	C
33	0.68	0.86	1.26	2.58	1.36	0.95	1.39	0.26	1.95	C
34	0.38	0.51	1.33	1.15	1.87	0.72	1.87	0.33	1.72	C
35	0.85	1.01	1.19	4.49	1.18	1.04	1.22	0.19	2.04	C
36	0.40	0.48	1.20	1.97	1.73	0.60	1.51	0.20	1.60	C

Table-2 : Distribution pattern of stem borer, *C. partellus* on maize during *Kharif*, 2020.

SMW	Mean density ($\bar{x}$)	Variance (S^2)	Variance to mean ratio ($S^2/\bar{x}$)	Dispersion pattern (K)	Co-efficient of variation (CV)	Mean crowding index (X)	Lloyd's patchiness index ($X/\bar{x}$)	Index of clumping (IDM)	Mean colony size (C)	Pattern of distribution
32	0.17	0.24	1.46	0.36	2.96	0.62	3.75	0.46	1.62	C
33	0.42	0.52	1.24	1.71	1.73	0.66	1.59	0.24	1.66	C
34	0.53	0.83	1.56	0.96	1.71	1.09	2.04	0.56	2.09	C
35	0.60	0.89	1.48	1.25	1.57	1.08	1.80	0.48	2.08	C
36	0.30	0.35	1.16	1.83	1.97	0.46	1.55	0.16	1.46	C

patchiness index (Lloyd, 1967), clumping index (David and Moore, 1954), mean colony size (Tanigoshi *et al.*, 1975), mean clump size (Arbous and Kerrich, 1951), Iwao's patchiness regression (Iwao's, 1968) and Taylor's power law (Taylor, 1961) were analyzed to test the dispersion behaviour of *C. partellus*. and B which were obtained from the regression of the mean crowding against mean density refers to the basic component of dispersion and the pattern of distribution respectively (Iwao, 1968). The regression constants 'a' and 'b' of Taylor's power law also indicated the sampling parameter and the aggregation index respectively (Taylor, 1961).

Statistical Analysis

$$(i) \text{ Dispersion index} = \frac{\text{Variance}}{\text{Mean}}$$

$$(ii) \text{ Dispersion pattern (K)} = \frac{(\bar{x})^2}{s^2 \bar{x}}$$

Where, $\bar{x}$ = mean density

s^2 = variance

$$(iii) CV = \frac{s}{\bar{x}} \times 100$$

Where, s = standard deviation

$\bar{x}$ = mean

$$(iv) \text{ Mean Crowding Index (X)} = \bar{x} + \frac{s^2}{\bar{x}} - 1$$

$$(v) \text{ Lloyd's Patchiness Index} = \frac{X}{\bar{x}}$$

(vi) Taylor's power law : This gives a relation between variance and mean.

$$S^2 = a \cdot \bar{x}^b \text{ (Taylor, 1961) where 'a' is a constant}$$

depending upon experimental conditions and 'b' is the coefficient of contagion.

(vii) Iwao's patchiness index relates mean crowding (X^*) to mean density as :

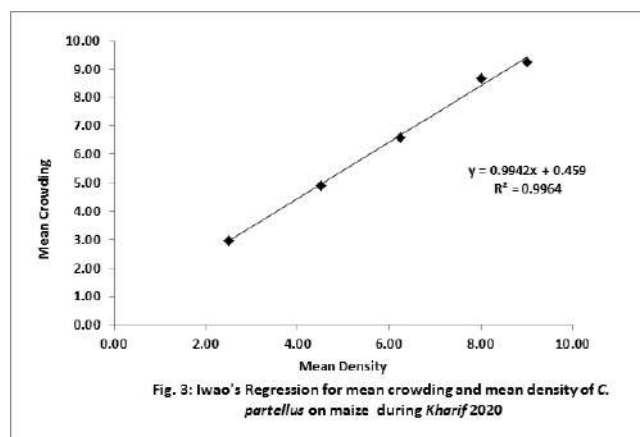
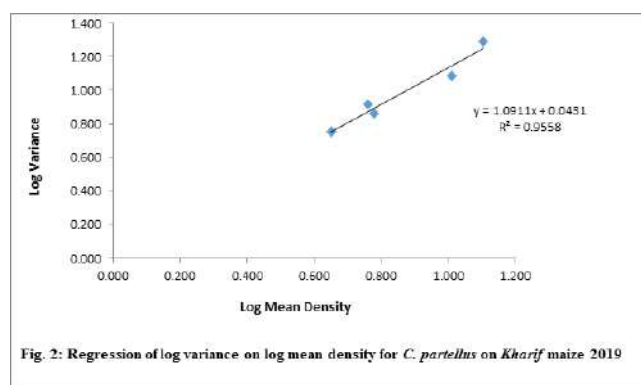
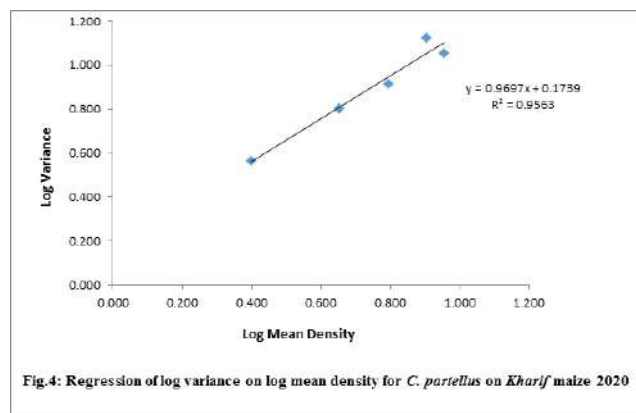
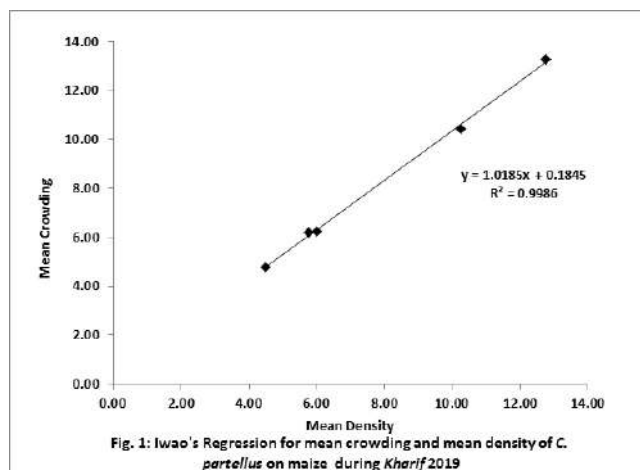
$X^* = X$ (Iwao, 1968) where ' ' is the index of basic contagion and ' ' is the density contagiousness coefficient.

$$(viii) \text{ Index of Clumping} = \frac{S^2}{\bar{x}} - 1$$

$$(ix) \text{ Mean Colony Size} = 1 + \text{mean crowding}$$

Results and Discussion

The spatial distribution data presented in Table-1 and 2 revealed that clumped type of larval distribution during *Kharif* 2019 and 2020, respectively. The values of variance to mean ratio exceeded unity in all the sampling occasions indicating a contagious type of distribution. The mean crowding index ranged from 4.76 to 13.29 and 2.97 to 9.26 during 2019 and 2020, respectively and the Lloyd's index was close to 1.0 during both the year. The values of other parameters viz., Clumping Index (I_{DM}) values were all positive; Mean Crowding Index (X) values were greater than Mean Density and Lloyd's Patchiness Index values were greater than one, which confirmed the clumped nature of dispersion of *C. partellus* larvae. The mean colony size (C) also increased with the increase in number of larvae. The Iwao's patchiness regression was computed as $X^* = 0.184 + 1.018$ (Fig. 1) and $X^* = 0.459 + 0.994$ (Fig.3) during 2019 and 2020, respectively. The index of basic contagion (a) was positive, the positive values revealed positive association. Further, the density contagiousness coefficient were $b = 1.018$ and $b = 0.994$ during 2019 and 2020, respectively, being greater than



unity revealed that the colonies were over dispersed. The regression equation based on Taylor's Power law was computed as $\log S^2 = 0.043 + 1.091 \log$ (Fig. 2) and $\log S^2 = 0.173 + 0.969 \log$ (Fig. 4) during 2019 and 2020, respectively. The value of the index of aggregation (b) were more than unity, thus confirmed the aggregate nature of distribution during both the year.

The results of present investigation are in acquiescence with the findings of Overholt *et al.* (1994), who observed that the distribution of *C. partellus*

remained aggregated through the larval and pupal life stages in maize. Jalali and Singh (2003) reported that the spatial distribution of the maize stem borer, *C. partellus* in fodder maize ecosystem was aggregated in Kharif, Rabi and Summer seasons.

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Impact of Front Line Demonstration on Growth and Essential Oil Yield of Lemon Grass Cv. Krishna through Drip and Fertigation in Tribal Belt of Korea District (C.G.)

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Abstract

Lemongrass (*Cymbopogon citratus* Linn.) a tropical grass that belongs to the family Poaceae (Gramineae) is one of the most important medicinal and aromatic plants. It produces an essential oil which has a high economical value. The present study was carried out at Manendragarh and Baikunthpur block of Korea district (C.G.) during *kharif* 2019-20 and 2020-21. There were two treatments in which one was local check and second was cultivation of improved variety of lemon grass with full package of practice under drip and fertigation. Field diagnostic visits, regular surveys, farmer meetings and training programmes ensured application of balanced and optimum doses of nutrients through fertigation and timely plant protection measures. The data related to the cost of cultivation, production, productivity, gross return and net return were collected as per schedule and analysed. Result of the present study revealed the higher average essential oil yield in the improved package of practices demonstration was recorded (135.72 kg/ha) as compared to farmers practice (74.21 kg/ha) traditional adopted by the farmers. The percentage increase in the yield over farmer's 82.89 was recorded. The technology gap and extension gap were computed 94.28 and 61.51 kg/ha respectively, along with 69.47 percent of technology index. The demonstration field gave higher average net return Rs. 202100 and B:C ratio is 1: 1.47. The result of the study indicated the gap existed in the potential yield and demonstration yield is due to soil fertility and weather conditions. Present result clearly show that the essential oil yield and economics of lemon grass can be boost up by adopting recommended technologies.

Key words : Lemon grass, drip irrigation, fertigation, b:c ratio, yield.

Introduction

Lemon grass is one of the most widely grown essential oil plants in the tropics and subtropics of India, Indonesia, Madagascar, and countries in Africa and South America (Anaruma *et al.*, 2010; Ganjewala and Luthra, 2010; Weiss, 1997). Lemongrass is grown as a perennial crop under either irrigated or non irrigated conditions. Lemongrass biomass is steam distilled for the extraction of essential oil, a natural product with wide application in the food and pharmaceutical industries, perfumery and cosmetics, and eco-friendly pesticides (Ganjewala and Luthra, 2010; Weiss, 1997). Lemongrass oil has a pleasant and refreshing aroma and antifungal and antibacterial properties (Anaruma *et al.*, 2010; Pandey *et al.*, 2003; Kumar *et al.*, 2007, 2009; Inouye *et al.*, 2001; Pattnaik *et al.*, 1996). However, lemongrass essential oil production is currently limited to the tropics and subtropics. Essential oil content of the stems and leaves average 0.25-0.35% with citral being the main component (80-86%).

Reduced agricultural productivity and water use efficiency are mainly due to conventional method of irrigation (flooding) and poor adoption of scientific water management practices. Availability of irrigation water is limited and therefore, it should be utilized most efficiently by adopting latest irrigation technologies (Patel *et al.*,

2000). Therefore, drip method of irrigation is most suited for semi-arid and arid areas where water is scarce and where low water consuming and high value crops can be grown. Drip method of irrigation helps to reduce the over exploitation of ground water that partly occurs because of inefficient use of water under surface method of irrigation (Meena *et al.*, 2017). Fertigation is one important precision farming technique which can give better nutrient use efficiency as compared to surface irrigation method. Application of nutrients untimely, following inappropriate method of application leads to severe loss of nutrients by leaching and fixation (Harisha *et al.*, 2017). Application of fertilizer in small quantities to the soil at any given time improves fertilizer use efficiency, helps to maintain nutritional balance and nutrient concentration at optimum level, saves energy and labour, provides opportunity to apply the nutrient at critical stages of crop growth and minimizes hazard of ground water. Information on water requirement and fertigation in lemon grass is lacking for Korea region. With an objective to combat the causes of poor yield and low economic returns, dissemination of recommended technology through frontline demonstration was attempted in the Korea district of Chhattisgarh.

Material and methods

Krishi Vigyan Kendra, Korea carried the technology to the

Table-1 : Yield performance and technology gap, technology index and extension gap in Lemon grass essential oil production under FLD.

Year	No. of FLDs	Oil yield (kg/ha)			% increase over FP	Technology gap (kg/ha)	Extension gap (kg/ha)	Technology index (%)
		PY	RP	FP				
2019-20	5	230	130.52	72.94	78.94	99.48	57.58	76.22
2020-21	5	230	140.92	75.48	86.70	89.08	65.44	63.21
Average	5	230	135.72	74.21	82.89	94.28	61.51	69.47

PY= Potential yield, RP= Recommended practice, FP= Farmers practice, B:C ratio= Benefit/cost ratio

Table-2 : Comparative economics of lemon grass essential oil production under FLD and farmers practice.

Year	Gross expenditure (Rs)/ha		Gross return (Rs)/ha		Net return (Rs)/ha		B:C ratio	
	RP	FP	RP	FP	RP	FP	RP	FP
2019-20	1,45,987	88,087	326300	182350	180313	94263	1.24	1.07
2020-21	1,28,413	72,087	352300	188700	223887	116613	1.74	1.62
Average	1,37,200	80,087	339300	185525	202100	105438	1.47	1.32

RP= Recommended practice, FP= Farmers practice, B:C ratio= Benefit/cost ratio

farmers field through frontline demonstrations in the villages viz Dudhaniya and Lai between 2019-20 and 2020-21. The average area under each demonstration was 5.0 ha with 5 beneficiaries in each demonstration. Through field diagnostic visits, surveys, farmer meetings etc the factors contributing to low productivity like varietal issues, faulty management practices, lack of irrigation, poor nutrient management, negligent plant protection measures were identified. The field was prepared by deep ploughing and harrowing after *Kharif* crops. Planting of lemon grass slips var. Krishna was done in Feb-March. Krishna var. was developed by CIMAP and it is suitable for both irrigated and rainfed and also hill slopes. One or two slips were planted into each hole, about 5-8 cm deep and spacing was kept 60 x 30 cm. All the participating farmers were trained on various aspects of lemon grass production technologies. The data related to cost of cultivation, production, productivity, total return and net return were collected in both treatments as per schedule from all selected farmers. An average of cost of cultivation, yield, net returns of different farmers was analyzed by the formula. The drip irrigation system was installed and operated daily except on rainy days to provide the sufficient moisture to the plants. The lateral lines were laid parallel to the crop rows and each lateral served two rows of crop. The laterals were provided with on line emitters of 4 lt hr⁻¹ discharge capacity. Emitters were fixed 0.3m apart to serve the irrigation water requirement of four plants. Inline drippers with a discharge rate of 4 lt hr⁻¹ was followed for all the plants spaced at 60x 30cm. Fertigation is done as per the recommended dose with 60:50:120 NPK kg of NPK/ha and is applied throughout the cropping period once in three days. Water soluble fertilizers like 19:19:19, 0: 0:50 and urea are used. The scheduling interval of fertigation was followed at weekly intervals for 13 weeks starting

from 5th to 17th week after planting in the field. All other steps like site and farmer selection, layout of demonstration, farmers' participation etc were followed as suggested by Choudhary (1999). In case of local check (control plots) no change was made in the existing practices of imbalanced use of organic and inorganic fertilizers and little or no use of fungicides and pesticides. Well before the demonstrations training was imparted to the farmers and their exposure visits to the KVK instructional-cum demonstration farms were conducted. Visits of the farmers and the extension functionaries were also organized to demonstration plots to disseminate the message at large. Yield data were collected from the control and demonstration plots and cost of cultivation, net income and benefit/cost ratio were computed.

Results and discussion

In Lemongrass cultivation, fresh herbage yield and dry yield are considered as main oil yield contributing characters (Gajbhiye *et al.*, 2013). Performance of lemon grass var. Krishna under drip and fertigation was found to be substantially higher under the demonstration plots than under control during all the demonstration years (Table-1). The average oil yield under demonstrations was 130.52 and 140.92 kg/ha during 2019-20 and 2020-21 respectively. The findings are confirmed with the findings of Ram *et al.*, 1993, Godara *et al.*, 2013, Behara *et al.*, 2015, Singh and Singh, 2014, Premathilake *et al.*, 2018 and Adawadkar *et al.*, 2019. The yield enhancement due to technological intervention was to the tune of 78.94 and 86.70 per cent over control. The cumulative effect of technological intervention over two years revealed an average yield of 135.72 kg/ha i.e 82.89 per cent higher over local check. The year-to-year fluctuations in yield and cost of cultivation can be explained based on variations in microclimatic conditions and marketability price. The data

clearly reveal that the net returns from the demonstration plots were substantially higher than control plots during all the years. An average net return was observed to be Rs 202100 in comparison to control plot i.e Rs 105438. Thus, on an average additional income of Rs 96662 is attributed to the technological intervention provided in demonstration plots. Economic analysis revealed that benefit/cost ratio in demonstration plots was comparatively higher than control plots. The highest benefit cost ratio (1.74) was observed in the year 2020-21 followed by 1.24 in the year 2019-20. The variation in B:C ratio could be due to price variation during the study years. The average B:C ratio of demonstration and control plots was 1.47 and 1.32 respectively during the study period. Hence, favourable B:C ratio proved the economic viability of the intervention made under demonstration and convinced the farmers on the utility of intervention.

Technology gap, Extension gap and Technology index : It is evident from data (Table-1) that the on an average technology gap, the differences between potential yield and yield of lemon grass demonstration plots was 94.28 kg/ha. The technology gap observed may be attributed to dissimilarity in the soil fertility status, agricultural practices and local climatic situation. On an average extension gap of 61.51 kg/ha was observed during the trial which emphasized the need to educate the farmers through various extension means i.e. front line demonstration for adoption of improved production and protection technologies, to revert the trend of wide extension gap. More and more use of latest production technologies with improved variety, drip and fertigation will subsequently change this alarming trend of galloping extension gap. The technology index shows the feasibility of the demonstrated technology at the farmers field. The average technology index recorded 69.47 per cent during FLDs programme, which shows the efficacy of good performance of technical interventions. This will accelerate the adoption of demonstrated technical intervention to increase the oil yield of lemon grass.

Conclusion

The results of front line demonstration convincingly proved that the essential oil yield of lemon grass could be increased by 82.89 per cent with the better technological intervention with drip and fertigation. Favourable benefit/cost ratio is self-explanatory of economic viability of the demonstration. The technology is suitable for enhancing the productivity of lemon grass and appropriate time for area expansion under lemon grass production in Korea dist. The suitable climate for its growth can transform lives of many rural growers if more interventions are conducted and technical knowledge is given to the growers with bottom up policy.

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Performance of Front Line Demonstration on the Yield and Economics of Linseed in Seoni District of M.P.

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Abstract

Linseed is an importance Rabi oilseed crop having highest content of omega-3 fatty acid called alfa linolic acid. Total 125 demonstrations were conducted in linseed crop by the active participation of the farmers with objective of improved technologies. The improved technologies consist improved variety, STV based plant nutrient application, seed treatment, integrated diseases and pest management etc. The average two year data observed that an average yield of demonstration plot was 13.22q/ha over control (10.43 q/ha) with additional yield of 2.79q/ha and the increase average productivity by 26.64 per cent. The average net return from the demonstration plot was higher (Rs. 32030/-) in comparison to farmers practice (Rs. 23005/-). An average benefit: cost ratio of the demonstration plot and local check were 2.52 and 2.22. The average extension gap, technology gap and technology index were 2.78, 6.78 and 33.90 respectively.

Key words : Linseed, economics, front line demonstration, yield.

Introduction

Linseed (*Linum usitatissimum* L.) is the second most important Rabi oilseed crop and stands next to rapeseed-mustard in area of cultivation and seed production in India. It has highest content of the omega-3 fatty acid called alpha linolic acid. It is also reach source of protein, dietary fibres and phytoestrogens. The oil content of the seed varies from 33-47 per cent. About 20 % of the total linseed oil produced in India is used by farmers and rest about 80% goes to industries for the manufacture of paints, varnish, oilcloth, linoleum and printing ink etc. Linseed has an important position in Indian economy due to its wide industrial utility. Omega-3 enriched eggs and meat are obtained by feeding linseed to poultry and livestock, and enriched beverages are produced by linseed oil supplementation. Many health benefits have been associated with the consumption of linseed.

In India, linseed is grown mostly under rainfed (63%), Utera (25%) , irrigated (17%) and in input starved conditions in major linseed producing states i.e. Madhya Pradesh, Chhattisgarh, Maharashtra, Jharkhand, Uttar Pradesh and Odisha (Srivastava,2009). In Seoni district 3141 ha area under linseed cultivation in 2018-19 with 1297 metric tonnes production and the productivity of 413 kg/ha. Productivity of linseed in M.P. is 1265 kg/ha (Agriculture statistics, 2018-19). It indicates that the productivity of linseed in Seoni district is comparatively low. It may be due to unavailability of suitable high yielding varieties, lack knowledge of improved production technologies, more specifically the sowing methods and plant nutrient management. The productivity of linseed

could be increased by adopting recommended suitable management production practices. Front line demonstration is the best tool of field demonstration with main objective to demonstrate complete scientific production technology at farmer's field. Potentiality of recommended technology through front line demonstration was attempted in this study with an objective to combat the causes of low yield and lower economic returns.

Materials and Methods

Jawaharlal Nehru Krishi Vishwa Vidyalaya, KVK, Seoni were conducted 125 frontline demonstrations on farmers field during 2018-19 and 2019-20 at nine different villages viz. Badalpar, Yerma, Partapur, Jamunia, Babai, Rampuri, Khairi, Sarandi and Pondi. During these years of study in area of 50 hectare was covered with plot size 0.4 ha under frontline demonstration with active participation of 125 farmers. Before conducting frontline demonstrations a list of farmers were prepared from group meeting and training was given to the selected farmers regarding complete package of practices.

The soils of demonstration site were clayey in texture with pH ranges 6.2 to 7.8. The available nitrogen, phosphorus and potassium varied between 195-262, 20-27 and 280-440 kg/ha respectively. In demonstration plots use of quality seed (JLS-66) improved variety, timely line sowing, STV based plant nutrient application, timely weeding, need based IPM and IDM were emphasized and comparison has been made with the farmers practice (local check). The necessary steps for the selection of site and farmers, layout of demonstration etc were followed as

Table-1 : Performance of front line demonstrations on yield and per cent increase of linseed.

Year	Area (ha.)	No. of Farmers	Seed Yield (q/ha)			% Increase over control
			Potential	Demonstration	Control	
2018-19	30	75	20	12.29	9.75	26.05
2019-20	20	50	20	14.15	11.12	27.24
Average				13.22	10.43	26.64

Table-2 : Performance of front line demonstrations on Technology gap, Extension gap and Technology index of linseed.

Year	Technology gap (q/ha.)	Extension gap (q/ha.)	Technology index (%)
2018-19	7.71	2.54	38.55
2019-20	5.85	3.03	29.25
Average	6.78	2.78	33.90

Table-3 : Performance of front line demonstrations on Economics of linseed.

Year	Expenditure (Rs.)		Gross return (Rs.)		Net Return (Rs.)		B:C Ratio	
	Demo	Local Check	Demo	Local Check	Demo	Local Check	Demo	Local Check
2018-19	20150	18220	49160	39000	29010	20780	2.43	2.14
2019-20	21550	19250	56600	44480	35050	25230	2.62	2.31
Average	20850	18735	52880	41740	32030	23005	2.52	2.22

suggested by Choudhary (1999). The tradition practices were maintained in case of local check. Yield data was collected from farmer's practices and demonstration plots and cost of cultivation, net return and benefit: cost ratio were calculated and analyzed. Finally the extension gap, technology gap and technology index were calculated using the formula as suggested by Samui et al (2020).

Extension gap = Demonstration Yield - Farmers Yield

Technology gap = Potential Yield - Demonstration Yield

Technology Index (%) = [Technology gap/Potential yield] x 100

Result and Discussion

The yield of linseed in demonstration and local checks is sown in the table-1. It is evident from the results that under demonstration plot, yield of linseed was sustainable higher than that of local check in both the years of the study. Yield in linseed under demonstration ranged from 1229-1415 kg/ha during the period under study. Technological intervention increased the yield to tune of 26.05 per cent during 2018-19 and 27.24 per cent during 2019-20 respectively over the local check. Fluctuations in the yield observed over the years were mainly on account of variation in soil moisture availability, rainfall, sowing time and pest & disease infestations. Similar enhancement in yield under frontline demonstrations was documented by Dhaka et. al. 2015, Lal et. al. 2016, Meena et. al. 2016 and Verma et. al. 2016 and Singh et. al 2017. Yield in frontline demonstration and potential yield of the crop was compared for estimating yield gaps. These gaps were further categorized as technology and extension gaps. The technology gap indicates a gap in demonstration yield over the potential yield, and this was 771 kg and 585 kg per hectare. The technology gap

observed may be attributed to dissimilarities in soil fertility, and other vagaries of weather in the demonstration areas. Hence to narrow down the gap between the two types of yield in different varieties, location specific recommendation may become necessary.

Extension gap ranged from 254-303kg/ha during the period under study (table-2). A wide extension gap emphasized the need to educate farmers using various means to facilitate adoption of improved production technologies, to reverse the trend. Technology index refer to the feasibility of variety at farmers field.

Various economic indicators like expenditure, gross returns, net returns and benefit: cost ratios of frontline demonstrations are also presented in the table-3. The economic indicators clearly shows that the net returns from the recommended practices were substantially higher than the local check (farmers practice), during the study years. The average net returns from the demonstration were higher (Rs. 32030/ ha) in comparison to farmers practice plot (Rs. 23005/-). An average Rs. 9025/- as additional income was recorded through the innovative technological interventions that is improved variety, seed treatment, balance plant nutrition, plant protection measures and balance cultural practices. Economic analysis of the yield concluded that the benefit: ratios of demonstrations plots were significantly higher over farmers practice. The benefit: cost ratio of the demonstration plot and farmers practice was 2.43 and 2.14, 2.62 and 2.31 during the year 2018-19 and 2019-20 respectively. The overall average benefit: cost ratio varied from 2.52 to 2.22 between the demonstration and farmers practice plot respectively. The benefit: cost ratio of the system proved the economic viability of the interventions

made under demonstration and convinced the farmers on the utility of the interventions. The authors like Mishra et al 2009 in potato, Gurumukhi and Mishra 2003 in sorghum also reported similar findings. The data also revealed that the maximum increase in yield was recorded in the year 2019-20, while maximum benefit: cost ratio of 2.62 was also recorded during the same year. The variation in benefit: cost ratio during the different years may be related to the yield performance and other inputs and production in that particular year.

Conclusion

On the basis of the result obtained in present study it can be concluded that the use of improved production technologies of linseed cultivation can reduced the technology gap to a considerable extent thus leading to increase productivity of linseed in the district. Extension gap which emphasise the need to educate the farmers through various means like off campus training, on campus training, method demonstrations, frontline demonstrations etc. Technology index which shows the feasibility of the technology demonstrated has depicted good performance of the intervention.

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Price Spread and Farmers Share in Consumer Rupee of Coconut Value Chains in Coimbatore District—A Systematic Analysis

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Abstract

Horticulture in India is increasingly recognized in recent years and considered as a promising agribusiness venture, to meet its potential to raise the farm income, provides nutritional and livelihood security for the grown population. Coconut a multifaced crop is dominating the plantation crop production, but the domination of intermediaries results in huge price spread from the ultimate customers (Dhara, 2016). This study attempts analyze the price spread and marketing efficiency on farm income in coconut sector. Price spread analysis, Farmer's share in consumer rupee and market efficiency analysis were used to address the stated problem. Among the various value chains operated in Coimbatore district, CVC III (Through FPC) had the lowest price spread with Rs.5073, Rs.5288, Rs.4451 and Rs.4483 in the study district, which was the most efficient value chains in this region. Price spread in this district Channel V was higher among the value chains with Rs.18523, Rs. 16657, Rs. 11269 and Rs.11968 respectively. Among the various value chains, it was found that farmer's share in consumer rupee was higher in CVC III (Through FPC).

Key words : Price spread, intermediaries, market efficiency, coconut value chain.

Introduction

Horticultural sector in India comprises a wide range of crops like fruits, vegetables, flowers, spices, plantation crops like coconut, areca nut, tea, coffee and some medicinal plants and aromatic plants (National Horticultural Board 2018). Horticulture sector contributes to 33 per cent of total agriculture output (PIB, 2019). Plantation crops production has shown impressive growth in area and production. Among plantation crops, Coconut with production of 41765 lakh nuts, Areca nut with 8.33 lakh tonnes and cashew nut with 8.17 lakh tonnes is producing in India in the year 2018-19. Globally India leads first in coconut production and productivity. The annual production of coconut in India is around 2437 crore nuts and average productivity is around 11616 nuts per hectare. In India, Coconut is cultivated in an area of 20.98 lakh hectare. Coconut crop alone contributes Rs 34,100 crore to GDP. But the situation in grassroot level is different, i.e., coconut farmers were facing many constraints in marketing the coconuts. Various studies shows that coconut marketing starts from the farmers field after harvesting the nut. Marketing of coconut differs from that of other fresh fruits and vegetables because of its natural durability of coconuts. Harvesting of coconut is done by laborers hired by the farmers or by the harvest contractor. Labor for harvesting is the another challenge, since the availability of technical labour is sparse, that effects the quality of harvesting nuts (Barin Banu 2019). Besides this the intermediaries also faces problems in labours for dehusking of nuts, loading and unloading. Due

to its bulkiness of nuts, problems in transportation and transportation cost. Apart from this the domination of intermediaries in this crops results in huge price spread from the ultimate customers (Dhara, 2016). Apart from this the following are constraints pertaining to marketing of coconut, lack of government procurement system, lack of co-operative marketing, lack of proper market information, monopoly of market intermediaries, fluctuation in market price, high commission among intermediaries, were the major problems faced by the coconut growers. The objective of this study is to analyze the price spread of various value chains and evaluate the efficiency and suggest the effective value chain prevalent in the study district.

Price Spread : analyzed the problem faced by the traders in coconut marketing, the researcher concluded that marketing efficiency is high due to fewer intermediaries and low marketing margin and the producer's share is inversely related to consumer's price. found out from the study on price spread of coconut in Hassan district and concluded that the producer share in consumer rupee was the highest in channel I (100.00 %) followed by channel III (76.56 %), channel II (74.94 %) and in channel IV (66.22 %). The producer's share in consumer's rupee in channel IV was low because producer sold their nuts to middlemen like village merchants and commission agents. This clearly showed that selling coconuts directly to consumer in the market is advantageous, but it is done rarely. Maximum producer sold their produce directly to wholesalers/commission agents and village traders.

reported that producer share in the consumer's rupee in coconut was the highest (98.50 percent) in the channel I (Producer to Consumer) and the lowest (34.10 percent) in channel VI (Producer to Commission agent to Wholesaler to Retailer to Consumer).

Research Methodology

A Multi-stage random sampling technique was employed to select the respondents based on the time and resource constraints. In the first stage, among various districts in Tamil Nadu, Coimbatore was selected based on the area and production of coconut. These districts contributed to 39.26 percent of the area under coconut cultivation in the state (CDB, 2019). In the second stage, based on the area under coconut cultivation, three taluks in each district viz., Pollachi, Anaimalai and Kinathukadavu in Coimbatore district was selected. In the third stage, two blocks were selected from each taluk based on the area under coconut cultivation and farmers were randomly selected from the villages of selected blocks. Twenty-five farmers from three taluks in Coimbatore was selected with the total of 75 coconut farmers were selected randomly. The farmers were contacted individually for collection of details regarding constraints in production and marketing of coconut with the help of a well-structured and pre-tested interview schedule. Besides the sample farmers, commission agents, harvest contractors, exporters, processors, wholesalers and retailers were selected randomly to analyse the problems in coconut marketing. The details of the sample respondents were given in Table 1. Primary data was collected from the respondents during the months of April – September 2019 and the secondary data collected were related to the agricultural year 2018-19.

Table-1 : Sample intermediaries, processors and consumers in the value chain selected for the study.

District / Intermediaries	Coimbatore	Total
Farmers	75	75
Commission agents	10	10
Harvest Contractors	10	10
Exporters	10	10
Farmer Producer Company	1	1
Processors	5	5
Wholesalers	10	10
Retailer	10	10
Total	71	131

Tools of Analysis

Price Spread : In the process of marketing coconut and its products, the difference between price paid by consumer and price received by the producer for an equivalent quantity of coconut was considered as "Price Spread." In this study, the price spread was worked for two different situations as detailed below :

Difference between price paid by the consumer and price received by the farmers when coconut was sold directly without processing.

Difference between price paid by the processor and price received by the farmers when coconut was processed into value added products.

Farmer's Share in Consumer Rupee : Further, the farmer's share in consumer rupee was calculated with the help of the following formula.

$$Fs = (Fp/Cp) \times 100$$

Where,

Fs = Farmer's share in consumer rupee (percentage)

Fp = Farmer's price

Cp = Consumer's price

Price spread analysis of coconut value chains : Price spread is defined as the difference between the price paid by consumers and the price received by producers for an equivalent quantity of the commodity. The economic efficiency of the marketing system of an agricultural commodity is generally measured in terms of the price spread. Lower the price spread, greater the marketing efficiency and vice versa.

Marketing cost is the cost involved in moving a product from one stage to another in the value chain. Marketing margin is that part of income which accrued is over and above the marketing cost incurred by the market functionary. The price spread prevalent in the value chain of coconut in the Western region of Tamil Nadu was analyzed and presented in the following section.

Coimbatore District : The price spread analysis was carried out for five different value chains in coconut prevalent in the district and tabulated in Table 2. In CVC I, the farmers with the help of harvest contractors harvested the produce and sold to wholesalers and, in turn, to the retailer. The marketing cost of the harvesting contractor contributed to 9.80 percent of the total cost, followed by the marketing cost of the retailer (2.60 percent). Similarly, the marketing margin of the retailer was higher, with 10.00 percent of total cost followed by the marketing margin of wholesaler (8.70 percent) and harvest contractor (2.70 percent). The reason for higher marketing cost in the case of harvest contractors included harvesting charges, transportation costs to the wholesalers' yard and dehusking charge, which also was borne by the harvesting contractor. In the case of marketing margin, retailers and wholesalers had a higher margin due to lower quantities handled while harvest contractors had a lower margin due to higher quantities transacted.

In CVC – II, the harvested coconut was directly sold

Table-2 : Price Spread Analysis of Coconut Value Chains in Coimbatore district.

Intermediaries	Particulars (Rs. / 1000 nuts)	CVC I		CVC II		CVC III		CVC IV		CVC V	
		Rs.	%	Rs.	%	Rs.	%	Rs.	%	Rs.	%
Farmers	Producer Price	15257	66.33	15758	68.51	22278	79.56	16532	51.66	15343	47.95
	MCF	-	-	600	2.61	600	2.14	600	1.88	600	1.88
	PHL	-	-	50	0.22	50	0.18	50	0.16	50	0.16
	Producers Gross Price	15257	66.33	16408	71.34	22927	81.88	17182	53.69	15993	49.98
Harvest Contractors	MCHC	2233	9.71	-	-	-	-	-	-	-	-
	MMHC	542	2.36	-	-	-	-	-	-	-	-
	PHL	30	0.13	-	-	-	-	-	-	-	-
	HC. Price	18062	78.53	-	-	-	-	-	-	-	-
Commission Agents	MCCA	-	-	1172	5.10	-	-	441	1.38	-	-
	MMCA	-	-	452	1.97	-	-	-	-	410	1.28
	PHL	-	-	30	0.13	-	-	-	-	-	-
	CA. Price	-	-	18062	78.53	-	-	17623	55.07	16403	51.26
Processors	MCP	-	-	-	-	-	-	-	-	3482	10.88
	MMP	-	-	-	-	-	-	-	-	8535	26.67
	PHL	-	-	-	-	-	-	-	-	30	0.09
	P. Price	-	-	-	-	-	-	-	-	28450	88.91
Exporters	MCE	-	-	-	-	-	-	2500	7.81	-	-
	MME	-	-	-	-	-	-	3560	11.13	-	-
	PHL	-	-	-	-	-	-	50	0.16	-	-
	E. Price	-	-	-	-	-	-	23733	74.17	-	-
FPC	MCFCPC	-	-	-	-	1396	4.99	-	-	-	-
	MMFCPC	-	-	-	-	497	1.78	-	-	-	-
	PHL	-	-	-	-	30	0.11	-	-	-	-
	FPC. Price	-	-	-	-	24850	88.75	-	-	-	-
Wholesalers	MCWS	-	0	-	-	-	-	-	-	-	-
	MMWS	2008	8.73	2008	8.73	-	-	2637	8.24	-	-
	PHL	30	0.13	30	0.13	-	-	30	0.09	-	-
	WS. Price	20100	87.39	20100	87.39	-	-	26400	82.50	28450	88.91
Retailers	MCR	550	2.39	550	2.39	300	1.071	550	1.72	300	0.94
	MMR	2300	10.00	2300	10.00	2800	10.000	3000	9.38	3200	10.00
	PHL	50	0.22	50	0.22	50	0.18	50	0.16	50	0.16
	R. Price	23000	100.00	23000	100.00	28000	100.00	30000	100.00	32000	100.00
	Consumer Price	23000		23000		28000		30000		32000	
	Price Spread	7743		7242		5723		12818		16657	

Table-3 : Farmers Share in Consumer Rupee in Coimbatore district. (Rs. / 1000 nuts)

S. No.	Particulars	CVC I	CVC II	CVC III	CVC IV	CVC V
1.	Farmers selling price	15257	15758	22278	16532	15343
2.	Consumer purchase price	23000	23000	28000	30000	32000
3.	Farmers share in consumer payment (%)	66.33	68.51	79.56	55.10	47.94

to the wholesaler via commission agents, the marketing cost incurred by the farmer consisted of dehusking charge which was about 2.80 percent followed by marketing cost of commission agents which was about 5.20 percent that consisted of transportation and loading/unloading cost while transporting the nuts to the buyer's place. Marketing cost for wholesalers was very minimum, and marketing cost to the retailer was 2.60 percent of the total net price.

Marketing margin of the retailers and wholesalers was 10.00 percent and 8.70 percent as existed in the CVC I. In CVC II, as coconut sale was dealt in bulk volumes, marketing margin to the commission agent was only 2.00 percent.

In CVC III, the member farmers of FPOs sold the products via FPOs and in turn, the product was sold to

retailers. FPO acted as a commission agent and wholesaler. The marketing cost to farmers was 2.30 percent (Rs.650) and to FPC was 5.10 percent. Retailer's marketing cost was 1.30 percent and the marketing margin was 10.00 percent. FPCs shared a margin of 1.80 percent with the member farmers, thus increased the profit to the farmers.

In CVC IV, the marketing cost of farmer/producer (2.20 percent) was incurred because the producer had to bear the dehushing charges incurred at the farm. The farmer transported the nuts to the storage yard of the exporter via the commission agent. The exporter sorted and packed the products. The marketing margin of the commission agent was 1.50 percent. The exporter had to bear the transportation cost, loading/unloading/exporting cost etc., which contributed to 8.50 percent. The importer, in turn locally supplied the products to the wholesaler and the nuts were sold through the retailers. The marketing cost of retailer contributes to 2.00 percent. The marketing margin for retailers and wholesalers is the same as CVC I (10.00 and 8.80 percent respectively). Exporter shared a margin of 11.90 percent and the commission agent shared 1.50 percent. But in this case, the farmer got more benefit because the husk was sold separately and hence the price received by the farmer in CVC IV was (Rs. 17,732 per 1000 nuts), including the sale of husk.

In CVC V, the harvested coconut from farmer's field was sold to the processor then sold directly via the retailer, in which the marketing cost for commission agents and farmer was very minimum, i.e., because the processor bears all the cost (loading, transportation, etc.); hence the marketing cost of the processor is 11.00 percent of the price paid by the retailer. Retailers share was 1.10 percent as a marketing cost. Marketing margin for the processor was higher among all the chains, which was around 26.70 percent of the net price paid by the consumer, followed by 10.00 percent for retailers and 1.30 percent for commission agents. The detailed price spread of Coimbatore district is enclosed in Annexure VII.

Farmers Share in Consumer Rupee in Coimbatore district : The details of the farmers share in consumer rupee in Coimbatore district for coconuts in the existing value chains are reported in the Table-3.

From the table, it is evident that farmers share in consumer rupee ranged from 47.94 percent to 79.56 percent among the five value chains in the Coimbatore district. CVC III (Through FPC) in Coimbatore district held the highest farmers share with 79.56 percent due to limited intermediaries in the value chain resulted in lower marketing cost and marketing margin. Due to the length of value chain CVC V, the farmers share in consumer rupee (47.94 percent) was lesser. Results showed that by

avoiding the regular traditional value chain resulted in minimizing the marketing cost, marketing margin and farmers could get a better share in the price paid by the consumer.

Conclusions

From the above section it was clear that, the price spread of coconut value chains in Coimbatore was calculated and analyzed using price spread analysis. Among the various value chains operated in Coimbatore, CVC III (Through FPC) has a lower price spread with Rs.5073, Rs.5288, Rs.4451 and Rs.4483 respectively in Coimbatore district was the most efficient value chains in this region. Price spread in Channel V was higher among the value chains with Rs.18523, Rs. 16657, Rs. 11269 and Rs.11968 respectively in this district. This was due to the length of chain and a higher margin by the processor resulted in high price spread. After VC III, VC II had the lowest price spread in this region. It is concluded that if the length of the chain increases, price spread also gets increased and vice versa.

In order to explain the Farmer's Share in Consumer Rupee for coconuts in the Coimbatore region of Tamil Nadu, among the various value chains in this region, it was found that farmers share in consumer rupee was higher in CVC III (Through FPC). This state-of-the-art value chain was established recently, which reformed agricultural marketing to an extent, followed by CVC II (Through Commission Agents) was higher since the number of intermediaries in this chain was lesser compared to other chains. CVC V in the region was the least effective chain, since the Farmers Share in Consumer rupee was very less when compared to all other chains. But the price paid by the consumer was higher in this chain, which was shared mostly by the processors.

Recommendations

Based on the findings from the study, measures taken by the policy makers includes, Strategizing the price discovery mechanism to fix price through an official source of information to the farmers and intermediaries reduces the ambiguity in price fluctuation. Policies of Regulated markets, NAFED, PCMS and e-NAM in the State to be revamped by along with copra procurement, the said agencies should include and trade raw coconuts also. Coconut Producer Companies in the State is changing the trend in marketing of coconuts. Small, Marginal and Medium farmers can collectively involve in direct marketing through these CPCs. Reduction in length of the value chain increase the profitability and gained better market efficiency.

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Spatio-Temporal Variability and Availability of Solar Radiation for Photosynthesis in the Kalaburgi District, Karnataka—A Case Study

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Abstract

Extreme weather and temperature changes have been noticed in recent days, and these are increasingly being acknowledged as significant components of climate change. This research used gridded data with a 0.5-degree resolution from the NASA POWER project's estimate of global energy resources, we assessed the spatial-temporal variability of solar radiation over the Kalaburgi district of Karnataka, India, for the period 1981-2018. The non-parametric Mann-Kendall (MK) test and Sen's slope estimator used to detect and quantify trends in solar radiation. The research area's solar radiation data studied for the past 38 years to assess its fluctuation. The trend in solar radiation was determined using the non-parametric statistical methods Mann Kendall test and Sen's slope estimator. The research's main findings are that average solar radiation has been observed spatially dispersed in the range 16.54 to 19.03 MJm⁻² day⁻¹ over the studied region for the previous 38 years, from 1981 to 2018. For the last 38 years, the solar radiation has shown a linear rising trend for Mann- Kendall test and Sen's estimate over the research region.

Key words : Mann-kendall (MK) test, sen's slope estimator, spatial analysis, interpolation

Introduction

Energy emitted by the sun in the form of radiant (or electromagnetic) radiation is referred to as solar radiation. In addition to providing light and heat for the Earth, photosynthesis relies on it for energy. The metabolism of the environment and its people depends on this radiant energy. Energy, heat, and light are all provided by solar radiation. On land and in the sea, infrared radiation provides heat. The Earth's surface would be 32°C colder if there were no solar radiation (1). Solar radiation is another source of light. Unless predators evolved to live in gloomy surroundings, they would be unable to effectively hunt their prey because they would lack the light provided by the sun. Human eyes can only perceive colours in the visible range, while certain other animals can also see UV light (1). Long-term observational radiation records are accumulating evidence that surface solar radiation experiences significant multi-decadal changes, which should be included in solar resource estimates (2 and 3). It is in this context that the current study is being carried out in the Kalaburgi District, Karnataka State's North Eastern Region, to explore the long-term spatio-temporal variability of solar radiation and analyse its trend.

Materials and Methods

Description of Study Area

Location : The area selected for the present study comes

under the north eastern zone of Karnataka state, India (Fig.-1). The entire district situated on Deccan plateau and altitude ranges from 300 to 750 m above Mean Sea Level (MSL). Most of the area is covered with black soil and to some extent red soil as well. The study area lies between 17°12' and 17°46' N latitude and 76° 04' and 77°54' E longitude.

Climate : The district's climate is typically dry, with lows of 8°C and highs of 45°C, with an average annual rainfall of 750 mm. May with its average high of 40 degrees Celsius, while December is the coldest with a mean low of 15.9 degrees Celsius. As the summer months approach, temperatures soar up to 45 °C, average wind speed is 5.5 ms⁻¹, average day length varies from 10-12 hours.

Data collection : NASA POWER, a global energy resource forecast project, provided data on solar radiation (MJm⁻²day⁻¹) for the current study. For the years 1981-2018, historical data was gathered for seven locations: Aland, Afzalpur, Chincholi, Chittapur, Kalaburgi, Sedam, and Jewargi.

Statistical analysis : Statistical analysis of long-term solar radiation executed. For statistical data analysis spreadsheet package of MS Excel was used. The verified by using Mann- Kendall Test and Sen's slope estimator for the study area.

Trend Analysis : The solar radiation data freely

Table-1 : Decadal average of solar radiation, MJ m⁻² day⁻¹.

Place	Latitude	Longitude	1981-1990	1991-2000	2001-2010	2011-2018
Aland	17.5700	76.5694	19.08	19.24	19.15	18.18
Afzalpur	17.2116	76.3575	19.00	19.35	19.47	18.22
Chincholi	17.4605	77.4188	19.02	18.91	19.42	18.44
Chittapur	17.1002	77.0827	19.05	18.93	19.12	18.28
Sedam	17.1797	77.2869	19.01	18.62	19.32	18.48
Jewargi	17.0197	76.7700	19.10	19.30	19.71	18.67
Kalaburgi	17.3297	76.8341	19.20	19.40	19.45	18.59

Table-2 : Mann- Kendall trend (Z) , Sen's slope value (Q), Highest, Average and lowest of the solar radiation, MJm⁻² day⁻¹.

Places Indices	Afzalpur	Aland	Chincholi	Chittapur	Sedam	Kalaburgi	Jevargi
Z value	-0.01	-3.89	1.52	-0.45	1.5	-0.77	-0.77
Q value	-0.051	-0.008	0.041	-0.007	0.021	-0.009	-0.009
Highest	19.90 (2008)	19.90 (2009)	20.05 (2009)	20.05 (2009)	20.05 (2009)	19.90 (2009)	19.90 (2009)
Average	19.03	19.03	18.94	18.92	18.94	19.03	19.03
Lowest	17.33 (2012)	17.14 (2018)	17.64 (2013)	17.64 (2013)	19.64 (2013)	17.14 (2018)	17.14 (2018)

worldwide in gridded form with 0.5 degree resolution from 1981 to 2018 were collected from the National Aeronautics and Space Administration prediction of worldwide energy resource (NASA POWER) project ([https://power.larc.nasa.gov / data-access-viewer/](https://power.larc.nasa.gov/data-access-viewer/)). Trend analysis of solar radiation data carried out to assess the long-term variability of solar radiation by Mann-Kendall test and Sen's slope estimator.

Mann-Kendall Test : The Mann Kendall test is an effective means of exploring time series data. Non-parametric techniques concentrate on the location of the sampled population's probability distribution, rather than on individual characteristics of the population. Mann-Kendall trend identification is commonly employed with a series. The suggested test was (4), which was later developed by (5) and significantly enhanced by (6). Mann-Kendall statistic (S) detects if the data trend is increasing or decreasing. When a number is positive, it means there is an increase in the amount of the constituent over time; when a value is negative, it means there is a reduction in the amount of the constituent over time. Detailed procedure presented in (7).

Sen's slope estimator : Trend in a time series can be calculated using a simple non-parametric method developed by (8). Mann-Kendall test is used to find out a significant increase or decrease in parameter under consideration. Kendall's correlation of coefficient is (Kendall's tau), an effective and general measurement of correlation between two variables (4 and 5). This type is extensively used for testing the trend in hydrological data, however, it does not estimate a trend slope. Therefore, the non-parametric Sen's method, is a linear model (9), is

applied to calculate the slope of an existing trend's value and confidence interval. It is estimated using the statistic Sen's Slope (unit change per time period) or the magnitude of the trend. This approach involves computing slopes for all the pairs of time points and then using the median of these slopes as an estimate of the overall slope. Detailed procedure presented in (7).

Spatial analysis : To look for spatial distribution patterns in the data, the ArcGIS V. xx software's Spatial Analysis Tool used.

Spatial Interpolation : Using data from nearby sampled sites, spatial interpolation used to estimate a variable in an unsampled place. The Spatial Analysis Tool in the ArcGIS V. xx software used for interpolation creating and analysing the map of long term annual meteorological data. The study area's solar radiation map was generated using the Inverse Distance Weighting (IDW) interpolation approach. We used this technique because, IDW technique takes the less neighboring unknown location points and When compared to other interpolation methods, it will produce more precise results than kriging and spline. By assuming the attribute value of an unknown site is weighted average of a known location; IDW's spatial interpolation was carried out utilising value from known nearby locations based on distance weighting (10).

The collected meteorological data viz. average temperature, maximum and minimum temperature, rainfall, wind speed, relative humidity and solar radiation analyzed from 1981-2018 using deterministic IDW interpolation technique available in ArcGIS V. xx software.



Fig.-1 : Location of the study area.

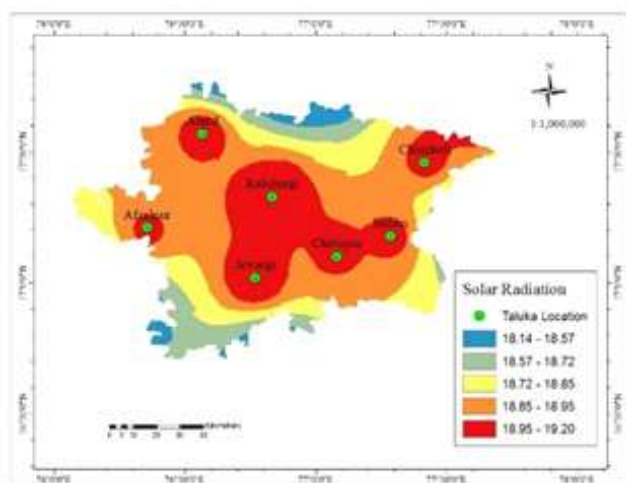
Results and Discussion

In this section presented results and discussion of the assessment of long term spatio-temporal variability of solar radiation from 1981 to 2018 for seven locations of Kalaburgi district using Mann-Kendall test and Sen's slope estimator method.

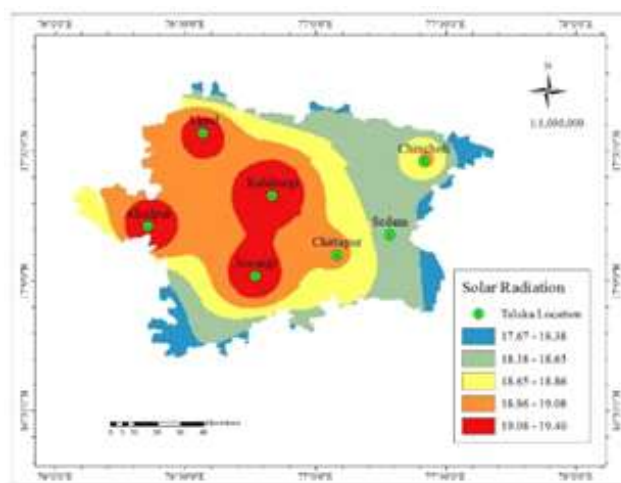
Spatial variability analysis : The spatial variability maps of solar radiation prepared to display the spatial distribution in the study area. The spatial variability analysis of average solar radiation and carried out in ArcGIS V_{r.xx} in spatial analyst tool by IDW interpolation technique. The spatial variability maps of average solar radiation (Henceforth, aveS_{rad}) of the study area from 1981-2018 prepared for four decade and spatial distribution in 38 years presented in the Fig. 2 (a to e) and Table 1. The spatial distribution of aveS_{rad} from 1981-1990 Fig. 2 (a) observed higher in Afzalpur, Jewargi and part of Kalaburgi, Chittapur and Sedam between 18.43 to $19.00 \text{ MJm}^{-2} \text{ day}^{-1}$ comparatively in several more locations in the research area range from 14.33 to $18.43 \text{ MJm}^{-2} \text{ day}^{-1}$. During 1991 to 2000 Fig. 2 (b) the spatial distribution of aveS_{rad} observed lower over the Chincholi and Sedam from 18.91 to $18.97 \text{ MJm}^{-2} \text{ day}^{-1}$. Also, observed higher in Afzalpur, Aland, part of Kalaburgi between 19.22 to $19.32 \text{ MJm}^{-2} \text{ day}^{-1}$ and Aland, Chittapur, Chincholi and part of Kalaburgi in the range of 18.97 to $19.22 \text{ MJm}^{-2} \text{ day}^{-1}$. The spatial distribution of aveS_{rad} between 2001 to 2010 presented in Fig. 2 (c) and observed higher in the part of Kalaburgi, Jewargi, Afzalpur, Aland and Sedam in the range of 19.19 to $19.46 \text{ MJm}^{-2} \text{ day}^{-1}$ with lower in the range 17.72 to $19.19 \text{ MJm}^{-2} \text{ day}^{-1}$ in other places. The spatial

variability of aveS_{rad} from 2011 to 2018 Fig. 2 (d) observed slightly different than the last three decades with a range of 13.80 to $18.47 \text{ MJm}^{-2} \text{ day}^{-1}$. The aveS_{rad} in the last 38 years from 1981 to 2018, shown in Fig. 2 (e) found spatially distributed in the range 16.54 to $19.03 \text{ MJ m}^{-2} \text{ day}^{-1}$ over the study area. Solar energy reaching the earth's surface is reflected to the atmosphere by about 30 percent. Different earth surfaces have different capacities to reflect back the solar energy. Therefore, the green areas and non-radiating surfaces play an essential role in reducing radiation. The reduction in green areas and increase in hard surfaces increases the radiation, which in turn increases the air temperature (11).

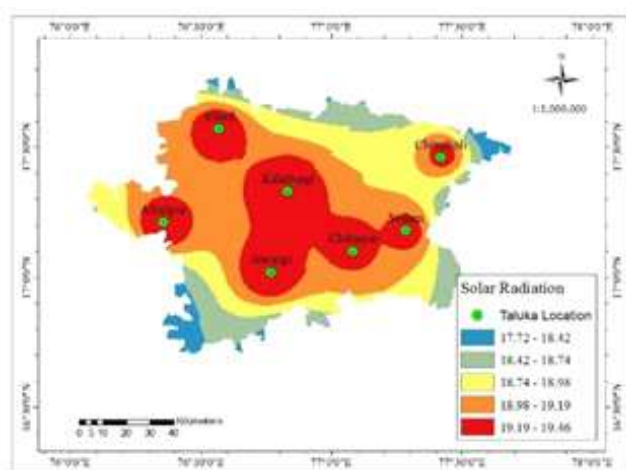
Time series analysis : Long term trend analysis of solar radiation (Henceforth, S_{rad}) from 1981 to 2018 presented in Fig. 3 (a to g), and Mann- Kendall test (Z), Sen's slope (Q), yearly highest, longterm average, and lowest values of S_{rad} is presented in Table 2. The Aland observed S_{rad} highest in 2001 with $19.77 \text{ MJm}^{-2} \text{ day}^{-1}$ and lowest in 2018 with $17.14 \text{ MJm}^{-2} \text{ day}^{-1}$ and average with $19.03 \text{ MJm}^{-2} \text{ day}^{-1}$ illustrated in Fig. 15 (a). The statistical analysis results observed for Mann- Kendall test (Z) with -3.89 and Sen's slope (Q) with -0.008 over the Aland. In the Afzalpur S_{rad} recorded highest with $19.76 \text{ MJm}^{-2} \text{ day}^{-1}$ in 2001, lowest with $17.33 \text{ MJm}^{-2} \text{ day}^{-1}$ in 2013 and average with $19.04 \text{ MJm}^{-2} \text{ day}^{-1}$ and statistical analysis results for Mann-Kendall test (Z) with -0.009 and Sen's slope (Q) with -0.051 shown in Fig. 3 (b). In the Chincholi S_{rad} recorded highest with $19.66 \text{ MJm}^{-2} \text{ day}^{-1}$ in 2011, lowest with $17.65 \text{ MJm}^{-2} \text{ day}^{-1}$ in 2013 and average with $18.94 \text{ MJm}^{-2} \text{ day}^{-1}$ shown in Fig. 3 (c). The statistical analysis results of S_{rad} observed over Chincholi for Mann- Kendall test (Z) with



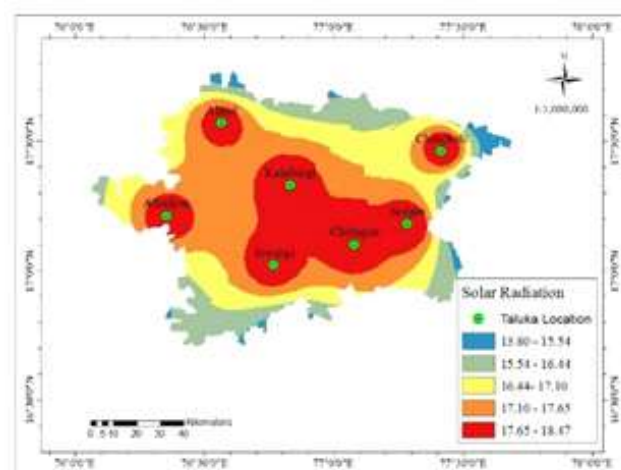
(a)



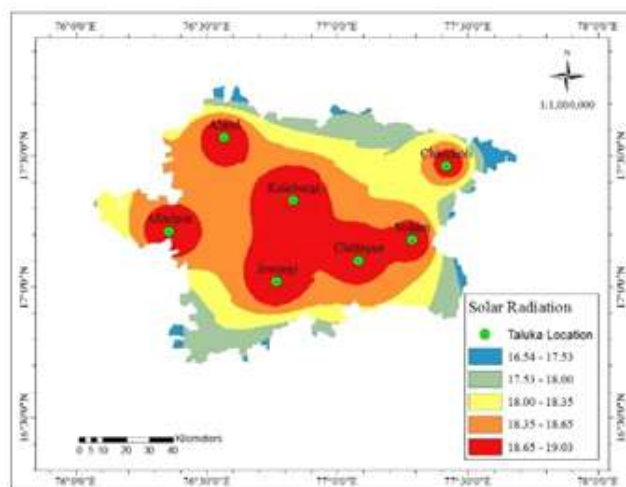
(b)



(c)



(d)



(e)

Fig-2 : Spatial variability maps of average solar radiation, $\text{MJm}^{-2} \text{day}^{-1}$, for (a) 1981 to 1990, (b) 1991 to 2000, (c) 2001 to 2010, (d) 2011 to 2018 and (e) 1981 to 2018.

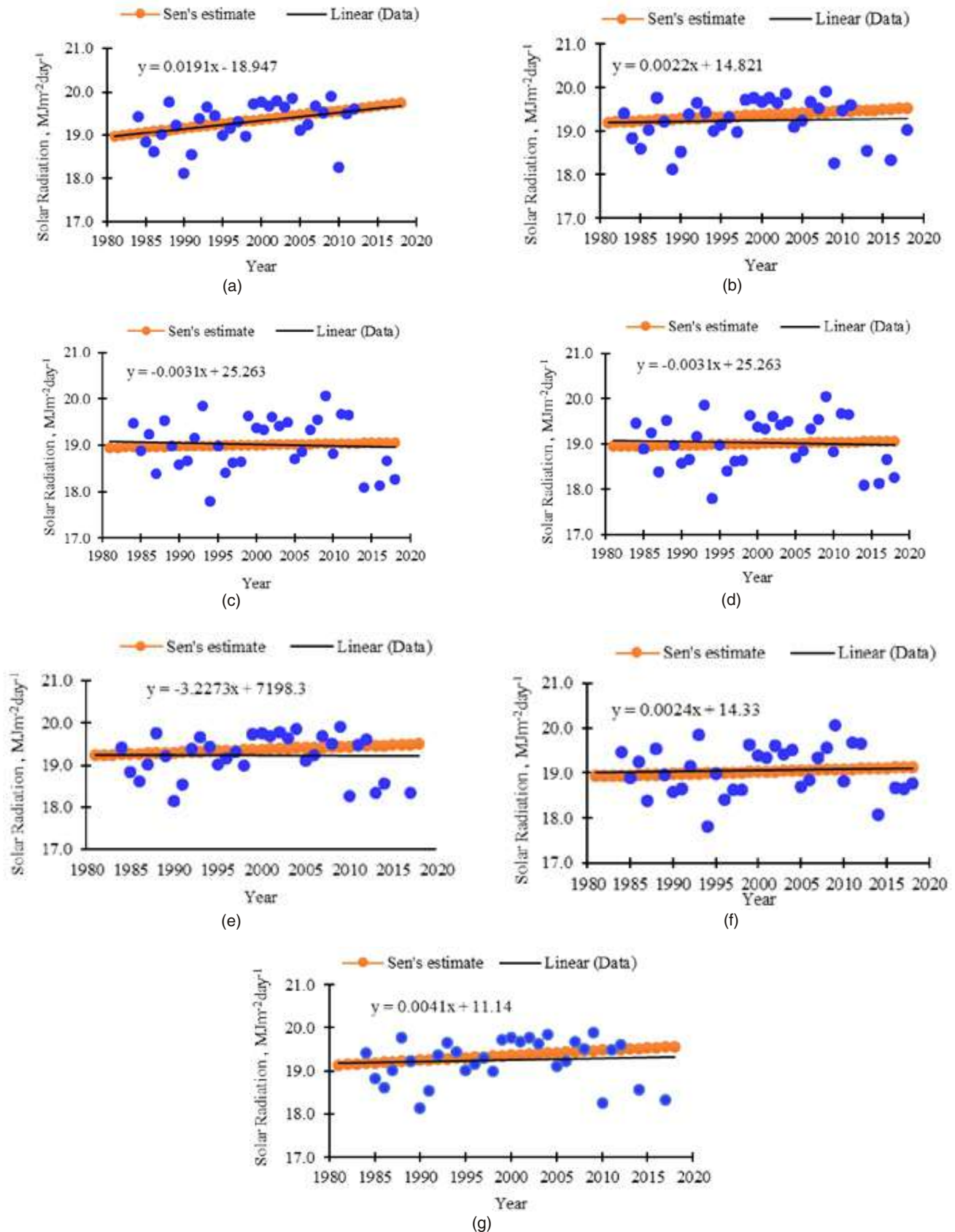


Fig-3 : Long term trend analysis of solar radiation, MJm⁻² day⁻¹, from 1981 to 2018 for (a) Aland (b) Afzalpur (c) Chincholi (d) Chittapur (e) Kalaburgi (f) Seda and (g) Jewargi.

-0.45 and Sen's slope (Q) with -0.007 presented in Table 4.1. In Chittapur S_{rad} observed highest in 1993 with $19.85 \text{ MJ m}^{-2} \text{ day}^{-1}$, lowest in 2003 with $17.64 \text{ MJ m}^{-2} \text{ day}^{-1}$ and average with $18.94 \text{ MJ m}^{-2} \text{ day}^{-1}$ shown in Fig. 3 (d) and also analysed statically for Mann- Kendall test (Z) with -0.45 and Sen's slope (Q) with -0.007. The Fig. 3 (e) shows S_{rad} received in Kalaburgi highest in 1988 with $19.76 \text{ MJ m}^{-2} \text{ day}^{-1}$ and lowest in 2018 with $17.14 \text{ MJ m}^{-2} \text{ day}^{-1}$, average with $19.03 \text{ MJ m}^{-2} \text{ day}^{-1}$ and also statistical results obtained for Mann- Kendall test (Z) with -0.77 and Sen's slope (Q) with -0.009. In the Sedam S_{rad} observed highest in 2008 with $19.78 \text{ MJ m}^{-2} \text{ day}^{-1}$, lowest in 2013 with $17.64 \text{ MJ m}^{-2} \text{ day}^{-1}$ and average with $18.94 \text{ MJ m}^{-2} \text{ day}^{-1}$ presented in Fig. 3 (f). The statistical analysis result obtained for Mann- Kendall test (Z) with -0.45 and Sen's slope (Q) with -0.007 for Sedam. The highest S_{rad} observed in 2006 with $19.77 \text{ MJ m}^{-2} \text{ day}^{-1}$, lowest in 2018 with $17.14 \text{ MJ m}^{-2} \text{ day}^{-1}$ and average with $19.03 \text{ MJ m}^{-2} \text{ day}^{-1}$ for Jewargi shown in Fig. 3 (g). Also, the Mann- Kendall test (Z) with -0.77 and Sen's slope (Q) with -0.009 resulted from statistical analysis for Jewargi. The S_{rad} exhibited increasing trend linearly for Mann- Kendall test and Sen's estimate over the study area for last 38 years.

Conclusion

Solar radiation is the most essential weather parameters crop growth and photosynthesis process in overall. A study region of about 38 years' length of solar radiation data was used to estimate the amount of variability. In order to measure the overall trend in solar radiation, Mann Kendall and Sen's slope estimator were employed. The preliminary results derived from the study are that throughout the course of the 38-year period from 1981 to 2018, an average of about 16.54 to $19.03 \text{ MJ m}^{-2} \text{ day}^{-1}$ has been spatially dispersed across the studied region. The S_{rad} demonstrated a linear trend over the research region over the last 38 years for the Mann- Kendall test and Sen's estimate.

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Performance of India's Agricultural Trade During WTO Regime

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Abstract

Agricultural trade of India has undergone some noteworthy changes after WTO (World trade organization) formation. The compound annual growth rate of the value of India's agricultural exports has increased from 2.98% during Pre-WTO to 12.60 % during Post-WTO. India's average share in the world total agricultural trade has gone up from 1.03% to 1.67% during the same period. The openness of Indian agricultural sector, measured as the ratio of the value of the total agricultural export and import to the gross domestic product of agriculture (AGDP), has jumped up from 3.90% in Pre-WTO to 7.25% in Post-WTO. It indicates the increasing importance of the agricultural exports in the Indian agricultural economy. Secondary data acquired for analysis included agricultural export, agricultural import, GDP, and AGDP. To show the contribution of agricultural sector in GDP and AGDP, tabular analysis, averages and percentage share were calculated. The rising trend in the proportion of Agri-trade to Agri-GDP in India after formation of WTO. The increasing trend in the proportions of India's Agri-exports/imports to Agri-GDP that shows the potential of increasing integration of Indian agriculture with global markets for agriculture.

Key words : *Agricultural trade, gross domestic product, export and import.*

Introduction

Agriculture sector is the fundamental constituent of the Indian economy and this sector provides employment to more than 50 per cent population and contributes 17.32 per cent of gross domestic product. (Central Statistics Office, New Delhi). Agriculture in India helps to ameliorate the conditions of those who belong to the lowest rungs of the social and economic strata. It softens the harsh edge of extreme poverty and plays an important role in improving the health and nutrition of the India's rural masses. By providing income and upholding the human right to food, farming establishes a resilient rural sector as a basis for a relatively egalitarian distribution of income and production (Ramphul 2012). One percentage growth in agriculture in India is at least two to three times more effective in eliminating poverty than the same growth originating from the non-agriculture sectors (Janvry and Sadoulet 2010). As a matter of fact, the sustained and accelerated development of agriculture in India is the key to the acceleration in tempo of its economic growth, equity and a significant dent in poverty and hunger.

In the era of trade liberalization, globalization and the World Trade Organization regime, Agricultural trade of India has undergone some noteworthy changes. The compound annual growth rate of the value of India's agricultural exports has increased from 2.98% during Pre-WTO to 12.60 % during Post-WTO. India's average share in the world total agricultural trade has gone up from 1.03% to 1.67% during the same period. The

openness of Indian agricultural sector, measured as the ratio of the value of the total agricultural export and import to the gross domestic product of agriculture (AGDP), has jumped up from 3.90% in Pre-WTO to 7.25% in Post-WTO. It indicates the increasing importance of the agricultural exports in the Indian agricultural economy. In addition, as it has been duly acknowledged by the Government of India (GoI) in the Economic Survey (2012b), since a faster agricultural growth is necessary to achieve the desired economic growth for the economy as a whole, it is imperative to find the way forward for enhancing the agricultural growth. The falling share of agriculture and allied sectors in GDP is an expected outcome in a fast growing and structurally changing economy (Annual report, DAC, 2014-15). The importance of agriculture in a country like India is not likely to decline due to concerns for food security, employment, rural poverty and availability of wage goods (Vyas, 2003).

India is a net exporter of agricultural commodities with net exports earnings of US\$ 28.66 billion in the year 2015. Nonetheless, liberalization, globalization, world Trade organization can greatly enhance the role of agriculture as an engine of growth in low-income countries like India by making it possible for the agricultural sector to grow considerably faster than the domestic consumption. It also increases the potential for enhance agricultural export from India to World.

However, there is a dearth of empirical studies to examine the link between agricultural export and import and agricultural growth in India. The study is undertaken

to fill up this important gap in the literature and to make a quantitative contribution in the field of the objective assessment of the Impact of WTO on agricultural export and import and growth in gross domestic product (GDP) and agricultural Gross domestic Product (AGDP) in India. Objective of the study under the following heads :

To study the share of AGDP in GDP of Country.

To examine the contribution of agricultural export and import in AGDP.

To examine the contribution of agricultural export and import in GDP.

Materials and Methods

The study was based on secondary data collected from the various published sources, viz., various issues of handbook of RBI, FAO Trade year Book, Statistical Abstract in India, indiastat.com, FAOSTAT etc. The data were grouped into two periods (Pre-WTO and Post-WTO) depending upon the formation of world trade organization and its effect on export and import of agricultural sector, Period-I related to agricultural trade before formation of world trade organization and ranged from 1975 to 1994 and Period-II ranged from 1995 to 2015 which is the Post-WTO period. Data acquired for analysis included agricultural export, agricultural import, GDP, and AGDP. To show the contribution of agricultural sector in GDP and AGDP, tabular analysis, averages and percentage share were calculated.

Results and Discussion

India's agricultural trade share to GDP and Agri-GDP during pre-WTO regime : It has been seen from the Table-1 that with the decline in the agriculture share to GDP i.e. 37.15 per cent (1975) to 25.36 per cent (1995). Declined agricultural share also found out by the Mahadevan (2003) It is also noticed that both agricultural exports and imports share's to GDP and Agri-GDP are also declined similar results were found by (Sheshagiri *et al.*, 2011) Highest agriculture export ratio to agriculture domestic product is recorded for the years of 1976 and 1995 i.e. (5%, 6.5%) similar result also observed in case of agriculture export to GDP in 1975 (1.72%) & 1976 (1.76%) and lowest is recorded for the year 1988 (0.74%). In case of agriculture imports to Agri-GDP & GDP are found to be lowest during 1991 i.e. (0.93 & 0.26 per cent). It is clearly indicated that new economic reforms increase agriculture exports and reduce the imports and beneficial for agriculture sector trade.

After becoming India, a member nation of the World Trade organization on 1st January 1995, after that India's agricultural sector promotes free and fair trade. The Agreement on Agriculture of the WTO is the first

Table-1 : Shares of agricultural Export and Import (As ratio to AGDP & GDP) during pre-WTO regime.

Pre-WTO period (1975-1994)					
Year	AGDP/GDP	AX/AGDP	AM/AGDP	AX/GDP	AM/GDP
1975	37.15	4.63	4.83	1.72	1.79
1976	35.21	5.00	4.83	1.76	1.70
1977	36.84	4.62	3.35	1.70	1.23
1978	34.91	3.84	2.55	1.34	0.89
1979	32.90	4.56	2.43	1.50	0.80
1980	34.80	3.96	2.33	1.38	0.81
1981	33.46	4.22	2.26	1.41	0.76
1982	31.98	3.70	2.29	1.18	0.73
1983	32.99	3.31	2.39	1.09	0.79
1984	31.55	3.40	2.92	1.07	0.92
1985	29.88	3.45	2.51	1.03	0.75
1986	28.54	3.46	1.91	0.99	0.54
1987	28.13	3.12	2.26	0.88	0.63
1988	29.24	2.53	2.24	0.74	0.66
1989	28.22	3.23	1.29	0.91	0.36
1990	28.04	3.46	1.22	0.97	0.34
1991	28.42	3.50	0.93	1.00	0.26
1992	27.74	3.77	1.73	1.04	0.48
1993	27.99	4.36	1.35	1.22	0.38
1994	27.36	3.75	2.55	1.03	0.70
Average	31.27	3.79	2.41	1.20	0.78

Source : FAO stat., World Bank, AGDP/GDP-Agricultural gross domestic product ratio to Gross domestic product, AX/AGDP-Agricultural export ratio to agricultural gross domestic product, AM/AGDP-Agricultural import ratio to agricultural gross domestic product, AX/GDP-Agricultural export ratio to gross domestic product, AM/GDP-Agricultural import ratio to gross domestic product.

multilateral agreement, meant to curb unfair practices in agricultural trade and set off the process of reforms in the agricultural sector. So, it is also the main objective of the study that how India's agricultural trade performed during 1995 to 2015 (post-WTO regime) even after the import and customs duties of many products are drastically reduced or abolished completely.

India's agriculture Exports, Imports and their share in Gross Domestic products in table 2 revealed that the share of agriculture exports in the total GDP is 1.53 per cent in the year 1995 after that it is continuously decline till 2015 (1.34 %) except the years of 2012 (2.05%) & 2013 (2.2%). But the share of agriculture imports in the total GDP is 0.62 per cent, which increased to 1.04 per cent in year 2015. The agricultural export share decreased and import share in GDP has increased reason behind this was that after WTO formation, value of export started shrinking as international prices started falling Due to falling international prices imports into the country became more attractive. This way the net earnings from agriculture trade in the post WTO period dropped to a very low level.

Table-2 : Shares of agricultural export and import (As ratio to AGDP& GDP) during post-WTO regime.

Year	Post-WTO period (1995-2015)				
	AGDP/GDP	AX/AGDP	AM/AGDP	AX/GDP	AM/GDP
1995	25.36	6.05	2.45	1.53	0.62
1996	26.35	5.89	2.22	1.55	0.59
1997	25.27	5.46	2.49	1.38	0.63
1998	25.27	5.02	3.68	1.27	0.93
1999	23.71	4.45	3.81	1.06	0.90
2000	22.11	4.94	2.87	1.09	0.63
2001	22.14	5.05	3.78	1.12	0.84
2002	19.92	5.66	4.13	1.13	0.82
2003	19.99	5.68	4.28	1.13	0.86
2004	18.03	5.64	4.10	1.02	0.74
2005	17.86	6.22	3.70	1.11	0.66
2006	17.41	7.04	4.42	1.22	0.77
2007	17.34	8.24	3.99	1.43	0.69
2008	17.30	7.97	4.21	1.38	0.73
2009	17.28	6.99	5.72	1.21	0.99
2010	17.52	6.91	3.69	1.21	0.65
2011	17.19	9.41	5.36	1.62	0.92
2012	16.85	12.18	6.44	2.05	1.08
2013	17.15	12.92	5.85	2.22	1.00
2014	16.62	10.67	6.21	1.77	1.03
2015	15.90	8.45	6.54	1.34	1.04
Average	19.84	7.18	4.28	1.37	0.82

Source : FAO stat., World Bank, AGDP/GDP-Agricultural gross domestic product ratio to Gross domestic product, AX/AGDP-Agricultural export ratio to agricultural gross domestic product, AM/AGDP-Agricultural import ratio to agricultural gross domestic product, AX/GDP-Agricultural export ratio to gross domestic product, AM/GDP-Agricultural import ratio to gross domestic product.

Table-3 : Comparison of agricultural export and import before and after WTO period.

Variables	1975-94 (Pre-WTO)	1995-2015 (Post-WTO)	Difference
AGDP/GDP	31.27	19.84	-11.43
AX/AGDP	3.79	7.18	3.39
AM/AGDP	2.41	4.28	1.87
AX/GDP	1.20	1.37	0.18
AM/GDP	0.78	0.82	0.04

On account of WTO and globalization of the Indian economy, the increase in export and import also raised the proportion of average trade in agricultural GDP from 3.79 (export) and (import) 2.41 per cent in pre-WTO to 7.18 (export) and (import) 4.28 per cent during post-WTO period. Similar findings were observed by Ghosh (2017).

Data presented in table 3 depicted that ratio of AGDP to GDP had decline in post-WTO period (19.85) from pre-WTO period (31.27) still there has trade surplus in agricultural trade that showed the potential of agricultural sector in foreign trade. Similar findings were

reported by Sharma (2012). The post WTO period showed increase in ratio of agricultural imports to GDP as well as agricultural import to AGDP and also ratio of agricultural exports to GDP as well as agricultural export to AGDP. There has been less than two times increase in average ratio of agricultural export and import to AGDP from pre-WTO to post-WTO whereas average ratio of agricultural export and import to GDP from pre-WTO to post-WTO showed that increase in agricultural export was more as compared to agricultural import. This way the agricultural trade became favourable and net earnings from agriculture trade in the post WTO has improved.

Conclusion

The share of AGDP to GDP had decline in post-WTO period (19.85) from pre-WTO period (31.27) still there has trade surplus in agricultural trade that showed the potential of agricultural sector in foreign trade. Agricultural trade improved during post-WTO period as average increase in share of agricultural export to GDP and AGDP was more than share of agricultural import. The results clearly show that in the post-reforms era growth of agricultural GDP decelerated while that of overall national GDP increased significantly during the same period. However, the gap between agriculture and overall GDP increased significantly in the post-WTO period, indicating deceleration in agricultural growth compared with overall GDP. As agricultural growth has always been an important component for inclusiveness so the high GDP growth without high agricultural growth is likely to lead to acceleration in inflation in the country, which would adversely affect the larger growth process. (Government of India, 2011a). The rising trend in the proportion of Agri-trade to Agri-GDP in India after formation of WTO. The increasing trend in the proportions of India's Agri-exports/imports to Agri-GDP that shows the potential of increasing integration of Indian agriculture with global markets for agriculture.

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Digital Innovation : Challenges and Opportunities for First Generation or New Entrepreneurs

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Abstract

Digital innovation is an endless process which leads to an increase in the profit and gives competitive edge to the organization. It is the implementation of the latest technologies for achieving maximum productivity. The increased use of digital tools and interpenetration of digital and physical materiality in work practices offer new sets of challenges and opportunities that need to be carefully investigated. Newer research opportunities lie in understanding different forms and capabilities of ongoing digital convergence. As an entrepreneur it is crucial for to understand that technology is highly volatile concept that changes every day and accordingly the way the market function as a first generation entrepreneur need to be technically update with the technology is revolving around otherwise in efficiency may lead to disruption. The paper focuses on the role, importance and characteristics of digital innovation for 1st generation entrepreneurs. The paper also discusses about challenges and opportunities for digital innovation. Various structural changes in terms of technological advancements are needed to meet the customer demand in market. Some of the technological advancements to meet consumer demand in market that focused are brand building, digital marketing, online shopping and license deals etc.

Key words : *First generation entrepreneurs, digital innovation, technological advancements.*

Introduction

Digital innovation is the application of new technologies to existing business problem or practices the process is continuous and should takes place in phases of the manufacturing making of the product with each page having advancement of technology. Digital innovation is becoming a game-changer. The changes option for a first generation and type in your to adopt digital innovation in their processes has many folds it helps in enhancing traditional manufacturing process with digital technologies it helps in fulfilling the real-time requirement of the industry consumers instantly it gives entirely new manufacturing system with advanced technologies to meet various challenges prevailing in the market.

The Heterogeneity of the Digital Innovation Ecosystem : The ecosystem of digital innovation has many layers. The tangible one consists of hardware manufacturers and network operators that require huge capital investment and Research and design expenses. Higher layers include software producers and platforms to success depend on network effects and consumer base size. The mix of digital innovations is established deep and firmly in the heterogeneity of the digital innovation ecosystem.

Mutual Interdependencies : Interdependency between various elements is a defining characteristic of digital innovation. There are research program to produce knowledge However, various new products and services are brought into the market through S M E . Big

companies create ecosystems that hold their size to attract small companies.

The Global Reach of Digital Innovation : Digital Technologies allow firms to reach out on physical borders at virtually no cost. This creates opportunities to increase the return on their innovation efforts. However building global market presence requires firms substantial funding for the scale up phase. So far however, few European digital firms succeed globally. Important roles in this process also play on technology markets example second hand markets for ideas and technologies.

ICT Play a Vital Role : In producing economic sector as well as, it enables technologies to facilitate the modernization of organization and their financial performance throughout the economic sectors. Digitally enabled organizations are the main sources through which the digital technology is transforming the economic and social benefits in the market. These firms are also more likely to become high growth companies and to survive longer than traditional non digital ones. Digital organizations follow the opportunities connected with the changing pattern of innovations.

Digital Innovation Disturbs the Economy and Society : Radical innovations transform the entire economy and society. This disruption through digital innovation leads to lots of scope to create new societal challenges. Disruptions achieved by digital innovations also have negative implications, example relocation of economic activity and jobs transformation.

Importance of Digital Entrepreneurship

More consumers : As digital entrepreneurship is related with the utilization of digital systems for execution of all business activities, the communication between a buyer and a seller becomes easy the communication through internet is easy when compared to other means of communication. Buying goods and products through online is the convenient way for consumers to buy. Now days, people are more interested to purchase anything online than spending their time in going to stores. Hence the number of customers can be increased due to convenience of buying.

Keep up with the competition : The usage of digital marketing enables a company to attain more customers and strong enough to meet the competition. In order to face various market challenges, digital technology is very essential for every business in order to face the challenges and grow their business.

Maximize the value of website : Every website of a business is supposed to offer services as much as possible to make visitors as efficient customers and in turn consumers. Different entrepreneurs follow different ways to achieve this but one common aim for everyone is to have high sales for their company. Hence, well designed website for every business can be a platform to achieve this goal.

Reduced costs : Digital technology is very feasible in financial aspect. This means digital marketing is very affordable. The costs are varied depending on the kind of strategy they use for marketing products. So automatically the costs can be decreased with the use of digital technologies.

Instant feedback : One of the important advantages is that people can highly involve in interacting process with the customers. As this conversation is two way, the entrepreneurs can get feedback instantly. An entrepreneur can know immediately when the customer is not satisfied with the product offered. He/she can modify the products if necessary according to the needs of customers. This makes an entrepreneur to follow the trends that occurred in requirements, tastes and preferences of the customers.

Some Other Benefits of Digital Entrepreneurship

The main advantage is that you can manage your business from anywhere in the world, provided that you have access to the internet. With this kind of mobility, other advantages arise, such as:

Spending more time with your family : This doesn't mean that you won't have a routine, nor that you can spend all day playing video games with your kids. Still,

digital entrepreneurship will certainly provide you with more freedom to adjust your schedules and spend more time with your family.

Flexible hours : At the beginning of your business, you'll need to work hard to conquer your space in the market, especially if you manage the business alone. But working hard doesn't mean working all day long because no one is productive all the time. When you are a digital entrepreneur, you define your schedule, work during the hours when you are more efficient, and even postpone an appointment because of an unforeseen event, which is much more difficult when you work from 8:00 am to 6:00 pm.

Cost savings : If you only need a computer with internet access to get started, you will save a lot by not having to lease a space for your company and all the expenses with utilities, taxes, etc. Of course, the amount spent will vary according to your business model, but it is certainly cheaper to start an online business than to have a physical establishment.

Reaching more people : More than 4 billion people on the planet now have access to the internet. That's more than 50% of the world's population. This clearly shows that doing business online is the best way to reach more people globally. In a physical business, you would have your operations limited by geographic barriers, but as a digital entrepreneur with a well-defined marketing strategy, you can reach out to various parts of the country and get more people to learn about your product.

Scalability : Scaling a business means increasing the volume of production and sales without increasing investments and the fixed cost for the same proportion. After you have developed your material and made it available online, anyone who pays for it will be able to access it without you having to record the lessons again. This type of product will never be out of stock unless you decide to delete it. It's very different from teaching in a classroom, in which you would have to be where the students are and be restricted to where you live.

Pillars of Digital Entrepreneurship

Many studies, as said above, digital entrepreneurship differs from traditional or general entrepreneurship in many aspects which have been examined for years. The European Commission (2013) recognized 5 elements as pillars of digital entrepreneurship in which each element is related to analyze the concept of entrepreneurship.

Digital Knowledge Base and ICT Market : Digital knowledge base is a type of technology which is used to store complex unstructured and structured data or information which is used by computer systems. A digital

knowledge based system comprises of knowledge – base that characterize the facts and an interface engine that justify these facts and also use many rules and logical forms in order to produce other facts from existing information. Information and communication technology is also one of the technologies that are responsible for transmitting all kinds of information of industries or companies electronically. ICT is the major tool or technology that is used for process of digital entrepreneurship.

Digital Business Environment : Digital business environment can be explained as a virtual place in which one or more computer systems are used to record or save business information and details of individuals' interaction. This can be done through digital social environments, also called as social networking sites which consist of single central server to share information or data to each and every client.

Access to Finance : Finance is the primary concept and requirement for every business to carry on both short term and long term activities effectively. Access to finance is defined as the capability of an individual or an enterprise to attain financial services along with credit, deposit, payment, insurance and other risk managing services. The extent of finance depends on the type of business, its products and services. The management of available finance is very important for every entrepreneur for reducing financial risks. There are many formal and informal financial services which provide financial support.

Digital Skills and E-Leadership : There are many kinds of skills which are essential for every individual who wants to become an entrepreneur. Among them, the digital skills are related to digital entrepreneurship. Digital skills can be defined as the skills of an individual which are associated with the usage of digital technologies. Attention on the process of using digital technologies should be more to eliminate the disturbances in digital business environment.

E-Leadership, in other words, electronic leadership, is a process to influence the people in order to change their attitudes, intentions, behavior and also performance in the way they can achieve their goals perfectly. E-Learning can be used not only for digital entrepreneurship, but also for other aspects in order to attract people towards the specific fields.

Entrepreneurial Culture : An entrepreneurial culture is defined as an environment where people are influenced and motivated to obtain innovative thinking power to bear risks. In the case of business, an entrepreneurial culture is a program or a place where employees are encouraged to express their innovative thoughts or products.

Types of digital entrepreneurship

There are many types of digital businesses, even for those who have never worked with online sales these are :

Digital Producers : Producers are those who create content to be consumed online. This material can be in various formats, such as eBooks, video lessons, and podcasts. To become a Producer, you just need to have knowledge that is useful for others and the desire to share it.

Affiliate : Affiliates are professionals that promote third-party products in exchange for commissions for each sale made. This profession is highly recommended for those who already have online influence, but don't wish to create their own content, as is the case of digital products, nor manage inventory, as is the case of physical products.

E-commerce : E-commerce designates a type of commerce that is carried out online. Unlike the digital products we mentioned earlier, products sold in virtual stores are not consumed on the Internet, but rather delivered to consumers' homes.

Startup owner : Startups are businesses that can start online and eventually migrate to a physical environment if the entrepreneur feels the need. First of all, for a startup to be successful, it needs to identify a recurring problem and propose a solution. This solution should also be simple to understand and put into practice. Otherwise, people won't be interested in using it. As a startup owner, you can also develop a variety of products, such as software, applications, and services. This will depend a lot on the type of problem you want to solve and who are your potential customers.

Digital Influencer : Digital influencers are considered by many to be the profession of the moment because they have no age limit or market niches. You can have a blog or YouTube channel about makeup, for example, and develop partnerships with brands that are interested in reaching your audience.

Innovative Ideas For Successful Digital Entrepreneurship

Interestingly enough, entrepreneurship and innovation are two different concepts, but they're often associated with the same goal. Entrepreneurship means starting your own business, while innovation consists in creating something completely different, or that has values and differentials that make a product or service unique. For those who wish to undertake in the digital world, innovation is critical, after all, the internet allows entrepreneurs to create experiences that are more relevant, as well as enabling the use of automation to facilitate their processes a few of them are :

Affiliate Marketing Platforms : If you want to be a digital content producer, you can promote it on affiliate marketing platforms. In this case, affiliates who have blogs, YouTube channels, or even paid media knowledge, do the promotion work for you. The big advantage is that their authority and the traffic generated are combined, and boost your digital product sales.

The Use of Software for Marketing Automation : In order to increase the volume and efficiency of this e-mailing, the use of email marketing automation tools is ideal. In addition to sending emails and helping segment potential customers, they also offer performance reports that show which actions were successful or not. After evaluating the performance, all you have to do is correct the course.

Consulting and Thematic Events : Creating you tube channel or even creating thematic events in real life might be an innovative idea; after all, they can attract a target audience with specific interests and needs. In other words, this is a way of capturing new customers and, at the same time, strengthening your name in the market. The innovation, of course, will be up to your creativity.

Conclusion

The variations between traditional and digital entrepreneurship is highly focused as this is very important for every entrepreneur to justify their type of business. In examining this, many key issues which differs digital entrepreneurship are highlighted. The current review paper is theoretical which depends on existing work done by many authors in order to understand the phenomenon of new digital entrepreneurship. This paper

presents a new way of thinking regarding internet and digital businesses.

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Status and Involvement of Tribal Women in Rice Farming Activities : A Study of Gond Tribes of Bastar Plateau

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Abstract

The study was conducted in the Kanker and Kondagaon districts in the state of Chhattisgarh in the year 2019-20. Kanker and Kondagaon were randomly chosen from the 28 districts of Chhattisgarh. Out of seven block of Kanker only 2 blocks were selected viz., Kanker, Narharpur and from Kondagaon district out of Five blocks 2 blocks were selected for research i.e. Baderajpur, Keshkal. Each selected block comprised three villages chosen at random, for a total of 12 villages in the sample. A total of 10 Gond Tribal women were chosen at random from each of the villages. As a result, a total of 120 Gond Tribe women were included in the research. The majority of Gond Tribe women (46.66 %) were in their middle years. In the studied area, the majority of the respondents (36.67%) were illiterate. In terms of land holdings, the majority of the respondents (32.50 %) had 1 to 2 ha of land in the small land holding category. Cent per cent of respondents had Irrigation Availability, followed by 55.83 per cent had Tube well irrigation. Majority of the respondents having annual family income from 1 to 1.5 Lakh, The findings of the study revealed that Tribal women's (50%) regularly participate in Mahila Mandal Samiti. (74.17%) respondents were depends on Agriculture only, Mostly (95%) the women's were engaged in Transplanting, Majority of the women's were spent their time in Rice farming activities. women's were also devote their time in Hand looms activities to earn additional income from the above mentioned activities. Mostly (55%) the women farmers uses medium source of information. Correlation between respondents' chosen qualities and their level of engagement in rice farming activities out of eight variables occupation, source of information, and time devotion, this three variables had positive and highly significant relationships, whereas variable annual income had a positive and significant relationship with the extent of Tribal women's involvement in rice farming activities. The findings of the multiple regression analysis show that education and source of information, contributed significantly at the 0.01 level of probability. At the 0.05 level of probability, the variables land ownership, yearly income, and time devoted contributed considerably, whereas the remaining factors had little effect on tribal women's involvement in rice farming operations.

Key word : *Involvement in rice farming activities, handlooms.*

Introduction

India's agriculture is the country's backbone and its plays an important role in the economy, is regarded as the largest sector of the country's economic activity. Agriculture is a significant part of the Indian economy, contributing for around 17% of total GDP. The total population of Chhattisgarh is 3.22 crore as of 2020. About 80% of the population in the state is engaged in agriculture and 43 per cent of the entire arable land is under cultivation. The tribal population according to 2011 census of Chhattisgarh state is 7.82 Lakh constituting about 30.6 per cent of the total population of the state. It is the 10th largest state in India with an geographical area of 137.90 thousand ha. Chhattisgarh known for rice cultivation and called "Rice Bowl" of India. In Chhattisgarh state tribal women engaged at about 90 per cent in various agricultural activities. The tribal women about 12 to 15 hours per day involving in agriculture and allied activities. The tribals are mainly depending on agriculture, forest, and livestock. On an average, about 85 per cent of the tribal men and 99 per cent of the tribal women are involved in agriculture. A tribal women can participate actively in all agricultural operations including, ploughing,

digging, transplanting, weeding harvesting, threshing, winnowing and storing food grains. In agriculturally backward areas, tribal women are forbidden to touch a plough and cannot dig the groundnut but in all other agricultural operations, women participate actively and traditionally these are a female's job.

Materials and Methods

The study was conducted in Kanker and Kondagaon district of Chhattisgarh. The Chhattisgarh state consists of 28 districts, among which Kanker and Kondagaon district was selected. Kanker and Narharpur block was selected purposively from Kanker district and Keshkal, Baderajpur block was selected from Kondagaon district. 12 villages were chosen randomly and data was collected purposively from 120 (10×12) respondents via personal interview. To find out the involvement of Tribal women in rice farming activities were worked out. Data were analysed by using appropriate statistical methods like mean, percentage and correlation.

Results and Discussion

Socio-economic profile of the Gond tribe women : The maximum of the respondents (46.66%) belonged to

Table-1 : Socio-economic profile of the Gond tribe women.

S. No.	Categories	Frequency	Percentage
1.	Age		
	Young (up to 33 years)	34	28.33
	Middle (34-54 years)	56	46.66
	Old (more than 54 years)	30	25.01
2.	Education		
	Illiterate	44	36.67
	Primary	36	30.00
	Middle	23	19.17
	High school	10	8.33
	Under graduate	6	5.00
	Post graduate and above	1	0.83
3.	Occupation		
	Agriculture only	89	74.17
	Agriculture + Labour	23	19.16
	Agriculture + Animal husbandry	6	5.00
	Agriculture + Service/ Business	2	1.67
4.	Land holding		
	Marginal Farmer (below 1 ha)	03	2.50
	Small Farmer (1-2 ha)	39	32.50
	Semi-medium Farmer (2-4 ha)	31	25.83
	Medium Farmer (4-10 ha)	32	26.67
	Large Farmer (above 10 ha)	15	12.50
5.	Annual income		
	Up to Rs.1.0 Lakh	8	6.67
	1.01 to 1.5 lakh	39	32.50
	1.51 to 2.0 lakh	29	24.17
	2.01 to 4.0 lakh	31	25.83
	More than 4.0 Lakh	13	10.83
6.	Social participation		
	Gram panchayat	10	8.33
	Co-operative society	8	6.66
	Aanganbadi	17	14.16
	SHG's	25	20.85
	Mahila mandal samiti	60	50

Table-2 : Distribution of Tribal women in involvement of rice farming activities.

S. No.	Practices	Participation index (in %)
1.	Cleaning of field	81.66
2.	Nursery raising	61.66
3.	Sowing	86.66
4.	Transplanting	95
5.	Manuring and fertilizer applications	30
6.	Weeding	90.83
7.	Irrigation	68.33
8.	Plant protection measure	28.33
9.	Harvesting	92.5
10.	Winnowing	90
11.	Storage	59.16

middle age group (34-54years), The findings depicts that maximum women 36.67 per cent were illiterate. 74.17 per cent were dependent on agriculture only. Maximum respondents (32.50%) of the selected farmers had land holding between 1-2 ha. As regards to Annual income the higher percentage of the respondents (32.50%) had their family income in the range of 1 to 1.5 Lakh, 50 per cent

Table-3 : Correlation analysis of independent variables with the extent of involvement of tribal women in rice farming activities.

S. No.	Independent variable	Coefficient of correlation
1.	Age	-0.165
2.	Education	0.046
3.	Land holding	0.129
4.	Annual income	0.170*
5.	Social participation	-0.052
6.	Occupation	1.742**
7.	Source of information	2.660**
8.	Time devotion	1.235**

**Correlation is significant at the 0.01 level, *Correlation is significant at the 0.05 level.

respondents were regularly participated in Mahilamandal samiti.

Extent of involvement of Gond Tribal women in different rice farming activities : Table-2 shows the extent of involvement of Gond Tribal women in different rice farming activities. The overall participation index was 95 per cent where in majority (61.66%) had medium level, 28.33 per cent of the respondents with low level of participation index in rice farming activities.

Relationship between independent variables and Dependent variables : Correlation analysis of independent variables like occupation, sources of information, time devotion, had positive & highly significant whereas variable annual income had positive & significant relationship with the extent of involvement of tribal women in rice farming activities. The variables like education and Land holding had positive and non-significant variables Age & social participation had negative & non-significant relationship with the extent of involvement of tribal women in rice farming activities.

Conclusions

On the basis of above findings it may be concluded that Mostly the (95%) women are engaged in transplanting. Transplanting is a laborious work which helps to generate income for tribal women. Women are doing almost all the agricultural work starting from sowing of seeds to harvesting and processing the agricultural produce. Agricultural operations are heavily dominated by women. The form of female engagement in agricultural production differs depending on the farm household's land ownership status. Women contribute about three fourth of the labour required for agricultural productions. More than 60% of agricultural activities have traditionally been managed by women, which is a well-known figure. Women invented agriculture, according to cultural anthropological literature.

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Evaluation of Fungicides Against Early and Late Blight Disease of Tomato

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Abstract

Early blight (*Alternaria solanais*) and late blight (*Phytophthora infestans*) are the major diseases of tomato crop. Various fungicides were evaluated for the management of early and late blight diseases. The field experiment was conducted at Regional Wheat Rust Research Station, Mahabaleshwar during the season *Rabi* 2015-16. Considering the disease control ability and fruit yield of tomato, Chlorothalonil 75 % WP @ 3.0 g/lit and 2.0 g/lit were found superior in controlling early blight, late blight disease intensity and also helpful for increasing the fruit yield per ha. Also, none of the treatments resulted any phytotoxic symptoms on potato leaves at concentration used in the experiment.

Key wards : Early blight, late blight, fruit yield, Phytotoxicity etc

Introduction

Tomato (*Solanum lycopersicum* L.), a popular fruit vegetable is grown throughout the world, both for fresh fruit consumption and processing industries. It ranks second in the world in vegetable after potato with regard to production. The crop is affected by several diseases among which early blight caused by *Alternaria solani* (Ellis and Martin) and late blight caused by *Phytophthora infestans* are the most important one. *Alternaria solani* (Ellis and Martin) is a soil inhabiting air-borne pathogen responsible for leaf blight, collar and fruit rot of tomato disseminated by fungal spores (Datar and Mayee, 1981). Also, late blight disease caused by *Phytophthora infestans* (Mont) de Bary is also another most significant constraints for tomato production in our country. Disease affect crop production as they cause premature defoliation and result in heavy losses in production by reducing quality and quantity of fruit (Holm *et al.*, 2003). Both diseases are very difficult to control (Pasche *et al.*, 2005). Host resistance is an important control measure. However, at present there are no tolerant and/or resistant tomato cultivars available against these diseases.

Failure to manage these diseases can cause reduction in yield (Malik *et al.*, 2014). It need to develop new effective fungicide which will be helpful for increase in quality and quantity of tomato production (Sahu *et al.*, 2013). Therefore, the present work was designed to investigate the efficacy of newer fungicides against the early and late blight pathogen under field conditions.

Materials and Methods

The field experiment was conducted at Venna Lake Farm, Regional Wheat Rust Research Station, Mahabaleshwar during the season *Rabi* 2014-15. The experiment was laid out in Randomized Block Design (RBD) with seven

treatments and three replications. The popular cultivar JK-811 was planted at 60X45 cm² spacing. Experiment was conducted with an objective to evaluate the bio-efficacy of newer fungicides for the management of early and late blight disease of tomato. Two sprays were given at 15 days interval after appearance of disease.

The disease intensity of early and late blight of tomato was recorded on the randomly selected 5 plants per plot based on 0-9 scale (Mayee and Datar, 1986). Disease intensity was monitored one day before each spray and final observation on PDI (Per cent Disease Index) was recorded 10 days after final spray. The fruit yield of tomato was recorded after harvestings (tones/ha). All the data of diseases incidence and yield were statistically analyzed by the following procedure of RBD. Calculations were made after applying the test of significance of the means. The per cent data of disease incidence was transformed to Arc sine value. The phytotoxic effects such as yellowing, chlorosis, epinasty, hyponasty, scorching burning of leaves due to fungicidal treatments were recorded by visual observations based 0-10 scale. The observations were recorded at 1, 3, 5, 7 and 10 days after 1st spraying.

Results and Discussion

Results regarding per cent intensity of early blight, late blight diseases of tomato and fruit yield in t/ hectare are presented in Table-1. The results indicates that all the fungicidal treatments have significantly controlled early and late blight disease as compared to control (untreated check) whereas significantly helped in increasing the yield of fruit per ha. As regards to early blight intensity, it was observed that amongst all the fungicidal treatments, least percent disease intensity (PDI) was recorded in treatment Chlorothalonil 75 % WP @ 3.0 g/lit (20.7 %) which was at par with Chlorothalonil 75 % WP @ 2.0 g/lit (24.31%) and

Table-1 : Efficacy of fungicides against Early blight and Late blight diseases in Tomato.

Sr. No.	Treatment Particulars	Early blight (PDI)*				Late blight (PDI)*				Tomato fruit yield (t/ha.)
		PTO	15 days after 1 st spray	15 days after 11 nd spray	% Control over untreated check	PTO	15 days after 1 st spray	15 days after 11 nd spray	% Control over untreated check	
1.	Chlorothalonil 75WP @ 1.0 g/lit	3.27	33.33 (35.23)	37.78 (37.90)	47.42	0.0	28.89 (32.45)	40.74 (39.65)	50.25	24.70
2.	Chlorothalonil 75WP @ 2.0 g/lit	3.23	12.59 (20.70)	17.04 (24.31)	76.28	0.0	14.07 (21.95)	21.48 (25.31)	73.77	28.80
3.	Chlorothalonil 75WP @ 3.0 g/lit	3.27	9.63 (17.97)	12.59 (20.70)	82.48	0.0	12.59 (20.70)	17.03 (21.83)	79.20	31.14
4.	Mancozeb 75WP @ 2.5 g/lit	3.20	25.92 (30.57)	34.81 (36.14)	51.55	0.0	27.41 (31.55)	42.22 (40.52)	48.44	25.00
5.	Copper oxy chloride 50WP @ 2.5 g/lit	3.23	33.33 (35.23)	45.18 (42.24)	37.12	0.0	34.81 (36.14)	46.67 (43.08)	43.00	23.77
6.	Zineb 75 WP @ 2.0 g/lit	3.20	34.82 (36.13)	49.63 (44.79)	30.92	0.0	37.83 (37.90)	51.11 (45.63)	37.59	21.73
7.	Untreated Check	3.13	40.74 (39.65)	71.85 (58.18)	—	0.0	40.74 (39.65)	81.89 (65.16)	—	17.91
	SE		1.49	1.79			1.16	1.96		1.22
	CD(0.05)	NS	4.20	5.05		NS	3.28	5.52		3.44
	CV %		8.39	8.22			6.41	8.45		8.59

*Mean of three replications. PTO-Pre -treatment Observation. PDI-Percent Disease Index, Values in the parentheses are arc-sine transformed values.

these treatments were significantly superior over standard fungicides in controlling disease. The present investigation are in agreement with Tofoli *et al.*, (2003) who evaluated the effectiveness of fungicides for controlling early blight as well as their effectiveness on tomato fruit yield. They reported that highest level of disease control, quality and increase in fruit yields were obtained with Azoxystrobin, Difenconazole followed by Mancozeb. Similarly, Bartlett *et al.*, (2002) noticed good efficacy of Azoxystrobin against tomato early blight.

As regards to late blight intensity, it was observed that amongst all the fungicidal treatments, least percent disease intensity (PDI) was recorded in treatment Chlorothalonil 75 % WP @ 3.0 g/lit. (21.83 %) which was at par with Chlorothalonil 75 % WP @ 2.0 g/lit (25.31%) and these treatments were significantly superior over standard fungicides in controlling disease. This result was also supported by the report of Ferro (1999) who found significant reduction of disease intensity with three or more applications of metalaxyl plus manzate in the field. It was observed that these treatments did not show any phytotoxic symptoms like leaf injury, wilting, vein clearing, necrosis, epinasty and hyponasty at any days on tomato crop.

As regards to fruit yield, all the fungicidal treatments were significantly superior over untreated check. Amongst fungicidal applications, Chlorothalonil 75 % WP @ 3.0 g/lit has recorded highest fruit yield (31.14 t/ha) which was at par with Chlorothalonil 75 % WP @ 2.0 g/lit (28.80 t/ha) and these treatments were significantly superior over rest of the treatments.

In brief results indicated that, Chlorothalonil 75 % WP @ 3.0 g/lit and Chlorothalonil 75 % WP @ 2.0 g/lit were found effective in managing early blight, late blight disease and also helpful for increasing the yield of tomato fruit per ha.

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Evaluation of Impact of Different Cropping System on Population of Pod Borer Complex in Pigeonpea

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Abstract

The field experiment was carried out during kharif 2011-12 and 2012-13 at Department of Agricultural Entomology, Vasantarao Naik Marathwada Krishi Vidyapeeth, Parbhani to understand the influence of cropping system on population of pod borer complex. The pooled results indicated that all the intercropping system reduced the incidence *H. armigera*, *M. obtusa* and *E. atomosa* population. With regard to grain damage by *H. armigera* and *M. obtusa*, pigeonpea + sorghum treatment proved best recorded 6.53 and 14.81 per cent grain damage respectively and pigeonpea + soybean recorded maximum grain damage (8.98 and 20.7 per cent) by *H. armigera* and *M. obtusa*, respectively. All intercropping system were superior than sole pigeonpea.

Key words : Pigeonpea, intercropping system, *H. armigera*, *M. obtusa*, *E. atomosa*

Introduction

Pigeonpea *Cajanus cajan* (L.) Millp. is an important pulse crop after gram, which is widely cultivated throughout India. It is also known by names like arhar, red gram or tur, grown in *Kharif* season of tropics and sub-tropics. Dominant producers of this crop are the countries in the India subcontinent, Africa and Central America. In the tropics, intercropping is an important component of small farm agriculture, the reason for evolution of these cropping systems may be the lower incidence of insect pest and yield of two crops. The lower incidence of pest might be due to the factors like increased parasitoid and predator population, availability of alternative prey, decreased colonization and reproduction in pest, chemical repellency making feeding inhibition by odor from non-host plant, prevention of emigration in pests and optimum synchrony. These factors were likely to be important in pest regulation in intercropping system (Bhatnagar and Davies, 1976). Hence the present investigations were carried out to understand the effect of intercropping on incidence of pod borer complex (*Helicoverpa armigera*, *Melanagromyza obtusa* and *Exelastis atomosa*) and their damages in pigeonpea.

Materials and Methods

The field experiment was carried out during *Kharif* season of 2011 and 2012, at the experimental farm of the Department of Agril. Entomology, Vasantarao Naik Marathwada Krishi Vidyapeeth, Parbhani (Maharashtra). To understand the influence intercropping system on population of pod borer complex (*H. armigera*, *M. obtusa* and *E. atomosa*) in pigeonpea. The investigation was laid out in randomized block design in four replications with

variety BDN-711. All the recommended cultural and agronomical practices were followed homogeneously in all the treatments to raise the good crop. The pigeonpea variety BDN-711 was sown in first week of July on plots measuring 6.3m X 5.4m. Following five intercropping system were evaluated for incidence of pod borer complex as well as pod damage in pigeonpea. The details of experiment are given below.

Crop	Variety
Pigeonpea	BDN-711
Sorghum	PVK-801
Soybean	MAUS-71
Green gram	BM-4
Black gram	BDU-1

Treatment details	Ratio	Spacing
T-1 Pigeonpea + Sorghum	2:4	45cm x 15cm
T-2 Pigeonpea + Soybean	2:4	45cm x 7.5cm
T-3 Pigeonpea + Green gram	2:4	45cm x 7.5cm
T-4 Pigeonpea + Black gram	2:4	45 cm x 7.5cm
T-5 Sole pigeonpea	-	90 cm x 15cm

The field observations on larval population of *H. armigera*, *M. obtusa* and *E. atomosa* were recorded.

At harvest five plants were randomly selected from each plot and observed for the individual pod borer damage. The per cent pod damage was calculated by counting the total number of healthy pods and infested pods. Hundred randomly selected pods at harvest were observed for the number of seed damage by the borer and pod fly. Finally per cent grain damage was calculated by using formula :

Table-1 : Average population of pod borer complex in different cropping system in pigeonpea.

Treatments	Population of <i>H. armigera</i> (larve/plant)			Population of <i>M. obtusa</i> (maggots and pupae/pod)			Population of <i>E. atomosa</i> (larve/plant)		
	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled
Pigeonpea + Sorghum	1.80* (1.52)	1.75 (1.50)	1.77 (1.50)	2.03* (1.59)	2.10 (1.61)	2.06 (1.60)	1.70* (1.48)	1.70 (1.48)	1.70 (1.48)
Pigeonpea + Soybean	2.65 (1.77)	2.62 (1.77)	2.63 (1.77)	2.72 (1.80)	2.78 (1.81)	2.75 (1.80)	1.80 (1.52)	1.78 (1.51)	1.79 (1.51)
Pigeonpea + Green gram	2.20 (1.64)	2.30 (1.67)	2.25 (1.65)	2.45 (1.72)	2.40 (1.71)	2.42 (1.71)	1.60 (1.45)	1.60 (1.44)	1.60 (1.44)
Pigeonpea + Black gram	1.90 (1.54)	2.05 (1.60)	1.97 (1.56)	2.12 (1.62)	2.20 (1.64)	2.16 (1.63)	1.70 (1.48)	1.60 (1.45)	1.65 (1.46)
Sole pigeonpea	2.60 (1.76)	2.50 (1.73)	2.55 (1.74)	2.67 (1.78)	2.72 (1.80)	2.69 (1.78)	1.70 (1.48)	1.68 (1.48)	1.69 (1.48)
SE +	0.03	0.03	0.03	0.03	0.02	0.03	0.02	0.02	0.02
CD at 5%	0.10	0.11	0.10	0.10	0.09	0.09	NS	NS	NS

Figures in parentheses are $\sqrt{x}$ 0.5 transformed values, *Average of 15 MW observations.

Table-2 : Grain damage by pod borer complex in different cropping system in pigeonpea.

Treatments	Grain damage by <i>H. armigera</i> (%)			Grain damage by <i>M. obtusa</i> (%)			Grain damage by <i>E. atomosa</i> (%)		
	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled	2011-12	2012-13	Pooled
Pigeonpea + Sorghum	7.05 (15.37)	6.02 (14.21)	6.53 (14.78)	14.32 (22.24)	15.30 (23.02)	14.81 (22.62)	4.00 (11.54)	4.20 (11.82)	4.10 (11.67)
Pigeonpea + Soybean	9.12 (17.58)	8.85 (17.30)	8.98 (17.44)	20.20 (26.70)	21.20 (27.41)	20.7 (27.05)	5.40 (13.43)	5.40 (13.43)	5.40 (13.43)
Pigeonpea + Green gram	8.15 (16.59)	7.40 (15.78)	7.77 (16.18)	18.60 (25.55)	19.52 (26.22)	19.06 (25.88)	4.82 (12.68)	4.70 (12.52)	4.76 (12.60)
Pigeonpea + Black gram	7.60 (16.00)	7.02 (15.37)	7.31 (15.68)	16.65 (24.08)	17.42 (24.67)	17.03 (24.37)	4.20 (11.82)	4.15 (11.75)	4.17 (11.78)
Sole pigeonpea	8.70 (17.15)	8.00 (15.43)	8.35 (16.78)	19.50 (26.18)	20.30 (26.78)	19.9 (26.47)	5.00 (12.92)	5.02 (12.95)	5.01 (12.93)
SE +	0.11	0.13	0.12	0.11	0.12	0.11	0.15	0.13	0.41
CD at 5%	0.36	0.42	0.37	0.34	0.37	0.34	NS	NS	NS

Figures in parentheses are Angular transformed values.

$$\% \text{ infestation of grain} = \frac{\text{Weight of infected grain}}{\text{Weight of total grains}} \times 100$$

From the above observations, the best intercropping system was recommended in order to evolve most effective preventive measures for the effective management of pod borer complex in pigeonpea. Finally the data was analyzed statistically.

Results and discussion

The effectiveness of various intercropping system against pod borer complex presented in the form of per cent pod damage at green pod stage and harvest stage and grain yield and the larval count of pod borer complex. The results of experimentation revealed that during *kharif* 2011-12. The lowest population of *H. armigera* (1.80 /plant) was recorded in pigeonpea + sorghum treatment followed by pigeonpea + black gram 1.90/plant and pigeonpea + green gram treatment (2.20/plant). These treatments are at par with each other. The highest population of *H. armigera* was recorded in pigeonpea + soyabean treatment (2.65 /plant) and at par with sole

pigeonpea (2.60/plant). During *kharif* 2012-13 and pooled results indicated similar trend, lowest population was recorded in pigeonpea + sorghum treatment (1.75 and 1.77/plant) respectively. While pigeonpea + soybean recorded 2.62 and 2.63/plant respectively (Table-1). Regarding the incidence of *M. obtusa* pigeonpea + sorghum combination proved better recorded 2.03, 2.10 and 2.06/pod during 2011-12, 2012-13 and pooled results. While highest population (2.72, 2.78 and 2.75/pod) was recorded in pigeonpea+soybean treatment respectively. During 2011-12 there were no significant differences in population of *E. atomosa* in different cropping system. Similar results were obtained during *kharif* 2012-13. However, pooled results also indicated no significant differences in *E. atomosa* population in various cropping system which may be due to negligible population of *E. atomosa* (Table-1). These results are in conformity with those of Deokar *et al.*, (1983) also reported that pigeonpea intercropped with pearl millet in 2:1 row proportion recorded higher incidence of *H. armigera* in intercropping than in pure crop of pigeonpea. The experiment conducted on research farm of CRIDA on

eight intercrops with pigeonpea as the base crop during rainy season of 2003, 2004 and 2005 revealed that the density of *H. armigera* population differed significantly across intercropping systems. Sole crop had higher infestation and intercropping with sorghum and castor reduced the infestation.

With regard to grain damage by *H. armigera* during *kharif* 2011-12, it is observed that minimum grain damage (7.05 per cent) was recorded in pigeonpea + sorghum treatment and maximum grain damage (9.12 per cent) was observed in pigeonpea + soybean treatment similarly during *kharif* 2012-13 and in pooled data minimum grain damage (6.02 and 6.53 per cent) recorded in pigeonpea+sorghum treatment, respectively. Similar trend was noticed in grain damage by *M. obtusa* during *kharif* 2011-12, 2012-13 and in pooled data, indicated 14.32, 15.30 and 14.81 per cent grain damage in pigeonpea + sorghum treatment, respectively. There were no significant differences in grain damage by *E. atomosa* in different cropping system in both seasons as well as in pooled data (Table 2). The present results are discussed in the light of findings of previous workers as Yadav *et al.*, (1992) studied the effect of crop management practices on the incidence of *M. obtusa* in 1984 and 1985 and found that grain damage was 3.8 per cent in sole crop and 3.3 per cent in pigeonpea + green gram intercropping. Ameta and Bhardwaj (1995) also observed that the incidence of pod borer complex was found to be less in intercropping system than in sole pigeonpea crop. The experiment conducted on research farm of CRIDA also revealed the similar results, pigeonpea + sorghum registered lowest level of grain damage (15.15 per cent) and the intercrop groundnut and

blackgram also reduced the grain damage (Srinivasa Rao *et al.*, 2006). Overall per cent grain damage was less in intercropping system as compared to sole pigeonpea. This may be due to overlapping of pod formation and flowering of pigeonpea with ear-head formation of sorghum which might have reduced the feeding damage to main crop pigeonpea by the pests.

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Bio-Efficacy of Native Isolate of Entomopathogenic Nematode, *Steinernema* sp. (AAU St-1) against *Spodoptera litura* (Fabricius) and *Spodoptera frugiperda*

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Abstract

Bio-efficacy of *Steinernema* sp. (AAU St-1) was carried out against *S. litura* and *S. frugiperda*. The per cent larval mortality (5 larvae/Petri plate) of *S. litura* and *S. frugiperda* at different inoculum levels, i.e., 20, 40, 60, 80 and 100 IJs per larva of *Steinernema* sp. (AAU St-1), was recorded every 24 hours up to 120 hours. The maximum (94.19%) per cent mortality of *S. litura* at 96 hrs was observed at 100 IJs per larva, followed by 70.46 and 59.97 at 80 and 60 IJs per larva, respectively. Similarly, 94.70 per cent larval mortality of *S. frugiperda* was recorded with *Steinernema* sp. (AAU St-1) at 100 IJs per larva after 96 hrs followed by 79.96 and 70.46 per cent with 80 and 60 IJs per larva, respectively. After 120 hrs, all the treatments gave the maximum (99.95%) mortality against both *S. litura* and *S. frugiperda*.

Key words : Bio-efficacy, Entomopathogenic Nematodes (EPNs), *Steinernema* sp. (AAU St-1), *S. litura* and *S. frugiperda*

Introduction

Nematodes associated with insects called entomophilic, entomogenous, or entomopathogenic are known to parasitize, cause disease and kill the insects within 24 to 48 hrs due to septicaemia. This group of nematodes is characterized by carrying specific symbiotic bacteria of the genus *Xenorhabdus* or *Photorhabdus* in their intestine. Symbiotic bacteria play an essential role in the pathogenicity of the nematode-bacteria complex to insect hosts and the subsequent reproduction of the nematodes in the hosts.

Biological control of insects with EPNs progressed since 1932 with the discovery of *Steinernema glaseri* (Glaser, 1932) infecting Japanese beetle (*Popillia japonica*, Newman). The EPNs of the families Steinernematidae and Heterorhabditidae (Order: Rhabditida) are of considerable use as biocontrol agents in different agroecosystems (Poinar, 1990). Entomopathogenic nematodes are currently used as biopesticides for managing several important insect pests worldwide (Shapiro-Ilan *et al.*, 2002). They have a broad host range and are highly infectious to lepidopteran insects particularly to cutworms (Poinar, 1990) and also to coleopterans like white grubs (Simons & Guys, 1980) and foliar pests (Saravanapriya, 2005). The primary objective of biological control is to reduce pest population below the economic threshold level by using natural enemies. They are remarkably more virulent against lepidopterous and coleopterous pests.

The EPNs of the families Steinernematidae and Heterorhabditidae are potentially useful for biological control in agriculture systems. The infective juveniles of

these families are free-living, non-feeding, and can search out their hosts. They have the potential for long-term establishment in the soil through recycling infected insect larvae. Keeping this in view, the present study was conducted under laboratory conditions to test the bioefficacy of native isolate *Steinernema* sp (AAU St-1) against the larvae of *Spodoptera litura* and *Spodoptera frugiperda*.

Materials and Methods

The studies were carried out in the Department of Nematology, B. A. College of Agriculture, Anand Agricultural University, Anand (Gujarat) during *Kharif* and *Rabi* 2020-21. The details of materials used and methods employed during experimentation are described here under different headings.

Isolation of Entomopathogenic Nematode : The bio-efficacy of native EPN, *Steinernema* sp (AAU St-1) was tested against *S. litura* and *S. frugiperda*. For the requirement of larvae, both cultures were maintained separately in the laboratory.

Rearing of *S. litura* : Egg masses and larvae of *S. litura* were collected from the field and sustained in insect cage for artificial rearing in the laboratory. Hatched larvae were separated in another insect cage with fresh castor leaves feed and covered with the black muslin cloth. First generation larvae were used and the late instar larvae were used for the bio-efficacy test.

Rearing of *S. frugiperda* : Larvae of *S. frugiperda* were collected from the field and sustained under an vial for artificial rearing in the laboratory. Hatched larvae were separated in another vial with fresh maize leaves feed,

Table-1 : Mortality of *Spodoptera litura* due to *Steinernema* sp. (AAU St-1)

Treatment No.	Mortality (%) at different interval		
	72 hrs	96 hrs	120 hrs
T ₁ (20 IJs /larva)	1.28 (0.05)	39.22 (39.97)	88.68 (99.95)
T ₂ (40 IJs /larva)	1.28 (0.05)	45.26 (50.46)	88.68 (99.95)
T ₃ (60 IJs /larva)	7.60 (1.75)	50.75 (59.97)	88.68 (99.95)
T ₄ (80 IJs /larva)	13.92 (5.79)	57.08 (70.46)	88.68 (99.95)
T ₅ (100 IJs /larva)	13.92 (5.79)	76.05 (94.19)	88.68 (99.95)
T ₆ (Distilled water)	1.28 (0.05)	1.28 (0.05)	1.28 (0.05)
S.Em ±	4.939	4.147	0.002
CD (5%)	NS	12.321	0.005
CV %	150.91	18.45	0.00

Notes : 1. Figures in parentheses are retransformed values, and those outside are arc sin transformed values 2. D-Duration, T-Treatment, NS-Non-significant.

Table-2 : Mortality of *Spodoptera frugiperda* due to *Steinernema* sp. (AAU St-1)

Treatment No.	Mortality (%) at different interval		
	72 hrs	96 hrs	120 hrs
T ₁ (20 IJs /larva)	20.24 (11.96)	44.98 (49.97)	88.68 (99.95)
T ₂ (40 IJs /larva)	20.24 (11.96)	44.98 (49.97)	88.68 (99.95)
T ₃ (60 IJs /larva)	29.72 (24.58)	57.08 (70.46)	88.68 (99.95)
T ₄ (80 IJs /larva)	32.89 (29.48)	63.41 (79.96)	88.68 (99.95)
T ₅ (100 IJs /larva)	38.93 (39.49)	76.69 (94.70)	88.68 (99.95)
T ₆ (Distilled water)	1.28 (0.05)	1.28 (0.05)	1.28 (0.05)
S.Em±	4.612	3.964	0.002
CD (5%)	13.704	11.778	0.005
CV%	38.63	16.49	0.00

Notes : 1. Figures in parentheses are retransformed values, and those outside are arc sin transformed values
2. D-Duration, T-Treatment.

and it was covered with lid. First-generation larvae were used for the bio-efficacy test.

The native isolated EPN, *Steinernema* sp (AAU St-1) was tested under laboratory conditions against larvae of *S. litura* and *S. frugiperda*. The sterilized Petri plates were kept in sequence according to treatments and repetitions. Each treatment was repeated four times. In total, twenty-four Petri plates were used for the experiment. The EPNs suspension contained IJs stored in sterile distilled water and examined under the binocular stereo zoom microscope to check the activity of IJs and diluted in the known quantity required.

Inoculum levels were 20, 40, 60, 80 and 100 IJs/larva of native EPN on *S. litura* and *S. frugiperda* (5 larvae/Petri plate). Then put the Whatman filter paper No. 1 in each Petri plate, and five larvae of *S. litura* and *S. frugiperda* (fourth instar) were placed in it. The aluminum wire sieve separated the larvae to avoid cannibalism.

Then, the required quantity of IJs in each Petri plate according to treatments and one ml of distilled water were inoculated in control.

Treatments (Number of IJs/larva)

T₁ = Inoculation of 20 IJs/larva

T₂ = Inoculation of 40 IJs/larva

T₃ = Inoculation of 60 IJs/larva

T₄ = Inoculation of 80 IJs/larva

T₅ = Inoculation of 100IJs/larva

T₆ = Inoculation of Distilled water

The observations were taken on the mortality of the host larvae after 24, 48, 72, 96 and 120 hrs from the time of inoculation. The experimental data were analyzed statistically as per the procedure given by Steel and Torrie (1980). for a completely randomized design (Factorial). The data were analyzed according to arcsine transformation. The standard error of mean (S.Em. ±) and critical difference (CD) at 5 % percent level of probability were calculated.

The same procedure and treatments were used for the bio-efficacy test of *S. frugiperda*.

Results and Discussion

Bio-efficacy of *Steinernema* sp. (AAU St-1) against *S. litura*

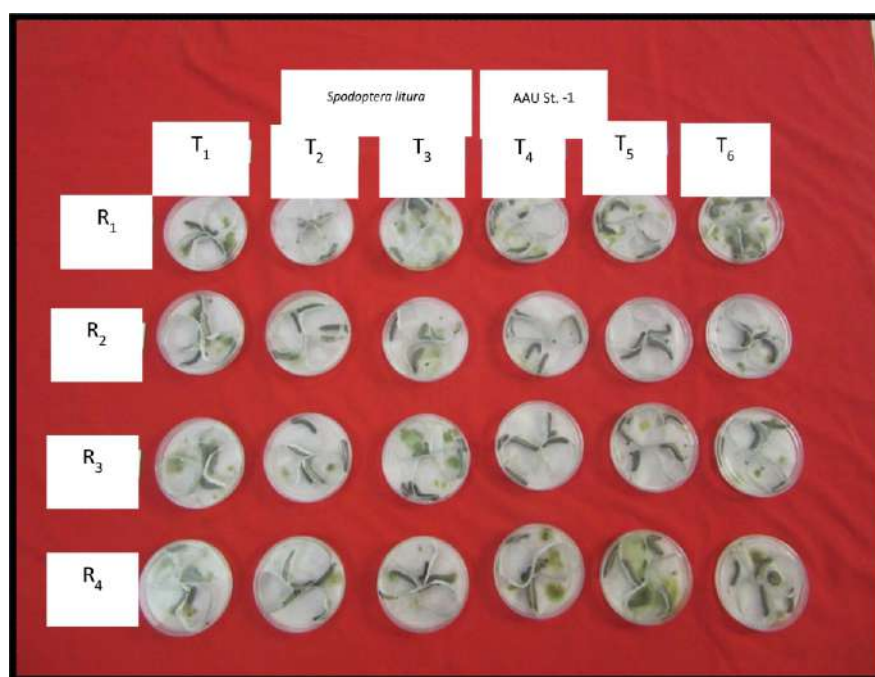
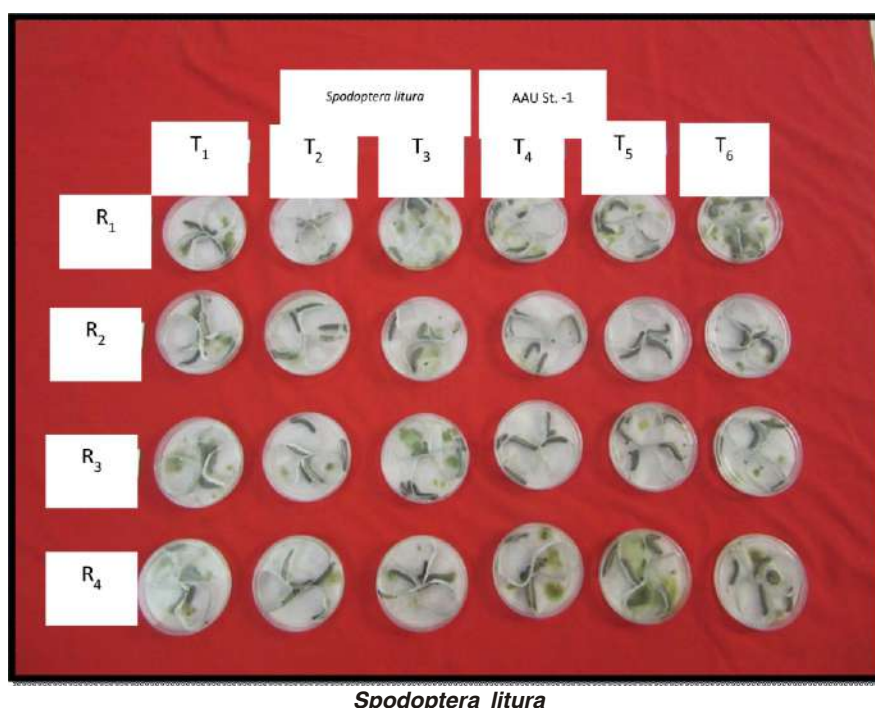
The data presented in table1 revealed that at 24 and 48 hrs of inoculation of *Steinernema* sp. (AAU St-1), there was no mortality found of *S. litura*, so the analysis was not made for 24 and 48 hrs. The mortality was found after 48 hrs.

After 72 hrs among all the treatments, inoculum level

Plate 1a : Rearing of *S. litura*.Plate 1b : Rearing of *S. frugiperda*.

with 80 and 100 IJs per larva gave the maximum (5.79%) mortality. Treatment with 60 IJs per larva was found the next (1.75%) effective treatment. After that, treatment with 20 and 40 IJs per larva recorded the lowest mortality (0.05%).

After 96 hrs among all the treatments, inoculum level with 100 IJs per larva gave the maximum (94.19%) mortality, followed by treatment with 80, 60 and 40 IJs per larva gave 70.46, 59.97 and 50.46 per cent mortality of *S. litura*, respectively. At the same time, the treatment with 20 IJs per larva showed the lowest (39.97%) mortality.



After 120 hrs, all the treatments gave the maximum mortality (99.95%).

Bio-efficacy of *Steinernema* sp. (AAU St-1) against *S. frugiperda* : The data on bio-efficacy of *Steinernema* sp. (AAU St-1) against *S. frugiperda* presented in table-2 indicated that, at 24 and 48 hrs of the inoculation of *Steinernema* sp. (AAU St-1), there was no mortality found of *S. frugiperda*, so the analysis was not done for 24 and 48 hrs. The mortality of *S. frugiperda* was found after 48 hrs of inoculation.

After 72 hrs among all the treatments, inoculum level with 100 IJs per larva gave the maximum (39.49%) mortality, followed by treatment of 80 and 60 IJs per larva gave 29.48 and 24.58 per cent, respectively. Treatment with 40 and 20 IJs per larva found the lowest (11.96%) mortality.

After 96 hrs among all the treatments, the maximum (94.70%) mortality was observed in inoculum level with 100 IJs per larva followed by 79.96 and 70.46 per cent with 80 and 60 IJs per larva, respectively. At the same

time, minimum (49.97%) mortality was observed with 40 and 20 IJs per larva. After 120 hrs, all the treatments gave the maximum (99.95%) mortality.

Our results were found similar to Adiroubane *et al.* (2010). They experimented with the efficacy of *S. siamkayai* against *S. litura* and concluded that the dosage increased the susceptibility was also increased in the third, fifth and pre-pupal stages of insect pests. Kamalia *et al.* (2019) also reported bio-efficacy of EPN, *Heterorhabditis indica* against *S. litura*. They concluded that *H. indica* against *S. litura* was directly proportional to the infective juvenile dose and exposure time. At 120 hrs after the application, a cent per cent larval mortality of *S. litura* was recorded at all the doses (20, 40, 60, 80 and 100 IJs/larva). The results were the same as our findings that the mortality increased as the dose increased. It may be because of the time required for entry of IJs into host insect and bacterial infection starting after the penetration of the nematodes into the body cavity of the insects. Therefore, infective nematode juveniles must locate the insect host and gain entry into the haemocoel. Consequently, it was concluded that the mortality of insect larvae increased with an increase in the inoculum levels and period of exposure.

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Residual Toxicity of Some Insecticides to *Trichogrammatoidea bactrae* Nagaraja on Eggs of Different Bollworms

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Abstract

The present investigation on Residual toxicity of some insecticides to *Trichogrammatoidea bactrae* Nagaraja on eggs of different bollworms was carried out at Bio-control Laboratory, Department of Agricultural Entomology, College of Agriculture, Latur (VNMKV, Parbhani), Maharashtra-India during 2018-19. The data on median lethal concentrations of nine different insecticides to the adults of *Tr. bactrae* revealed that among the insecticides tested in dry film vial residue bioassay, spinosad exhibited highest toxicity to *Tr. bactrae* adults with LC₅₀ value of 0.0103 and 0.0104 ml a.i. per l at 24 and 48 h interval of exposure, respectively followed by chlorantraniliprole (LC₅₀=0.0180 and 0.0181 ml a.i. per l), diflubenzuron (LC₅₀=0.0296 and 0.0265 mg a.i. per l), emamectin benzoate (LC₅₀=0.0321 and 0.0284 mg a.i. per l), indoxacarb (LC₅₀=0.0626 and 0.0627 ml a.i. per l), cyantraniliprole (LC₅₀=0.1120 and 0.1129 ml a.i. per l), lambda-cyhalothrin (LC₅₀=0.1579 and 0.0911 ml a.i. per l), quinalphos (LC₅₀=0.1743 and 0.1749 ml a.i. per l) and azadirachtin which was found to be least toxic to the adults of *Tr. bactrae* with LC₅₀ value of 2.1831 and 1.4806 ml a.i. per l. Based on Risk Quotient values, among the different insecticides, azadirachtin was found to be harmless however; spinosad and diflubenzuron was found to be highly dangerous insecticide to the adults of *Tr. bactrae*.

Key words : Residual toxicity, some insecticides, *Trichogrammatoidea bactrae*

Introduction

Trichogrammatids are smallest insects, ranging in size from 0.2 to 1.5 mm, solitary or gregarious idiobiont endoparasitoids of insect eggs. The family Trichogrammatidae is represented by over 800 described species in approximately 90 genera worldwide and is recognized from all vegetated terrestrial habitats (Pinto, 2006). Use of *Trichogrammatoidea* sp. in different pest control programme proves satisfactory as it gives high level of pest suppression in the field (Malik, 2001a; Liu *et al.*, 2004; Krishnamoorthy, 2012 and Mohamed *et al.*, 2016). However, the success of its release depends upon the factors such as interaction with target host, strain released and different biological characters that determine the efficacy of parasitism (Bouchier and Smith, 1996).

Attempts to suppress insect-pest populations by biological control measures have often failed because of deleterious effects of chemicals on the beneficial insects (Kapuge *et al.*, 2003). Moreover, majority of farmers usually adopt a faulty procedure of release of Trichogrammatids, without due consideration of safe waiting periods of insecticides for the parasitoids after chemical sprays. The contact toxicity and impact of chemical residues on Trichogrammatids have been examined in numerous studies using protocols developed by International Organization for Biological Control of

Noxious Plants and Animals (IOBC) and West Palaearctic Region Section (WPRS) working group (Hassan *et al.*, 1998). However, scanty information is available on safe waiting periods for the release of *Tr. bactrae* after insecticidal application.

Materials and Methods

The egg parasitoid *Tr. bactrae* maintained on eggs of *C. cephalonica*. The insecticides which are commonly being used for the control of bollworms on cotton were selected and purchased from the local market (Table 1). The commercial formulations of various insecticides were diluted with distilled water to obtain the desired concentrations. Plastic vial residue method was followed to assess the residual toxicity of insecticides to *Trichogrammatoidea* species as per the standard procedure proposed by Hassan *et al.* (1998) with slight modification. The vials were coated evenly with 0.5 ml of each concentration (one lower than recommended, one recommended and one higher than recommended) of 9 different insecticides and dried thoroughly. As a control, distilled water was used. The ten newly emerged adults of *Tr. bactrae* were released in the treated plastic vial. After 4 hr of exposure, the wasps were placed in a clean test tube and mortality was recorded at 24 and 48 hr after treatment (HAT). The experiment was replicated three times. Necessary corrections were made for natural mortality in the control as per Abbott (1925) for *Tr. bactrae* bioassays.

Table-1 : Details of insecticides assayed in the experiment.

Sr. No.	Common name with formulation	Recommended dosages (per 10 liter water)	Concentration of insecticide (Per cent)	Sr. No.	Common name with formulation	Recommended dosages (per 10 liter water)	Concentration of insecticide (Per cent)
1.	Azadirachtin 0.03% EC	50 ml	0.00015	6.	Lambda-cyhalothrin 5% EC	10 ml	0.0040
2.	Chlorantraniliprole 18.5% SC	3 ml	0.0055	7.	Spinosad 45% SC	1.6 ml	0.0070
3.	Cyantraniliprole 10.26% OD	12 ml	0.0123	8.	Quinalphos 25% EC	20 ml	0.05
4.	Emamectin benzoate 5% SG	2.7 g	0.00135	9.	Diflubenzuron 25% WP	6 mg	0.015
5.	Indoxacarb 15.8% EC	6.7 ml	0.0105	10.	Control (Distilled water)	-	-

Abbott's formula : Corrected per cent mortality

$$= \frac{T - C}{100 - C} \times 100$$

Where,

T = Per cent mortality in treatment

C = Per cent mortality in control

Then the data were subjected to probit analysis by Finney (1971) using computer software Polo Plus 1.0 (LeOra software) to obtain the value of median lethal concentration (LC₅₀) for each insecticide.

Calculation of Risk Quotient : Environmental risk assessment of pesticides and other chemicals often uses the Risk Quotient (RQ) method (deterministic approach) to express risk quantitatively. An RQ typically is calculated by dividing an environmental exposure value by a toxicity end-point value. Therefore, the RQ is a ratio of exposure to effect. The RQ then can be used by risk analysts and other decision makers to assess whether the value exceeds any predetermined threshold levels of concern (Peterson, 2006). This ratio is a simple, screening-level estimate that identified high- or low-risk situations. In this method, the estimated environmental concentration (EEC) is compared to an effect level, such as an LC₅₀ (the concentration of a pesticide where 50 per cent of the organisms die) (EPA, 2016). Risk Quotients for the insecticides were calculated from the LC₅₀ values based on the formula given below.

Risk Quotient

$$= \frac{\text{Recommended field rate (mg or ml a.i. per ha)}}{\text{LC}_{50} \text{ of beneficial insect (mg or ml a.i. per l)}}$$

Results and Discussion

The data revealed that among the insecticides tested in dry film vial residue bioassay, spinosad exhibited highest toxicity to *Tr. bactrae* adults with LC₅₀ value of 0.0103 ml

a.i. per l at 24 h interval of exposure followed by chlorantraniliprole (LC₅₀=0.0180 ml a.i. per l), diflubenzuron (LC₅₀ =0.0296 mg a.i. per l), emamectin benzoate (LC₅₀ =0.0321mg a.i. per l), indoxacarb (LC₅₀ =0.0626 ml a.i. per l), cyantraniliprole (LC₅₀=0.1120 ml a.i. per l), lambda-cyhalothrin (LC₅₀ =0.1579 ml a.i. per l), quinalphos (LC₅₀ =0.1743 ml a.i. per l) and azadirachtin was found to be least toxic to the adults of *Tr. bactrae* with LC₅₀ value of 2.1831 ml a.i. per l.

The data revealed that among the insecticides tested in dry film vial residue bioassay, spinosad was found to be most lethal insecticide to *Tr. bactrae* adults with LC₅₀ value of 0.0104 ml a.i. per l at 48 h interval of exposure followed by chlorantraniliprole (LC₅₀ =0.0181 ml a.i. per l), diflubenzuron (LC₅₀ =0.0265 mg a.i. per l), emamectin benzoate (LC₅₀ =0.0284 mg a.i. per l), indoxacarb (LC₅₀ =0.0627 ml a.i. per l), lambda-cyhalothrin (LC₅₀ =0.0911 ml a.i. per l), cyantraniliprole (LC₅₀ =0.1129 ml a.i. per l), quinalphos (LC₅₀ =0.1749 ml a.i. per l), however azadirachtin was found to be least toxic to the adults of *Tr. bactrae* with LC₅₀ value of 1.4806 ml a.i. per l.

These results are analogous with the findings of Osman *et al.* (2014) who evidenced that residues of emamectin benzoate caused the highest percentages of mortality of *Tr. bactrae* (65 per cent) followed by chlorantraniliprole (60 per cent), spinosad (55 per cent), lufenuron (35 per cent) and *Bt* (10 per cent). Perera and Hemachandra (2014) evidenced that mortality of *Tr. bactrae* significantly varied across the insecticides and the stage of *Tr. bactrae*. Fipronil caused highest mean mortality of all stages of *Tr. bactrae* followed by chlorfluazuron and azadirachtin. Wang *et al.* (2010) revealed that residues of betacypermethrin, diafenthiuron, avermectins, spinosad, chlorfenapy, fipronil and cartap exhibited 89.31-100 per cent mortalities in *Tr. bactrae* adults. Djuwarso *et al.* (1999)

Table-2 : Median lethal concentration and Risk Quotient of different insecticides to *Tr. batrae*.

Insecticides	Period (h)	LC ₅₀ (mg or ml a.i. per l)	90% Fiducial limits of LC ₅₀		LC ₉₀ (mg or ml a.i. per l)	X ² Value	Risk Quotient	Category
			Lower limit	Upper limit				
Azadirachtin 0.03% EC	24	2.1831	0.15387	30.9726	93.9622	0.0033	0.34	Harmless
	48	1.4806	0.01365	142.6824	4065.445	0.0702	0.51	Harmless
Chlorantraniliprole 18.5% SC	24	0.0180	0.00456	0.07137	0.4513	0.0349	1666.66	Moderately toxic
	48	0.0181	0.00462	0.07125	0.0006	0.0425	1657.45	Moderately toxic
Cyantraniliprole 10.26% OD	24	0.1120	0.05030	0.24964	1.1005	0.0110	535.71	Slightly toxic
	48	0.1129	0.05060	0.25198	0.0115	0.0114	531.44	Slightly toxic
Emamectin benzoate 5% SG	24	0.0321	0.01926	0.05358	0.0803	0.0011	264.80	Slightly toxic
	48	0.0284	0.01960	0.01370	0.0107	0.3333	299.29	Slightly toxic
Indoxacarb 15.8% EC	24	0.0626	0.05545	0.07071	0.0791	0.1277	1198.08	Moderately toxic
	48	0.0627	0.05560	0.07060	0.0496	0.1282	1196.17	Moderately toxic
Lambda-cyhalothrin 5% EC	24	0.1579	0.03420	0.72909	2.4178	0.0145	95.00	Slightly toxic
	48	0.0911	0.03350	0.24816	0.0053	0.0171	164.65	Slightly toxic
Spinosad 45% SC	24	0.0103	0.00663	0.01624	0.0233	0.2706	7281.55	Dangerous
	48	0.0104	0.01623	0.20567	0.0046	0.2943	7211.54	Dangerous
Quinalphos 25% EC	24	0.1743	0.12441	0.24441	0.4018	0.0193	1147.44	Moderately toxic
	48	0.1749	0.12508	0.24462	0.0759	0.0202	1143.51	Moderately toxic
Diflubenzuron 25% WP	24	0.0296	0.02197	0.04004	0.0698	0.0014	2533.78	Dangerous
	48	0.0265	0.01215	0.05816	0.0046	0.0756	2830.18	Dangerous

investigated that sihalotrin residues had negative effect on *Tr. batrae batrae* in *E. zinckenella* eggs. Chlorpyrifos was highly toxic to the immature stage of parasitoid in the *C. cephalonica* eggs and failed to record adult emergence. Monocrotophos and Deltamethrin were safer than the others if sprayed on immature stage 1-3 days old in *C. cephalonica* eggs. Hassan and Graham-Smith (1995) revealed that *Tr. batrae* was highly sensitive to endosulfan and fenvalerate, however *B. thuringiensis* found harmless.

Risk quotient of different insecticides : The data revealed that among the eight insecticides tested, spinosad and diflubenzuron were found to be “dangerous” to the adult of *Tr. batrae* with highest Risk Quotient values of 7281.55, 7211.54 and 2533.78, 2830.18 at 24 and 48 h interval of exposure, respectively. However, chlorantraniliprole was observed to be “moderately toxic” to the adults of *Tr. batrae* with Risk Quotient values of 1666.66 and 1657.45 at 24 and 48 h interval of exposure, respectively followed by indoxacarb (1198.08 and 1996.17), quinalphos (1147.44 and 1143.51). However, cyantraniliprole, emamectin benzoate and lambda-cyhalothrin were exhibited to be “slightly toxic” to *Tr. batrae* adults with Risk Quotient values of 535.71 and 531.44, 264.80 and 299.29 and; 95.00 and 164.65 at 24 and 48 h interval of exposure, respectively. Amongst the insecticide tested, azadirachtin was found to be “harmless” to the adults of *Tr. batrae* with very less Risk Quotient values of 0.34 and 0.51 at 24 and 48 h interval of exposure, respectively.

More or less similar results were obtained by Chunke (2017) who revealed that based on the Risk

Quotient values, spinosad was found to be “dangerous”, chlorantraniliprole, quinalphos and indoxacarb were “moderately toxic”, cyantraniliprole, emamectin benzoate and lambda-cyhalothrin were “slightly toxic” and; azadirachtin was “harmless” to *T. chilonis* adults. Shankarganesh *et al.* (2013) indicated that adults of egg parasitoids, *T. chilonis* and *T. brasiliensis* when exposed to nine different insecticides by glass vial residue method, lambda-cyhalothrin, and indoxacarb were more toxic to *T. chilonis*. However, *T. brasiliensis* was more sensitive to indoxacarb than other insecticides. Based on the Risk Quotient value, lambda-cyhalothrin and indoxacarb were observed dangerous to *T. chilonis* and *T. brasiliensis*. Analogously, Anoop Kumar *et al.* (2013) reported that lambda-cyhalothrin was found highly toxic to the adult wasps of *T. chilonis* with 100 per cent mortality within 2 h of exposure.

Conclusion

Based on Risk Quotient values, among the different insecticides, azadirachtin was found to be harmless however; spinosad and diflubenzuron was found to be highly dangerous insecticide to the adults of *Tr. batrae*. The present study was conducted under laboratory conditions in which insects were subjected to high pressure of insecticide. However, under field condition, the insecticide may have less negative impact on parasitoids. Since, natural enemy can take advantage of natural shelter, avoiding treated areas and other means. Therefore, further studies needs to be carried out to determine insecticides which can be used safely under field conditions without disrupting the ecological balance.

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Biochemical Evaluation of New Emerging Variety of Wheat Rich in Nutritional Characteristics and the Role of New Technology in Agriculture

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Abstract

Black wheat is a variety of pigmented wheat developed by crossing purple and blue wheat. The anthocyanin present in the outer layer is responsible for the black color of wheat grain. It consists of numerous nutritional and bio-active compounds including phenolic compounds, anthocyanins, carotenoids, phytic acid, essential amino acids, dietary fibers, vitamins and minerals. Black wheat, possess high protein content, dietary fiber, calcium, vitamin-K, total flavonoids, phenolic content and antioxidant activity than the conventional yellow wheat. The total phenolic content of black wheat is six times higher than yellow wheat with most abundant phenolic acid being ferulic acid. The black wheat led to present on of (UI), inflammation, cancer, diabetes, obesity, aging and large bowel protection. Nutrient and bio-active compound rich black wheat offers a great potential to develop healthy functional food.

Key words : Black wheat, anthocyanin, antioxidant properties.

Introduction

Cereals take an important place among all the food items and play key role for a healthy diet. Among the cereals, wheat is the leading one, devoted to multiple uses such as bread, noodles and biscuits. Wheat is a good source of starch, proteins, minerals and dietary fibre and is major contributor towards daily caloric requirements of wheat consuming population. Further enhancement in its nutritional value is expected to increase consumer demands regarding health, nutrition and convenience. Several crops with nutraceutical value are being commercially utilized in several countries across the world, e.g. quality protein maize with high lysine health, nutrition and convenience. Several crops with nutraceutical value are being commercially utilized in several countries across the world, e.g. quality protein maize with high lysine and tryptophan content, purple colored carrots, potatoes, sweet potatoes and maize with high anthocyanin content.

Anthocyanins have evoked the interest of number of researchers. Anthocyanins are normal constituents in colored fruits and vegetables. These can act as antioxidants and help in prevention of cardiovascular diseases, diabetes, inflammation, cancer, obesity and aging. Common wheat cultivars across the world are white (amber) in color. The colored wheat, rich in anthocyanin is quite uncommon. Purple color is localized to the pericarp whereas blue color to the aleurone. Black wheat resulted by the combination of genes for both purple and blue colors. Colored wheat has attracted the

attention of many breeders across the world but these lines exhibit low yield due to linkage drag. We have developed colored wheat lines with satisfactory yield potential and regional adaptation. In this manuscript we have characterized these lines, with respect to colored donor and recipient high yielding white wheat lines. Colored wheat lines were characterized for anthocyanin content and antioxidant activities. For validation of health claiming benefits of color wheat lines, its antiinflammatory effect was studied using macrophage cell line model. For assessment of bread making quality, chemical composition of colored advanced lines including minor components (minerals and vitamins) and rheological parameters were evaluated.

Sample Preparation : Wheat samples from the crops were picked and threshed to remove the peels. The seed samples were kept at a temperature of 25°C and a relative humidity of approximately 85% in an air-conditioned laboratory overnight to attain temperature equilibrium of the seeds before measurement. The samples of these crop were analyzed for their proximate composition. All the work pertaining to this investigation was done in the laboratories of NIRS in the directorate of research, C.S. Azad University of Agriculture & Technology, Kanpur (U.P.) The grain seeds were collected from legume section of Azad University of Agriculture & Technology, Kanpur. After cleaning and grinding the seed samples were determined using NIRS-2500. For analysis we should used three replication for each sample and used the average value for the spectrum calibration. We take

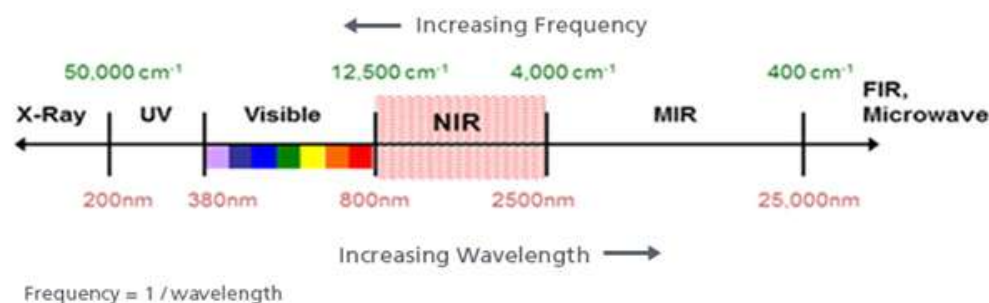


Table-1 : To study the physical and biochemical parameters of black wheat varieties.

S. No.	Name of Crop	Seed Index 100 no	Test Weight 1000 no	Protein (%)	Moisture (%)	Ash (%)	Fibre (%)	Methionine (%)	Tryptophan (%)
1.	KVK Daleepnagar Black Wheat	2.60	22.64	10.16	10.24	1.74	2.08	3.12	1.44
2.	KVK Daleepnagar Black Wheat	2.90	25.94	10.15	10.23	1.74	2.05	3.14	1.45
3.	KVK Daleepnagar Black Wheat	2.35	26.98	10.14	10.22	1.75	2.06	3.15	1.46
4.	KVK Daleepnagar Black Wheat	3.11	26.86	10.15	10.23	1.74	2.04	3.13	1.42
5.	KVK Daleepnagar Black Wheat	2.58	24.22	10.14	10.22	1.75	2.03	3.15	1.41
6.	Black Wheat 01	3.00	25.55	10.13	10.21	1.73	2.05	3.18	1.46
7.	Black Wheat 02	3.17	25.64	10.14	10.22	1.74	2.06	3.15	1.46
8.	Black Wheat 03	2.22	24.47	10.13	10.21	1.73	2.07	2.86	1.49
9.	Black Wheat 04	2.49	24.99	10.15	10.22	1.72	2.04	3.07	1.47
10.	Black Wheat 05	2.30	25.97	10.17	10.26	1.74	2.07	2.98	1.43
11.	Black Wheat 06	2.30	26.11	10.16	10.25	1.71	2.02	3.08	1.42
12.	Black Wheat 07	2.26	26.05	10.15	10.24	1.72	2.05	3.13	1.45
	Mean	2.64	25.45	10.14	10.22	1.73	1.96	3.09	1.44

130 gm samples to analyze the sample it works from 400-2500 nm wavelength.

It is an instrument through which Near Infrared (NIR) analysis a spectroscopic technique that makes use of the naturally occurring electromagnetic spectrum. This works in the region of the spectrum defined by wavelengths between 700nm and 2500nm. It is suited for quantitative determination of the major constituents in most types of food and agricultural products.

Principle Near Infrared light is directed onto a sample :

The light is modified according to the composition of the sample and this modified light is detected.

The spectral modifications are converted to information regarding the composition of the sample.

These conversion algorithms are called "calibrations".

Transmission and reflectance : Infrared spectrum was got by using infrared light which passes through the sample by follow the transmission. The light was reflected by the sample and follow the absorption properties which can be extracted from the reflectance. This spectroscopy

can be analyzed the sample by transmittance is good for measuring cheese to obtain a representative measurement throughout the sample. For homogenous samples such as milk powder, reflectance is ideal.

For both methods, the NIR wavelength range is an important consideration. For instance, a Short Wave NIR range (850 – 1050nm) gives good sample penetration with NIR transmission.

This table shows that seed index of the crop was maximum in black wheat-02(3.17g/100g)and minimum black wheat-03 (2.22g/100g). The test weight of the crop was maximum in KVK Daleepnagar black wheat (26.98g/1000gm) and minimum in KVK Daleepnagar black wheat (22.64g/1000gm). The protein content was present maximum in black wheat-05 (10.17%) and minimum in black wheat-01,03 (10.13%). The moisture was present maximum in black wheat-05(10.25%) and minimum in black wheat-01,03 (10.21%) .The Ash content was maximum in KVK Daleepnagar black wheat-03,05 (1.75) and minimum in black wheat-06 (1.71%). Fiber content was maximum in KVK Daleepnagar black wheat (2.08%) and minimum in black wheat-06(2.02%) . The aromatic amino acid Methionine amino acid was present maximum in black

wheat-06(3.18%) and minimum in black wheat-03 (2.86%). The Tryptophan was present maximum in black wheat-03(1.49%) and minimum in KVK Daleep nagar (1.41%).

It was concluded that black wheat-05 was superior in protein content, moisture content and tryptophan amino acid. KVK daleepnagar black wheat -03,05 was superior in ash and fiber content.

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Chapati and Ladoo Preparation by using Composite Flour of Wheat and Water Chestnut and their Sensory and Nutritional Evaluation

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Abstract

This study was carried out to assess the nutritional composition of the developed *chapati* and *ladoo* by using the composite flour of wheat and dried water chestnut. Four types of composite flours were prepared using wheat and water chestnut in ratios; 80:20, 60:40, 40:60 and 20:80 (type I, type II, type III and type IV, respectively). Water chestnut flour could be incorporated up to 20 % level in *chapati* and 60% level in *ladoo*. With the nutritional evaluation of products, it was found that after the incorporation of water chestnut flour in wheat flour, the content of total sugars, starch, total carbohydrates, calcium, total phenols, total flavonoids and antioxidant activity (DPPH) were increased significantly in the traditional products whereas crude protein, crude fat and crude fibre content were found to be decreased significantly.

Key words : Water chestnut flour, composite flour, sensory attributes and nutritional evaluation

Introduction

Water chestnut (*Trapa natans*) locally called as “Singhara” in India (Gani et al., 2010) belongs to the family Trapaceae, one of the free-floating plants, grown in shallow water fields, ponds or swampy lands in tropical and sub-tropical countries (Takano and Kadono, 2005). The fruit is used as a substitute for cereal in Indian subcontinent during fast days especially during Navratras and other sacred days when consumption of wheat flour is avoided.

Chestnut flour is produced from chestnut fruits which are first dried in a flow of hot air, then shelled, picked over by hand or mechanically to remove discolored chestnuts, and crushed with a stone grinding mill (Alary et al., 2007).

Chestnut flour may be used in gluten-free flour products due to its nutritional and health benefits. Water chestnut (*Trapa bispinosa*) is the major source of starch which contains approximately 72 % starch (Malik et al., 2012). Water chestnut flour contains high quality proteins (6.9%) with essential amino acids (4–7%), relatively high amount of sugar (20–32%), starch (50–60%), dietary fiber (4–10%), and low amount of fat (2–4%).

The derived products of chestnut present two specific advantages: low cholesterol level and absence of gluten which makes these products suitable for people with hypercholesterolemia and celiac disease, respectively (Demiate et al., 2001; Silva 2005; Borges et al., 2008; Chenlo et al. 2011; Demirkessen et al., 2011).

It has been hypothesized that the quality problems associated with using only chestnut or rice flour can be overcome by using their composition at certain level

(Demirkessen et al., 2010). Most snack foods being cereal based are monotonous in regard to their nutritional quality. Use of abundant supplies of sweet potato, colocasia and water chestnut in countries like India to substitute partially for wheat flour in quality products will not only reduce the excessive dependence on cereal grains but also improve the imbalance of nutrients through consumption of products based upon composite flour mixtures (Yadav et al., 2014). Therefore, flours from alternative sources such as sweet potato, water chestnut and other tubers including colocasia are being used as potential wheat flour substitutes adding variety and functionality to the product (Liu et al., 2006).

Keeping in view the above information, the present study was planned with the objective of development of some traditional products i.e. chapati and ladoo using composite flour and their sensory and nutritional evaluation.

Research Methodolgy

For the preparation of products wheat variety (WH-1105) was procured from Department of Genetics and Plant Breeding, College of Agriculture, Chaudhary Charan Singh Haryana Agricultural University, Hisar. Well dried water chestnut and other required ingredients were purchased from the local market in a single lot.

Formulation of composite flour : The clean and healthy wheat grains and dried water chestnuts were used for preparation of flour. The wheat grains were ground to fine flour in a mini flourmill. The dried water chestnuts were finely ground in an electric grinder. Composite flour was

prepared by mixing wheat flour (WF) with water chestnut flour (WCF) in the following ratios :

Type I flour (80% wheat flour: 20% water chestnut flour)

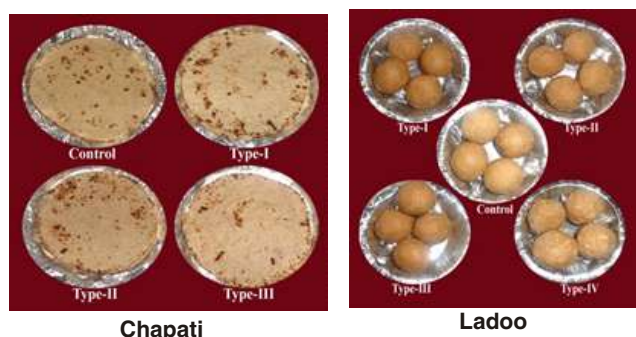
Type II flour (60% wheat flour: 40% water chestnut flour)

Type III flour (40% wheat flour: 60% water chestnut flour)

Type IV flour (20% wheat flour: 80% water chestnut flour)

The four types of flours were stored in air tight plastic containers for further analysis.

Preparation of Products



Sensory evaluation of developed products : All the products developed from composite flour were organoleptically evaluated using 9-point Hedonic Scale by a panel of ten semi-trained judges. The judges were selected from College of Home Science, CCS Haryana Agricultural University, Hisar.

Nutritional evaluation of the developed products : Moisture content was determined by employing the standard method of analysis (AOAC, 2000). Crude protein was estimated by standard method of analysis (AOAC, 2000), using KEL PLUS Automatic Nitrogen Estimation System. A factor of 6.25 was applied to convert the amount of nitrogen to crude protein. The crude fibre and ash were estimated by employing the standard method of analysis (AOAC, 2000). Crude fat was estimated by employing the standard method of analysis (AOAC, 2000) using the Automatic SOCS plus Solvent Extraction System. Total soluble sugars were estimated by method of Yemm and Willis (1954). Reducing sugars were estimated by Somogyi's modified method (Somogyi, 1945). The amount of non-reducing sugars was calculated as the difference between total soluble sugars and reducing sugars. Starch was extracted by the method of Cerning and Guilhot (1973). *In vitro* starch digestibility was assessed as per the method of Singh *et al.*

(1982). The concentration of total phenol of the methanolic extracts was determined by the Folin–Ciocalteu colorimetric method (Singleton *et al.*, 1999). The amount of flavonoids content in methanolic extracts was determined by aluminium chloride colorimetric method (Zhishen *et al.*, 1999). The antioxidant activity of the extracts, on the basis of the scavenging activity of the stable DPPH free radical, was determined by the method followed by Williams *et al.* (1995) as previously described by Tadhani *et al.* (2009).

Statistical analysis : The data obtained were analyzed statistically by using ANOVA and 't' test.

Results and Discussion

Sensory evaluation of products

Mean scores of organoleptic characteristics of Chapati : Data on mean scores of organoleptic characteristics of chapati are given in table-2.1.

Mean score for color of chapati prepared using 100% wheat flour (control) was 8.0 which fell under the category of liked very much. The scores for color of type I chapati was 7.8 whereas that of type II and type III was 7.0 and 6.1, respectively. Results revealed that score for control and type I chapati fell under the category of liked very much. The type II and type III chapati were liked moderately and liked slightly, respectively by the panelists.

The score for appearance of control chapati was 8.0 i.e. it was liked very much. The scores for appearance of type I, type II and type III chapati were 7.7, 6.9 and 6.2, respectively which fell under the category of "liked very much", "liked moderately" to "liked slightly", respectively.

The score for aroma of control chapati (8.0) was liked very much by the panelists. Type I, type II and type III had scores 7.7, 7.1 and 6.1, respectively and panelists liked very much, liked moderately and liked slightly, respectively the aroma of different types of chapati.

The texture of control chapati scored 7.9 followed by type I (7.7) type II (6.9) and type III (6.1). The scores for texture of control and type I chapati fell under the category of liked very much, whereas type II and type III chapati were liked moderately and liked slightly, respectively by the panelists.

The control chapati scored 8.0 for taste and liked very much by the panelists. Type I, type II and type III scored 7.7, 7.1 and 6.2, respectively for the taste which fell under the category of "liked very much", "liked moderately", and "liked slightly", respectively.

Data of overall acceptability score for control chapati was 7.98 and that of type I chapati was 7.7 which depicted

Table-1.1 : The proportion of ingredients used for preparation of chapati.

Ingredients	Control	Type I	Type II	Type III
Wheat flour (g)	100	80	60	40
Water chestnut flour (g)	-	20	40	60
Water (ml)	270	250	250	235

Table-1.2 : The proportion of ingredients used for preparation of laddoo.

Ingredients	Control	Type I	Type II	Type III	Type IV
Wheat flour (g)	100	80	60	40	20
Water chestnut flour (g)	-	20	40	60	80
Ghee (g)	45	45	45	45	45
Sugar (g)	50	50	50	50	50

Table-2.1: Mean scores of organoleptic characteristics of Chapati.

Type of Chapati	Color	Appearance	Aroma	Texture	Taste	Overall Acceptability
Control W.F (100)	8.00±0.30	8.00±0.30	8.00±0.30	7.90±0.31	8.00±0.30	7.98±0.30
Type I (WF:WCF :: 80:20)	7.80±0.29	7.70±0.30	7.70±0.30	7.70±0.30	7.70±0.30	7.72±0.29
Type II (WF:WCF :: 60:40)	7.00±0.30	6.90±0.27	7.10±0.18	6.90±0.28	7.10±0.18	7.00±0.23
Type III (WF:WCF :: 40:60)	6.10±0.23	6.20±0.25	6.10±0.23	6.10±0.28	5.90±0.23	6.07±0.23

Values are mean ± SE of ten independent determinations

WF: Wheat Flour WCF: Water Chestnut Flour

Table-2.2 : Mean scores of organoleptic characteristics of Ladoo.

Type of Ladoo	Color	Appearance	Aroma	Texture	Taste	Overall Acceptability
Control W.F (100)	7.20±0.36	7.30±0.37	7.20±0.33	7.20±0.59	7.60±0.22	7.31±0.35
Type I (WF:WCF :: 80:20)	7.70±0.21	7.80±0.20	7.30±0.21	7.70±0.26	7.30±0.26	7.56±0.20
Type II (WF:WCF :: 60:40)	7.80±0.25	7.80±0.25	7.50±0.22	7.80±0.29	7.65±0.35	7.71±0.26
Type III (WF:WCF :: 40:60)	7.95±0.28	7.95±0.28	7.70±0.26	8.10±0.28	7.90±0.31	7.90±0.31
Type IV (WF:WCF :: 20:80)	7.55±0.28	7.55±0.28	7.40±0.34	7.50±0.31	7.10±0.35	7.40±0.28

Values are mean ± SE of ten independent determinations

WF: Wheat Flour WCF: Water Chestnut Flour

that the control and type I chapati was liked very much. Type II and type III scored 7.0 and 6.0, respectively which were liked moderately and liked slightly, respectively. According to Digamberrao, 2013 sensory attributes of chapati remained unaffected with addition of 10 % chickpea and 10% soyabean flour.

Mean scores of organoleptic characteristics of Ladoo
: Data on mean scores of organoleptic characteristics of laddoo are given in table-2.2.

Mean scores for color of all types of laddoo prepared by incorporating water chestnut flour fell in the category of “liked very much” and were found more acceptable than control laddoo. Control laddoo scored 7.2 whereas type III laddoo scored 7.95 followed by type II (7.8), type I (7.7) and type IV (7.55).

It was observed that mean scores of laddoo for appearance of control laddoo was 7.3. Type III scored 7.95 followed by type I (7.8), type II (7.8) and type IV (7.5). These scores represented that appearance of type I, type II, type III and type IV laddoo were liked very much by the

panelists while laddoo prepared by 100% wheat flour was liked moderately by the panelists.

Mean scores for aroma of control laddoo was 7.2, whereas type III scored 7.7 followed by type II (7.5) type I (7.3) and type IV (7.4). The control, type I and type IV laddoo fell in the category of “liked moderately”, whereas type II and type III laddoo fell in the category of “liked very much”.

Mean scores for the texture of control, type I type, type II, type III and type IV laddoo were 7.2, 7.7, 7.8, 8.0 and 7.5, respectively. The data represented that texture of all the types of laddoo was liked very much and control laddoo was liked moderately by the panelists.

The taste of control laddoo got a score of 7.6 and it was liked very much by the panelists. Type III laddoo scored 7.9 followed by type II (7.65), type I (7.3) and type IV (7.1) laddoo which fell in the category of liked very much to liked moderately, respectively.

Control laddoo scored 7.4 and fell in the category of “liked moderately”. The scores for type I (7.56), type II

Table-3.1 : Proximate composition of the developed products (g/100g, on dry weight basis)

Products	Moisture	Crude Protein	Fat	Ash	Crude Fibre	Total Carbohydrates
Chapati						
Control W.F (100)	32.11±0.37	10.94±0.25	4.09±0.08	1.83±0.01	2.07±0.47	48.97±0.29
Type I (WF:WCF :: 80:20)	30.96±0.43	9.19±0.25	3.65±0.04	2.13±0.07	2.93±0.29	51.14±0.09
't' value	NS	4.90**	5.20*	4.41*	NS	3.21*
Ladoo						
Control W.F (100)	0.11±0.01	11.38±0.25	36.27±0.70	0.91±0.02	1.67±0.18	49.67±0.64
Type III (WF:WCF :: 40:60)	0.01±0.01	8.89±0.14	30.40±1.15	1.06±0.04	2.27±0.18	57.37±1.01
't' value	11.19**	8.57**	4.36*	3.64*	NS	6.45*

Values are mean ± SE of three independent determinations

**Significant at 1% level NS: Non Significant

WF: Wheat Flour WCF: Water Chestnut Flour

Table-3.2 : Total soluble sugars, reducing sugars, non-reducing sugars and starch content of products (g/100g, on dry weight basis).

Products	Total Soluble Sugars	Reducing Sugars	Non-reducing sugars	Starch	In-vitro starch digestibility (mg maltose /100g)
Chapati					
Control W.F (100)	5.92±0.07	4.11±0.06	1.81 ±0.12	73.75±0.14	88.00±1.16
Type I (WF:WCF :: 80:20)	6.25±0.14	3.87±0.09	2.38±0.09	76.33±0.08	84.00±0.58
't' value	NS	NS	3.744*	15.50*	3.10*
Ladoo					
Control W.F (100)	7.65±0.06	7.43±0.07	0.22±0.07	69.03±0.49	84.00±0.29
Type III (WF:WCF :: 40:60)	8.25±0.03	5.93±0.07	2.32±0.07	62.50±0.14	83.80±3.10
't' value	9.30**	15.91**	22.27**	12.77**	NS

Values are mean ± SE of three independent determinations

**Significant at 1% level NS: Non Significant

WF: Wheat Flour WCF: Water Chestnut Flour

Table-3.3 : Antioxidant activity of products.

Products	Total Phenols (mg GAE/100g)	Total Flavonoids (mg RE/100g)	Antioxidant activity DPPH (mg TE/100g)
Chapati			
Control W.F (100)	4.93±0.03	1.83±0.04	2.05±0.03
Type I (WF:WCF :: 80:20)	5.99±0.05	2.03±0.04	2.08±0.02
't' value	18.12**	3.64*	NS
Ladoo			
Control W.F (100)	4.01±0.29	0.68±0.04	2.05±0.03
Type III (WF:WCF ::40 : 60)	5.27±0.07	1.91±0.03	2.66±0.02
't' value	4.17*	27.06**	17.14**

Values are mean ± SE of three independent determinations

**Significant at 1 % level

NS: Non Significant

WF: Wheat Flour

WCF: Water Chestnut Flour

DPPH : 2,2 Diphenyl-1-Picrylhydrazyl

GAE : Gallic Acid Equivalent

RE : Rutin Equivalent

TE : Trolox Equivalent

(7.71) and type III (7.9) fell in the category of "liked very much" while type IV laddoo (7.3) fell in the category of "liked moderately" as judged by the judges.

On the basis of sensory evaluation, the most acceptable products were evaluated nutritionally. The chapati prepared with 20 % water chestnut flour and the laddoo with 60 % water chestnut flour were most acceptable. These products were evaluated for nutrient composition like proximate composition, total carbohydrates, total sugars, reducing sugars,

non-reducing sugars, starch, in-vitro starch digestibility, total minerals and antioxidant activity.

Proximate composition : The data on proximate composition of most acceptable products are given in the table-3.1.

Among the four types of composite flours, chapati developed with 20% water chestnut (type I flour) to wheat flour was found most acceptable which was nutritionally analyzed. The findings of study revealed that chapati prepared with wheat flour (control) and type I chapati

(supplemented) had almost similar amount of moisture and crude fibre with non-significant difference. Crude protein and fat content were significantly higher in control chapati (10.9 and 4.1 g/100g, respectively) whereas ash and total carbohydrate content were significantly higher in supplemented chapati (2.13 and 51.14 g/100g, respectively). Digamberao, 2013 observed higher content of total carbohydrates in control chapati (68.7 %) and that was found to be decreased with the addition of chickpea and soya bean flour.

It was found that laddoo prepared with type III composite flour was most acceptable. The nutritional analysis showed that moisture (0.11g/100g), crude protein (11.38 g/100g) and fat content (36.27 g/100g) of control laddoo were significantly higher than type III laddoo (0.01, 8.89 and 30.4 g/100g, respectively) whereas ash and total carbohydrates content were significantly higher in type III laddoo (1.06 and 53.37 g/100g, respectively) as compared to control laddoo (0.91 and 49.67 g/100g, respectively). A non-significant difference was observed in crude fibre content of control and supplemented laddoo.

Carbohydrate profile : Total soluble sugars, reducing sugars, non-reducing sugars, starch and *in-vitro* starch digestibility content of products are given in the Table 3.2.

The results of the study revealed that there was non-significant difference in total soluble sugar and reducing sugar content of type I and control chapati. Non-reducing sugars of type I chapati were significantly higher (2.38 g/100g) than that of control chapati (1.81 g/100g). The starch content of type I chapati (76.33 g/100g) was significantly higher than that of control chapati (73.75 g/100g). Control chapati had significantly higher *in-vitro* starch digestibility (88.0 mg maltose/g) as compared to type I chapati (84 mg maltose/100g).

Total soluble sugars and non-reducing sugars of type III laddoo (8.25 and 2.32 g/100g, respectively) were significantly higher than that of control laddoo (7.65 and 0.22 g/100g, respectively). On the other hand, control laddoo had significantly higher reducing sugars and starch content (7.43 and 69.03, respectively) as compared to type III laddoo (5.93 and 62.5 g/100g, respectively). A non-significant difference was observed for *in vitro* starch digestibility of control laddoo (84.0 mg maltose/100g) and type I laddoo (83.8 mg maltose/100g).

Antioxidant activity : The data obtained on antioxidant activity of products are given in Table 3.3. The findings of the study revealed that total phenols and flavonoids were significantly higher in type I chapati (5.9 mg GAE/100g and 2.03 mg RE/100g, respectively) than control chapati (4.93 mg GAE/100g and 1.83 mg RE/100g, respectively). A non-significant difference was observed for antioxidant activity (DPPH) of both the types of chapati.

Conclusions

It can be concluded from the results of the study that water chestnut flour seems to be suitable in preparation of various products. Water chestnut flour could be incorporated up to 60% level in laddoo, and 20% level in chapatti. Further nutritional evaluation of products revealed that with the incorporation of water chestnut flour in wheat flour, the content of total sugars, starch, total carbohydrates, total phenols, total flavonoids and antioxidant activity (DPPH) were increased significantly whereas crude protein, crude fat and crude fibre content were found to be decreased significantly. The study has shown a potential use of water chestnut flour in preparation of Indian traditional products with enhanced level of nutrients.

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Studies on Some Soil Series of Bhiwapur, Maharashtra

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Abstract

Forty six soil samples from nine different soil series of Bhiwapur tahsil of Nagpur district of Maharashtra state were selected for randomly to study the available macro as well as micronutrient status of the soil. The physico-chemical properties like pH, electrical conductivity (EC), organic carbon (OC) and free CaCO_3 content of the soils varied from 7.1 to 8.2, 0.10 to 0.36 dS m^{-1} , 3.45 to 7.75 g kg^{-1} and 1.58 to 10.75 per cent with the mean value of 7.65, 0.19 dS m^{-1} , 5.75 g kg^{-1} and 4.91 per cent, respectively. Most of the soils were found low in nitrogen (N) and phosphorus (P) and high in potassium (K). Available N status of these soils was in the range of 132 to 278 kg ha^{-1} (mean value of 198 kg ha^{-1}), available P varied from 5.14 to 24.56 $\text{kg P}_2\text{O}_5 \text{ ha}^{-1}$ (mean value of 12.56 $\text{kg P}_2\text{O}_5 \text{ ha}^{-1}$) and 94% of the soil samples showed high in available K content. The available S content was in the range of 5.23 to 23.15 kg ha^{-1} (mean value of 11.15 kg ha^{-1}). The soils were sufficient in available Mn and Cu, whereas, deficient in Fe and Zn. Soil DTPA-extractable micronutrients, Zn, Cu, Mn and Fe ranged from 0.29 to 1.44, 1.11 to 3.26, 6.62 to 17.44 and 4.10 to 10.17 mg kg^{-1} (mean value of 0.52, 1.89, 11.25 and 5.76 mg kg^{-1}), respectively. Soil pH of the surface layer had a significant and negative correlation with available S and Cu ($r = -0.395^{**}$ and -0.289^{**}). Soil OC showed a significant positive relationship with available N, Mn and Cu ($r = 0.539^{**}$, 0.398^{**} and 0.562^{**}). The free CaCO_3 was significantly and negatively correlated with available N, S, Fe, Mn and Zn ($r = -0.437^{**}$, 0.314^{**} , -0.372^{**} , -0.437^{**} and -0.268^{**}), respectively. The investigation provides preliminary information on fertility status of different soil series of Nagpur district (Maharashtra), which shall help in the formulation of nutrient management schedule in future for the better productivity of different crops.

Key words : *Macronutrient, micronutrient, correlation*

Introduction

The capacity of soil to produce successful crop depends upon the available nutrient status as well as physico-chemical characteristics of soil, which include texture, pH, soluble salts, organic matter and active calcium carbonate (Agrawal and Mehta, 1963). All these properties are quite important in deciding the management practices for obtaining yield and maintaining the proper soil health. It is therefore vital to have knowledge of the above soil properties so as to workout the type and quantity of any fertilizer, manure and amendment needed to improve the productivity of soil.

Fertilizer being the costlier input, the scientific approach towards profitable agriculture would imply the use of plant nutrients according to the actual needs of the soil crop situations, which can best be judged through soil testing. Soil characterization in relation to evaluation of fertility status of an area or region is an important aspect in respect to sustainable agriculture production.

The study on status of major and micro nutrients of swell-shrink soils of Maharashtra showed that, the soils were low in available nitrogen, very low to moderate in phosphorus and moderate to very high in potassium. In available micronutrient status, except Zn, all other micronutrients were well supplied (Patil *et al.*, 1994). For

proper recommendation of fertilizer application in different crops, knowledge of fertility status is essential. Since, no information is available on the nutrient status of different soil series of Bhiwapur tahsil of Nagpur District, the present work was conducted.

Materials and Methods

The present investigation was undertaken on nine soil series of Bhiwapur tahsil of Nagpur district (Maharashtra). The study area distributed in 137 villages located at 1254 m mean sea level with an average annual rainfall 1377mm. Forty six soil samples from nine soil series of Nagpur district were selected for random soil sampling to study the available macro as well as micronutrient status (fig.-1). The area was surveyed and five to six samples collected from each soil series, air dried, ground with wooden mortar and pestle and passed through 2mm stainless steel sieve. These samples were analyzed for pH, electrical conductivity (EC), organic carbon (OC) and free calcium carbonate by standard methods (Jackson, 1973). Available N was determined by alkaline KMnO_4 method (Subbaih and Asija, 1956), available P by extraction of soil with 0.5 M NaHCO_3 at pH 8.5 (Olsen *et al.*, 1954), K by using 1N neutral ammonium acetate solution (Jackson, 1973) and available S by turbidimetric method (Chesnin and Yien, 1951). These soil samples

Table-1 : Physico-chemical properties of different soil series of Bhiwapur tehsil.

Soil series association	No. of village covered	No. of sample collected	pH	EC (dS m ⁻¹)	OC (g kg ⁻¹)	Free CaCO ₃ (%)
Linga-Panara	6	6	7.4-7.8 (7.61)	0.12-0.26 (0.17)	3.45-5.85 (5.10)	1.58-4.57 (3.51)
Linga-Karla	5	5	7.7-8.0 (7.86)	0.15-0.23 (0.18)	5.30-7.53 (5.83)	3.25-6.75 (4.57)
Aroli-Linga	6	6	7.3-7.9 (7.7)	0.15-0.34 (0.20)	4.80-7.05 (5.92)	2.36-5.75 (4.37)
Yenwa-Muserkhapa-Pardi	6	6	7.1-8.1 (7.6)	0.10-0.27 (0.16)	4.95-7.75 (6.37)	1.98-8.75 (5.08)
Karla-Muserkahapa	4	4	7.3-7.7 (7.55)	0.17-0.36 (0.18)	5.10-7.36 (6.46)	2.57-5.75 (3.92)
Muserkhapa-Pardi	5	5	7.1-8.2 (7.76)	0.10-0.36 (0.23)	4.35-6.73 (5.45)	3.67-10.75 (5.83)
Borgaon-Ronghha	5	5	7.5-8.0 (7.8)	0.16-0.22 (0.20)	4.50-6.23 (5.01)	4.87-10.25 (6.72)
Rongha-Magarli	4	4	7.5-7.8 (7.62)	0.15-0.32 (0.21)	4.80-7.20 (5.78)	3.25-9.27 (5.61)
Wadhona-Aroli	5	5	7.1-7.7 (7.38)	0.10-0.32 (0.20)	3.90-6.73 (5.31)	2.59-9.38 (4.64)

Table-2 : Macro and micronutrient status of different soil series of Bhiwapur tehsil.

Soil series association	No. of village covered	No. of sample collected	Macronutrients (kg ha ⁻¹)					Micronutrients (mg kg ⁻¹)		
			N	P	K	S	Fe	Mn	Zn	Cu
Linga-Panara	6	6	163-241 (196)	9.5-17.6 (12.5)	281-376 (321)	6.33-16.98 (13.26)	5.98-10.17 (7.71)	7.75-14.11 (10.45)	0.50-0.90 (0.68)	1.18-2.12 (1.60)
Linga-Karla	5	5	159-275 (205)	7.1-15.2 (11.5)	258-336 (306)	5.23-22.05 (10.74)	4.78-8.71 (6.10)	7.51-13.42 (10.76)	0.39-0.59 (0.48)	1.13-2.97 (2.16)
Aroli-Linga	6	6	169-219 (202)	11.1-21.2 (16.7)	255-371 (305)	8.23-17.88 (11.81)	4.58-8.70 (5.69)	7.33-17.44 (12.52)	0.39-1.03 (0.65)	1.20-2.52 (1.84)
Yenwa-Muserkhapa-Pardi	6	6	183-278 (222)	12.5-24.5 (19.1)	259-425 (331)	6.23-21.45 (14.39)	4.10-8.86 (6.16)	6.67-15.62 (10.04)	0.38-1.44 (0.69)	1.75-3.26 (2.66)
Karla-Muserkahapa	4	4	163-198 (179)	6.5-12.5 (9.2)	280-379 (328)	8.87-15.45 (12.13)	4.98-7.32 (5.62)	8.44-14.42 (11.29)	0.40-1.30 (0.64)	1.50-2.29 (1.85)
Muserkhapa-Pardi	5	5	166-274 (225)	10.2-23.4 (17.7)	294-446 (342)	6.25-23.15 (15.12)	4.33-5.82 (4.91)	8.58-16.94 (12.81)	0.33-0.75 (0.48)	1.29-2.19 (1.88)
Borgaon-Ronghha	5	5	172-216 (194)	6.3-11.5 (8.6)	256-366 (318)	9.66-13.57 (11.70)	4.10-7.48 (5.38)	7.12-17.12 (12.50)	0.29-0.71 (0.40)	1.36-3.01 (2.20)
Rongha-Magarli	4	4	144-218 (189)	6.1-11.8 (8.9)	313-400 (347)	6.98-12.83 (8.48)	4.33-5.12 (4.73)	7.0-14.56 (10.81)	0.33-0.50 (0.40)	1.29-2.17 (1.88)
Wadhona-Aroli	5	5	132-214 (168)	5.1-12.8 (8.4)	256-373 (310)	8.89-19.23 (13.3)	4.19-7.48 (5.73)	6.62-15.96 (10.27)	0.40-0.66 (0.46)	1.11-2.21 (1.54)

were also extracted with solution consisting of 0.005M DTPA, 0.01M CaCl₂ and 0.1M triethanolamine (pH 7.3) as per the procedure described by Lindsay and Norvell (1978) for available micronutrient cations. The Zn, Cu, Fe and Mn content in extract were estimated using atomic absorption spectrophotometer model Z 2300.

Results and Discussion

Physico-chemical characteristics of soils : The physico-chemical characteristics of soils of nine soil series under study are presented in table 1. The soil pH ranged from 7.1 to 8.2 with the mean value of 7.65 which shows that majority of the soils are slightly to moderately alkaline in reaction. The EC of these soils varied from 0.10 to 0.36 dS m⁻¹ with a mean value of 0.19 dS m⁻¹. These values were within the safe limit for the crop growth. The soil OC

values ranged from 3.45 to 7.75 g kg⁻¹ with the mean value of 5.75 g kg⁻¹ indicating that the soils were low to moderately high in organic carbon content. The magnitude of free CaCO₃ content in soil ranges from 1.58 to 10.75 % showed that these soils were slightly calcareous to calcareous in nature. Similar observations have been reported by Jhibhkate *et al.*, 2009, while studying soils of Katol tahsil of Nagpur district.

Nutrient Status of Soils

Macronutrient status : The macronutrient status of the nine soil series of Nagpur district is presented in table-2. The available N content varied in the soils under study from 132 to 278 kg ha⁻¹ with the mean value of 198 kg ha⁻¹ indicating that all soils are found to be deficient in respect of available N content. The soil thus needs judicious

Table-3 : Correlation between soil properties and macro and micronutrients.

Soil properties	Macronutrients			Micronutrients				
	N	P	K	S	Fe	Mn	Zn	Cu
pH	—	—	—	-0.395**	—	-0.289**	—	—
EC	—	—	—	—	—	—	—	—
OC	0.539**	—	—	—	—	0.562**	0.398**	—
CaCO ₃	-0.437**	—	—	-0.314**	-0.268**	—	-0.437**	-0.372**

application of both organic manure and N fertilizer to meet the N requirement of crop in them. Available N showed significant positive relationship with soil OC ($r=0.539^{**}$) indicating an increase of available N to the crop with an increase in organic matter in the soil (Table 3). However, significantly negative correlation was obtained with free CaCO₃ ($r=-0.437^{**}$). Similar results were recorded by Meena *et al.* (2006) and Dhale *et al.* (2009).

The Present study revealed that the available P content is low to moderately high ranging between 5.14 to 24.56 kg ha⁻¹. These results were well within the range described by Dhale *et al.* (2009).

Available K content of the studied soils was high to very high (255-446 kg ha⁻¹ with a mean value of 323 kg ha⁻¹). The high potassium content may be attributed to presence of potassium supplying minerals in parent rocks of the area. The available P and K does not show any relationship with soil chemical properties. Similar report was also reported by Kashikar (1983) in black soil.

Available S content in the soil is low ranging from 5.23 to 23.15 kg ha⁻¹ with the mean value of 11.15 kg ha⁻¹. The most common cause of sulphur deficiency in these soils may be due to use of S free fertilizer like Urea and DAP. Available S found negatively correlated with pH ($r=-0.395^{**}$) and free CaCO₃ ($r=-0.314^{**}$). Similar values and relation was recorded by Sharma *et al.* (2008).

Micronutrient status : The DTPA-extractable Zn present in the soil ranged from 0.29 to 1.44 mg kg⁻¹ with an average value of 0.52 mg kg⁻¹. Considering the critical limit of 0.5 mg kg⁻¹ Zn (Gajbhiye *et al.*, 1993), the soils under study was categorized as low to marginal in available Zn status. The available Zn in soil has been found negatively correlated with free CaCO₃ ($r=-0.268^{**}$). These results are in agreement with Gajbhiye *et al.* (1993) and Jibhkate *et al.* (2009).

No deficiency was observed in DTPA-extractable Cu, as it ranged from 1.11 to 3.26 mg kg⁻¹ with the mean value of 1.89 mg kg⁻¹. Negative and significant relation between Cu and soil pH was observed ($r=-0.289^{**}$). A decline in pH of the soil leads to significant increase in Cu availability. Similar correlation coefficient were also worked out by Bhandari and Randhawa (1985). The data also indicated that Cu was positively and significantly

correlated with soil OC ($r=0.562^{**}$). Similar results were reported by Khalifa *et al.* (1996).

The DTPA-extractable Mn was sufficient in the studied soils, as it varied from 6.62 to 17.44 mg kg⁻¹ with the mean value of 11.25 mg kg⁻¹. Similar results were recorded by Chinchmalapure *et al.* (2000) while studying micronutrient status of soils from micro watershed of Wunna catchment near Nagpur. Manganese had significantly positive correlation with soil OC ($r=0.398^{**}$) and this might be due to the fact that organic matter may supply chelating agent. A significant negative correlation was observed between Mn and free CaCO₃ ($r=-0.437^{**}$). These relations were in conformity with the results of Yadav *et al.* (2009).

Considering the critical limit of < 0.5 mg kg⁻¹ Fe, twenty percent soil samples was observed deficit in DTPA-extractable Fe which varied from 4.10 to 10.70 mg kg⁻¹ (mean 5.76 mg kg⁻¹). Similar results were recorded by Jibhkate *et al.* (2009). The DTPA-extractable Fe bears negative and significant relationship with free CaCO₃ ($r=-0.372^{**}$). The negative relationship with CaCO₃ might be due to the fact that increase in CaCO₃ content favors the precipitation of Fe²⁺ to Fe³⁺ ions into insoluble hydroxides or transformation of available Fe into carbonates by CaCO₃ present in the soil. Similar trend was reported by Patil *et al.* (1994) and Chinchmalapure *et al.* (2000).

Conclusions

The study concludes that the soils of different soil series Bhiwapur tahsil of Nagpur district were low in available nitrogen, phosphorus and sulphur, high to very high in available potassium. The available Mn and Cu are well supplied in these soils but observed some deficiency of available Fe and Zn. The present investigation gives information regarding the fertility status of soils from different soil series of Nagpur district which shall help in the formulation of integrated nutrient management schedule for the better productivity of crops and sustainability of soil fertility.

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A Study on Agricultural Information Access Using ICT Tools Among the Farmers of Raipur District of Chhattisgarh

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Abstract

The present study entitled, "A study on agricultural information access using ICT tools among the farmers of Raipur district of Chhattisgarh" was carried out in purposively selected Raipur District of Chhattisgarh state in the year 2018-19. The main purpose of the study was to understand and document the use of ICT tools among the farmers for accessing agricultural information. For the investigation, a total of 120 farmers from 10 villages of two blocks of Raipur District were considered as respondents. The data revealed that majority of the farmers (39.17%) in study area were needed information regarding insect and disease management followed by information regarding nutrient management (32.50%), information of market (31.67%) and availability of inputs (30.83%). Only 5.83 per cent of the farmers were using radio daily, whereas, TV was found to have used by 22.50 per cent of the farmers weekly. Mobile was the most popular ICT tools among the farmers, which was using daily by 30.00 per cent of the respondents in study area. The computer was least popular ICT tools among the farmers. Findings of the study revealed that 5.83 per cent of the farmers had regularly used radio for obtaining information on nutrient management followed by insect & disease (5.00%) and post-harvest practices (4.17%). It indicates that 25.00 per cent of the respondents were regular users of TV for obtaining information related to insect & disease. In the study area, 23.33 per cent of the respondents were regular users of mobile for obtaining agriculture related information on insect & disease, whereas, 17.50 per cent of the respondents were used mobile regularly for getting information on both nutrient management and information of market. Only 2.50 per cent of the respondents were regularly using computer for obtaining information on insect & disease. A very few of the respondents (1.67%) were using computer regularly for information on government schemes and nutrient management. Print media was another ICT tool, which was regularly used by 16.67 per cent of the respondents for obtaining agriculture related information on insect & disease. Majority of the respondents (50.83%) reported that information obtained by ICTs on insect and pest management was completely useful (Complete Utility), whereas, 14.17 and 12.50 per cent of the respondents said that information on agriculture equipment and nutrient management was completely useful (Complete Utility). It can be concluded from the study that mobile was the most popular ICT tool followed by TV and print media for accessing agricultural information among the farmers of study area.

Key words : ICT Tools, ICTs in agriculture, Information need, information access.

Introduction

Agriculture has been one of the most important sectors in India since ancient times. From the recent past agriculture has been transforming from mere subsistence farming to profit making business. Information needs of farmers are changing from need based to demand driven. Indian agriculture could benefit tremendously with the applications of ICTs especially in bringing changes to socio-economic conditions of the poor in backward areas. Information and communication technologies (ICTs) are a broad category of technological tools and resources that are used to communicate as well as create, transmit, store and manage information, which ordinarily refers to computer based technology and telecommunication. This technology includes the computer, internet and network, hardware and software, satellite systems, broadcasting technologies (radio and TV) and telephone (landlines and cellular). As well as the various services and applications associated with them such as web portals, emails, SMS,

video conferencing, DSS (Decision Support System), MIS (Management Information System), expert systems, etc., those are electric systems for receiving, processing, storing, retrieving and transmitting the information. In the context of globalization and liberalization of the economy, information communication technology assumes great significance for the country.

In the Indian context, ICTs are having an impact on changing development activities and strategies not only in urban areas but also in the rural sectors. It has been proved by many initiatives that ICTs have been fulfilling the information and communication needs of people for agriculture and rural development. Mobile, Internet, WhatsApp, TV users and newspaper, magazine, journal, bulletin readers are increasing day by day. ICTs help in the fast sharing of information and various innovation along with playing a key role in changing the farmers living status by sharing and increasing their knowledge. The scenario of ICTs is changing day by day through various experiments of innovative ICTs initiatives in

Table-1: Distribution of the respondents according to their frequency of use of ICT tools for agricultural information. (n=120)

ICT Tools	Frequency of use					
	Daily	Weekly	Fortnightly	Monthly	Seasonal	Never
Radio	7 (5.83)	5 (4.17)	3 (2.50)	2 (1.67)	6 (5.00)	97 (80.83)
TV	21 (17.50)	27 (22.50)	9 (7.50)	8 (6.67)	11 (9.17)	44 (36.67)
Mobile	36 (30.00)	25 (20.83)	6 (5.00)	4 (3.33)	14 (11.67)	35 (29.17)
Computer	1 (0.83)	2 (1.67)	1 (0.83)	1 (0.833)	2 (1.67)	113 (94.17)
Print Media	17 (14.17)	9 (7.50)	7 (5.83)	3 (2.50)	12 (10.00)	72 (60.00)

agriculture as well as rural development in Indian perspectives. ICTs can assist an extension worker in serving the information demands of farmers more effectively. ICTs are helping in broad basing not only the agricultural extension activities and development of farming system research but also information dissemination and interaction among the researchers, extension workers as well as farmers. It also helps the farmers in various agricultural practices, pest and disease control, weather forecasting, etc. ICT can provide end-users with quick, accurate and trustworthy information in a user-friendly format for practical usage. Farmers have been able to decide what and when to plan, how to cultivate, when and how to harvest, what postharvest management practices to follow, when and where to market the produce and so on, thanks to the information distributed by ICTs.

Chhattisgarh is an agrarian state where most of the population is earning its livelihood from agriculture. Its betterment is only dependent on timely and accurate information flow up to the farmers. There are some backward areas in Chhattisgarh where the farmers facing the unavailability of electricity and mobile networks so that they cannot use modern ICT tools like computers, mobiles and other devices. They cannot access the internet which is the main source of information and knowledge nowadays. But in the case of Chhattisgarh plains, farmers are having various ICT tools, which are using by them to collect agricultural information. Farmers of Chhattisgarh are using ICTs tools like Radio, TV, Mobile, Print media and WhatsApp for getting agricultural information. Farmers are also using smart phones for getting information regarding new agricultural technologies. In this way, the present study was an effort to document the agricultural information access using ICT tools among the farmers of Raipur district of Chhattisgarh.

Research Methodology

The current research was conducted in the Raipur district of Chhattisgarh during the academic year 2018-19. Out of 28 districts in Chhattisgarh, Raipur district was selected purposively. There are 4 block in Raipur district, out of which 2 blocks Arang and Abhanpur were purposively selected for the study, because in these blocks maximum use of ICT tools were reported in secondary data. From

each of the selected blocks, 5 representative villages were selected randomly among the maximum ICT tools using villages of the respective block. From each of the selected village, 12 farmers were selected randomly for collection of data under this study. In this way 120 (10 X 12 = 120) farmers were considered as respondent. Selection of farmers was assured by asking some preliminary questions regarding use of ICT tools using semi-structured interview schedule. Those farmers were considered as respondents who had been using at least one ICT tools. The main purpose of the study was to determine the farmers' agricultural information needs and how they use ICTs to meet those needs.

To determine the agriculture information need, the respondents were asked about their information need on 12 aspects related to agricultural practices. The frequency and percentage for each of the aspects were calculated and presented in the form of bar diagram. Frequency of use of ICT tools i.e., radio, TV, mobile, computer and print media for obtaining agricultural information was studied among the respondent on a five-point continuum scale viz., daily, weekly, monthly, seasonal and never with providing scores as 4, 3, 2, 1 and 0, respectively for each of the five ICT tools. The frequency and percentage of each of the categories were calculated. To determine the use of ICT tools i.e., radio, TV, mobile, computer and print media for obtaining agricultural information among the respondents, 12 aspects of agricultural practices were considered and responses were recorded in three-point continuum scale and scores were given as 0, 1 & 2 for never, seldom and regular, respectively. The frequency and percentage of each of the categories was calculated. Utility of agricultural information obtained by the respondents using ICT tools i.e., radio, TV, mobile, computer and print media were also recorded under this study. In this regard, 12 aspects of agricultural practices were considered and responses were recorded in four-point continuum scale and scores were given as 0, 1, 2 & 3 for nil, partial, medium and complete, respectively. The frequency and percentage of each of the categories was calculated.

Results and Discussion

Agricultural information need among the farmers :
Access to agricultural information is vital for improving

Table-2 : Distribution of the respondents according to agricultural information access by them using ICT tools (n=120).

Agricultural information	Information access through ICT tools														
	Radio			TV			Mobile			Computer			Print media		
	Regular (%)s	Seldom (%)	Never (%)	Regular (%)	Seldom (%)	Never (%)	Regular (%)	Seldom (%)	Never (%)	Regular (%)	Seldom (%)	Never (%)	Regular (%)	Seldom (%)	Never (%)
Field Preparation	1.67	2.50	95.83	3.33	12.50	84.17	1.67	5.00	93.33	0.83	1.67	97.50	2.50	3.33	94.17
Availability of inputs	3.33	4.17	92.50	5.83	9.17	85.00	9.17	27.50	63.33	00	2.50	97.50	3.33	4.17	92.50
Information on Irrigation	2.50	4.17	93.33	5.00	6.67	88.33	1.67	7.50	90.83	0.83	1.67	97.50	0.83	2.50	96.67
Nutrient Management	5.83	10.83	83.33	17.50	35.83	46.67	17.50	30.00	52.50	1.67	3.33	95.00	14.17	17.5	68.33
Agricultural equipment	0.83	2.50	96.67	11.67	21.67	66.67	5.83	20.83	73.33	0.83	1.67	97.50	4.17	15.83	80.00
Insect and Disease	5.00	13.33	81.67	25.00	36.67	38.33	23.33	40.83	35.83	2.50	3.33	94.17	16.67	22.50	60.83
Post-harvest practices	4.17	9.17	86.67	15.83	0.83	46.67	10.00	15.83	74.17	00	1.67	98.33	3.33	15.00	81.67
Information of Market	2.50	5.83	91.67	9.17	18.33	72.50	17.50	25.00	57.50	0.83	2.50	96.67	1.67	4.17	96.67
Weather Forecast	1.67	3.33	95.00	10.00	39.17	49.17	8.33	28.33	63.33	00	0.83	99.17	2.50	5.00	92.50
Government Scheme	2.50	4.17	93.33	4.17	15.00	80.83	3.33	7.50	89.17	1.67	2.50	95.83	3.33	4.17	92.50
Credit and Finance	0.83	3.33	95.84	2.50	9.17	88.33	1.67	5.00	93.33	00	0.83	99.17	1.67	2.50	95.83
Insurance	0.83	0.83	98.34	0.83	1.67	97.50	00	0.83	99.17	0.83	00	99.17	0.83	0.83	98.34

production and productivity at farmer's level. The present age has been rightly called as an Information Age. Information has become the most important element for progress in farming community. In agriculture environment, relevant and timely information helps farmer's community to take right decision to sustained growth of agriculture activity. Use of information in agriculture sector is enhancing farming productivity in a number of ways. Accessing information on weather forecast, best practice in farming and timely access to market information helps farmer to make correct decisions about what crops to plants and where to sell their product and buy inputs. This study determined the agricultural information need among the farmers. The results presented in Fig. 1 are based on multiple responses given by the farmers about agricultural information needs. The data given in Fig.1 revealed that majority of the farmers (39.17%) in study area were needed information regarding insect and disease management followed by information regarding nutrient management (32.50%), information of market (31.67%), availability of inputs (30.83%), agricultural equipment (30.00%), government schemes (25.00%), post-harvest practices (24.17%), credit and finance (22.50%), weather forecast (21.67%) and field preparation (20.00%). Only 17.50 per cent of the respondents were needed information regarding irrigation management.

Frequency of use of ICT tools for agricultural information : In present scenario, information and communication technology (ICT) has become relevant in the agricultural sector. The extension service requires ICT for effective information delivery. Agricultural information access among farmers depends on their capability and frequency of use of ICT tools. In this regard a study was conducted to examine the frequency of ICT tools usage among the farmers. The Data (Table 1) explains that only 5.83 per cent of the farmers were using radio daily, whereas, 5.00, 4.17, 2.50 and 1.67 per cent of the respondents were using radio seasonal, weekly, fortnightly and monthly, respectively. The TV was found to have used by 22.50 per cent of the farmers weekly followed by TV was used daily, fortnightly, seasonal and monthly by 17.50, 7.50, 9.17, and 6.67 per cent of the respondents, respectively. Mobile was the most popular ICT tools among the farmers, which was using daily by 30.00 per cent of the respondents in study area. While, 20.83, 11.67, 5.00 and 3.33 per cent farmers of study area were using mobile weekly, seasonal, fortnightly and monthly, respectively. The computer was least popular ICT tools among the farmers, it was used by only 1.67 per cent of the respondents daily followed by both 1.67 and all 0.83 per cent of the respondents were using computer in both weekly, seasonal and all daily, fortnightly, monthly

Table-3: Distribution of the respondents according to utility of agricultural information obtained by them using ICTs. (n=120)

Particulars	Utility of information			
	Complete (%)	Medium (%)	Partial (%)	Nil (%)
Field preparation	2.50	7.50	21.67	68.33
Availability of inputs	11.67	16.67	40.83	30.83
Information on irrigation	5.00	5.83	22.50	66.67
Nutrient management	12.50	29.17	37.50	20.83
Agricultural equipment	14.17	11.67	33.33	40.83
Insect and disease management	50.83	15.83	14.17	19.17
Post-harvest practices	11.67	15.00	46.67	26.66
Information of market	10.00	23.33	55.00	11.67
Weather forecast	1.67	26.67	28.33	43.33
Government scheme	5.00	10.00	32.50	52.50
Credit and finance	4.16	5.00	19.17	71.67
Insurance	0.83	2.50	3.33	93.33

basis, respectively. As far as print media is concerned, 14.17 per cent of the respondents were found daily users followed by weekly (7.50%), seasonal (6.67%), fortnightly (5.83%) and monthly (2.50%) users. As per the above discussion, it can be concluded that frequency of use of mobile and TV was more as compare to other ICT tools for obtaining agricultural information among the farmers.

Agricultural information access using ICT tools : The importance and potential of ICTs in agriculture to increase the access and exchange of information among farmers is clear. Many studies in this regard have indicated its beneficial results. However, through improved communication, ICT are known to enhance or expand farmer networks. Mobile technology is seen as having a particularly positive impact in this area for fostering networks of farmers and improving agricultural information access among them. In this way, study conducted to determine the agricultural information access among the farmers. The data in the Table 2 reveals that majority of the respondents (5.83%) had regularly used radio for obtaining information on nutrient management followed by insect & disease (5.00%), post-harvest practices (4.17%), availability of inputs (3.33%), government scheme (2.50%), information of market (2.50%), availability of inputs (2.50%), field preparation (1.67%) and weather forecast (1.67%). While, 13.33 and 10.83 per cent of the respondents were seldom used radio for obtaining information related to insect & disease and nutrient management. In case of TV, it indicates (Table 2) that 25.00 per cent of the respondents were regularly used TV for obtaining information related to insect & disease, while, 17.50, 15.83 and 11.67 per cent of them were regularly used TV for obtaining agricultural information related to nutrient management, post-harvest practices and agricultural equipment, respectively. About 39, 37 and 36 per cent of the respondents were using TV seldom for information on weather forecast, insect & disease and nutrient management, respectively.

Mobile was the most popular ICT tool for obtaining agricultural information among the respondents. Table 4.16 elucidates that 23.33 per cent of the respondents were regular users of mobile for obtaining agriculture related information on insect & disease, whereas, 17.50 per cent of the respondents were used mobile regularly for getting information on both nutrient management and information of market. While, 40.83, 30.00 and 27.50 per cent of the respondents were using mobile seldom for information on insect & disease, nutrient management and availability of inputs, respectively. Computer was less popular ICT tool (Table 2) among the respondents. It can be observed from the Table 4.16 that only 2.50 per cent of the respondents were regularly using computer for obtaining information on insect & disease. A very few of the respondents (1.67%) were using computer regularly for information on government schemes and nutrient management. Print media was the another ICT tool (Table 2) among the respondents, which was regularly used by 16.67 per cent of the respondents for obtaining agriculture related information oAgricultural information insect & disease, while, 14.17 and 4.17 per cent of the respondents were using print media regularly for obtaining information on nutrient management and agricultural equipment, respectively.

Utility of agricultural information obtained by respondents using ICTs : The introduction of new and advanced technologies has allowed the agriculture sector to transform the way producers cultivate, harvest and sale their produces. The use of ICT in agriculture has accelerated agricultural and rural development by adopting innovative ways to improve the existing information and communication processes. It has particularly revolutionized smallholder agriculture and helped to address several challenges associated with the traditional form of agriculture. The main purpose of ICT is that accurate information should reach the farmers at the

right time to make more sustainable use of on-farm resources. But it is not necessary that the information obtained using ICTs are useful for all the farmers. The study assessed the utility of agricultural information obtained by respondents using ICTs and presented in Table 3. Utility of agricultural information obtained by the respondents was assessed by using the 12 particulars aspects of agricultural information. The respective data is analysed and presented in Table 3. Majority of the respondents (50.83%) reported that information obtained by ICTs on insect and pest management was completely useful (Complete Utility), whereas, 14.17 and 12.50 per cent of the respondents said that information on agriculture equipment and nutrient management was completely useful (Complete Utility). While, utility of information on nutrient management, weather forecast and information of market was medium for 29.17, 26.67 and 23.33 per cent of the respondents, respectively. Partial utility belonged for information on information of market, post-harvest practices, availability of inputs and nutrient management among 55.00, 46.67, 40.83 and 37.50 per cent of the respondents, respectively. It can be concluded from above discussion that information obtained by ICTs on insect and pest management, nutrient management, post-harvest practices and availability of inputs were more useful among the farmers.

Conclusions

Information has become the most important element for progress in farming community. In agriculture environment, relevant and timely information helps farmers' community to take right decision to sustained growth of agriculture activity. Use of information in agriculture sector is enhancing farming productivity in a number of ways. Accessing information on weather forecast, best practice in farming, and timely access to market information helps farmer to make correct decisions about what crops to plants and where to sell their product and buy inputs. It was found in the study that farmers of study area were using ICT tools viz. Radio, TV, Mobile, Computer and Print media for obtaining agricultural information. Farmers in study area fully agreed that the use of ICTs in agriculture has increased in the present scenario and ICTs are acting as a bridge to connect farmers from the entire country. Majority of the farmers in study area were needed information regarding insect and disease management, information regarding nutrient management, information of market, availability of inputs and information regarding agricultural. It can be concluded from above discussion that mobile was the most popular ICT tool followed by TV and print for accessing agricultural information among the farmers of study area. Frequency of use of mobile and TV was more

as compare to other ICT tools for obtaining agricultural information among the farmers. It was observed that information obtained by ICTs on insect and pest management, nutrient management, post-harvest practices and availability of inputs were more useful among the farmers.

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Perceived Constraints and Suggestions for Effective Functioning of Krishi Vigyan Kendra Gwalior District of Madhya Pradesh

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Abstract

The present study was conducted with one Krishi vigyan Kendra Gwalior district of Madhya Pradesh. The year of establishment, locations, accessibility and kind of host institution were the criteria for the selection. 209 trained farmers and 38 in service trainees was selected for sample. The result of the study concluded that lack time to participate, more theory part then practical, delivery of more knowledge less time period, less helpful in entrepreneurship development, perceived as major constraints faced by trainees. The suggestions provide by the trainees are useful and could be effective in improving the functioning of KVKs.

Key words : *trainees, Krishi Vigyan Kendra, constraints, suggestions, entrepreneurship development.*

Introduction

Establishment of krishi vigyan Kendra is a landmark in the transfer of agricultural technology in India. It is an innovative institution providing for effective linkage between research and farmers on one hand and between research and extension on the other. There are several KVKs functioning all over contry. This institution sponsored by ICAR research institute state agriculture universities and reputed voluntary organizations. Majority of these KVK are run by SAUs followed by NGO and ICAR institutions. The situation was very critical to look out the problem faced by trainees

Based on this aspect, the present study was planned with a specific objectives to identify different set of constraints faced by Krishi Vigyan Kendra and seek suggestions for effective functioning of Gwalior district of Madhya Pradesh.

Materials and Methods

The present study was conducted in Krishi Vigyan Kendra Gwalior with 209 trained farmers 38 in service respondents. Descriptive Research Design has been applied. Descriptive research aims to accurately and systematically describe a population, situation or phenomenon A Stratified random sampling method was used to select the sample from an exhaustive list of trainees (Farmers, Farm Women, Rural Youth and Extension Workers) participated in training programmes conducted by KVK Gwalior during past three years

The constraints was carried out through questionnaire by respondents to indicate various constraints which they faced during the training programme. The sample of the respondents for the study

comprised of two type sample 1- trained farmers, Sample II- In service trainingselected from KVKs. Altogether 209 trained farmers in sample I and 38 in service trainees were selected from KVK Gwalior chosen for the study. The collected responses were converted into an index by using proper statistical methods.

Result of the study : The findings of the study was presented Variety of constraints stated by both type of respondents (farmer and extension worker) is classified in to five groups and given in Table-1. Section A describes constraints related with subject matter of the training programmes where nearly six out of ten (59.11%) respondents complains about coverage of more theory than practical part as a regular problem while 28.74 per cent of them felt it occasionally. Delivery of more knowledge in less time period is another major constraints always experienced by 55.06 per cent respondents whereas 41.30 per cent respondents always felt a problem of post training guidance. Other contents related constraints occasionally experienced by the respondents are difficult to understand English and technical words/language of the subject used by the trainers (37.25 and 34.41%, respectively).

In demonstration related constraints, majority of the respondents (56.68%) always perceived training contents as less helpful in entrepreneurship development followed by 53.44 per cent respondents who considered cost of input/material recommended by KVK in unaffordable while 17.0 per cent of them found lack of confidence in trainers during the training as a constraint. More than one third of the respondents (34.82 %) sometimes felt difficulty in demonstrations due to large group of the trainees.

Table-1 : List of the constraints perceived by trainees through training programme.

S. No.	Constraints	Always	Some times	Never
A.	Subject Matter of Training			
1.	More theory than practical part	146(59.11)	71(28.74)	30(12.15)
2.	Lack of clarity in subject matter	80(32.39)	132(53.44)	35(14.17)
3.	Technical language of subject	50(20.24)	85(34.41)	112(45.34)
4.	Difficult to understand English/Technical language used by trainer	35(14.17)	92(37.25)	120(48.58)
5.	Non relevance of training to work area	51(20.65)	83(33.60)	113(45.75)
6.	Delivery of more knowledge in less time period	136(55.06)	80(32.39)	31(12.55)
7.	Lack of proper guidance after training	102(41.30)	75(30.36)	70(28.34)
B.	Demonstration Related			
1.	Lack of confidence in trainers during training	42(17.00)	73(29.55)	132(53.44)
2.	Difficulty due to large group of trainees	25(10.12)	86(34.82)	136(55.06)
3.	Less helpful in entrepreneurship development	140(56.68)	60(24.29)	47(19.03)
4.	Lack of skills in trainers to transfer his knowledge to the trainees	34(13.77)	68(27.53)	145(58.70)
5.	High cost of input/material recommended by KVK	132(53.44)	60(24.29)	55(22.27)
C.	Personal and Social			
1.	Lack of time to participate	158(63.97)	50(20.24)	39(15.79)
2.	Resistance from family members	123(49.80)	78(31.58)	46(18.62)
3.	Burden of work	128(51.82)	78(31.58)	41(16.60)
4.	Lack of capital to start suggested work	110(44.53)	70(28.34)	67(27.13)
D.	Transportation and other problems			
1.	Problem to reach the KVK	36(14.57)	58(23.48)	155(62.75)
2.	No transportation charges for attending the training	38(15.38)	72(29.15)	137(55.47)
E.	Physical Facility			
1.	Uncomfortable training room	39(15.79)	82(33.20)	126(51.01)
2.	Delay in start of training	35(14.17)	90(36.44)	117(47.37)

Personal and social constraints as always experienced by a large number of respondents in success of the training are; lack of time to participate (63.97%), burden of work (51.82%), resistance from family members (49.80%) and Lack of capital to start suggested work (44.53%).

The problem related to transport facility, problem in reaching KVK and physical facilities at the centre are other major constraints stated by a sizeable number of respondents (see table-1).

Suggestions by trainees provided by trainers and trainees to overcome the perceived constraints :

The information on the suggestions of trainees for effective functioning of KVKs was collected through questionnaire. The trainers suggested a number of measure through which, in their opinion, the effectiveness of training programmes of KVK could be improved. The suggestion are suggested by KVK trainees give below-

a. Suggetions given by farmers :

1. Practical demonstration of the new technology is more important than lectures, hence need to be improved and increased.

2. Training should be focused on various steps of entrepreneurship development and detail information

about each element must be given including capital arrangement and marketing alternatives where we can sell our products.

3. Duration of training programmes should be increased because lots of knowledge given by trainers in less time period is hardly useful.

4. Only recent and improved technologies should be given to the farmers to increase their income avenues.

5. Visit of successful farmers/entrepreneurs need to be arranged to expose the trainees with real functioning and actual learning by seeing.

6. Only interested participants to be invited for training programmes.

7. Size of training group to be restricted up to 20-25 only.

b. Suggestions given by extension workers

1. Location specific training should be organised.

2. More practical part should be incorporated in training courses.

3. Proper feedback should be taken during the training programmes to assess the knowledge level of extension workers.

4. Field visit is more important than lecture to improve effectiveness of training.

5. Old way of the training should be changed and adopt some new methodologies for creating more interest and improving retention of knowledge among trainees.

6. Specialist of new technology need to be invited to demonstrate properly.

7. Duration of the training should be increased.

Conclusion

Based on the findings of the study, it can be concluded that the trainer and trainees of Krishi vigyan Kendra perceived various constraints which need to be sorted out at the enlist, so the functioning of KVKs could be improve. The important perceived constraints were lack of time to participate and more theory then practical. The suggestions provide by trainees are useful and could be used to improve the functioning of KVK. The findings of the study are beneficial for programme coordinator and policy planners of KVK developing training training policies and action plan to perform their activities smoothly.

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Co-Integration of Castor Markets in India—An Econometric Analysis

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Abstract

The present study was undertaken to analyze castor seed market integration in six major regional markets located in Gujarat (Mehsana and Patan), Rajasthan (Jodhpur and Pali) and Karnataka (Haveri and Chitradurga) states of India, using monthly wholesale prices of castor seed during 2005 to 2020. Augmented Dickey-Fuller Unit root test indicated that the price series in each location are non-stationary at their levels, and stationary at their first differences. Co-integration results showed that the regional markets have price linkages and thus are spatially integrated. Johansen's multiple co-integration tests reveals that that their existence of five co-integration equations for selected castor seed markets based on likelihood-ratio test. Granger causality test explain that, Patan market prices of Gujarat will have influence on Rajasthan and Karnataka castor seed commodity markets price, Its clearly manifest to be independent market for castor seed prices among the selected markets in India and also the bidirectional relationships exist in Gujarat and Rajasthan domestic markets evidencing the interstate price influence of proximities, which indicated the price transmission happening in long run adjustments and the presence of short run equilibrium existed among the castor seed markets in India. Vector error correction estimates indicates that, extent of castor seed markets integration for different lags in the current study.

Key words : Unit root test (ADF), Johansen's multiple co-integrations, Granger causality, Independent market, Price transmission, Vector error correction.

Introduction

Castor (*Ricinus communis* L.) belonging to Euphorbiaceae family is an important non-edible industrial oilseed crop. The potential for castor oil to play a much larger role in the world economy had increased dramatically because of its multifarious applications in production of wide industrial products ranging from medicines to aviation fuels, fuel additives, biopolymers and biodiesel. Global demand for castor oil is rising constantly at 3–5% per annum. India is the largest producer of castor in the world and secured a virtual monopoly in castor production with 18.42 lakh tones production from 10.46 lakh ha area with 1810 kg/ha productivity. Mozambique, China and Brazil are the other major

world's single largest producer of castor seed accounting more than 85 per cent followed by China with about 7 per cent and Brazil with about 5 per cent of the world castor output. There has been a consistent increase in output primarily on account of rise in levels in India. Castor is drought tolerant and grows well in a wide rainfall and climatic conditions. It requires moderately high temperature with low humidity throughout the growing season to produce maximum yields. The castor duration varies between 145 and 250 days depending upon variety.

Castor seed contains 40 to 60 per cent oil, which is rich in triglycerides called ricinolein, castor oil is used as a lubricant in high speed engines and airplanes. Hydrogenated castor oil used in polishes, ointments, waxes, printing inks, cosmetic, hair dressings, soaps and for treatments of disinfections. It is also used for medicinal and lighting purpose; castor oil is used in veterinary uses also. Among the various castor growing states, Gujarat occupies the first place contributing for 80 per cent total production although acreage accounts for less than 50 per cent of total area cultivated in country. Andhra Pradesh used to be second largest producer until 2005-06, but Rajasthan outpaced Andhra Pradesh with significant rise in its castor output and occupied the second place. In addition other minor producer includes Karnataka, Tamil Nadu, Maharashtra and Orissa.

When prices in different locations or for related

There are varied opinions about the site of origin of castor. The Ethiopian-East African region is considered to be the most probable site of origin (Moshkin, 1986). India is also one of the centres of origin as tremendous natural diversity in castor is widespread in the country. Semi-wild and wild perennial castor forms are found growing in diverse habitats like forests, sea coast, river beds, open-cast coal mines, hill tops, mountain-valleys, roadsides, field bunds, railway tracks, garbage dumps, wastelands, backyards and many other areas across the country. In India, it's usually cultivated as a kharif crop in Gujarat and Rajasthan states, where as a rabi crop in Orissa, Madhya Pradesh and Uttar Pradesh. India is

Table-1 : ADF Unit root test for castor in selected markets of India.

Variable	Level	P-value	First difference	P-value
Haveri	-3.3119	0.0158	-20.8722**	0.0000
Chitradurga	-1.6977	0.4307	-12.08669**	0.0000
Patan	-2.0618	0.2605	-14.9211**	0.0000
Mehsana	-2.2120	0.2028	-15.4829**	0.0000
Jodhpur	-1.8790	0.3416	-12.0383**	0.0000
Pali	-1.9049	0.3295	-16.1095**	0.0000

Note : **Significant at 1 per cent level.

Table-2 : Pairwise granger causality test for castor markets in India.

Null hypothesis	F-statistic	P-value
HAVERI does not Granger Cause CHITRADURGH	2.55173	0.0809
CHITRADURGH does not Granger Cause HAVERI	2.99602	0.0526
JODHPUR does not Granger Cause CHITRADURGH	20.9589**	0.0000
CHITRADURGH does not Granger Cause JODHPUR	1.78812	0.1704
MAHESANA does not Granger Cause CHITRADURGH	17.5057**	0.0000
CHITRADURGH does not Granger Cause MAHESANA	0.95004	0.3887
PALI does not Granger Cause CHITRADURGH	18.4428**	0.0000
CHITRADURGH does not Granger Cause PALI	0.29613	0.7441
PATAN does not Granger Cause CHITRADURGH	16.3572**	0.0000
CHITRADURGH does not Granger Cause PATAN	1.80543	0.1675
JODHPUR does not Granger Cause HAVERI	19.9243**	0.0000
HAVERI does not Granger Cause JODHPUR	0.65419	0.5211
MAHESANA does not Granger Cause HAVERI	17.4362**	0.0000
HAVERI does not Granger Cause MAHESANA	0.81756	0.4432
PALI does not Granger Cause HAVERI	19.7659**	0.0000
HAVERI does not Granger Cause PALI	0.26502	0.7675
PATAN does not Granger Cause HAVERI	17.4362**	0.0000
HAVERI does not Granger Cause PATAN	0.81756	0.4432
MAHESANA does not Granger Cause JODHPUR	13.2658**	0.0000
JODHPUR does not Granger Cause MAHESANA	7.54839**	0.0007
PALI does not Granger Cause JODHPUR	12.7392**	0.0000
JODHPUR does not Granger Cause PALI	0.28587	0.7517
PATAN does not Granger Cause JODHPUR	45.4764**	0.0000
JODHPUR does not Granger Cause PATAN	2.74694	0.0669
PALI does not Granger Cause MAHESANA	14.5268	0.0000
MAHESANA does not Granger Cause PALI	6.43461*	0.0020
PATAN does not Granger Cause MAHESANA	52.8433**	0.0000
MAHESANA does not Granger Cause PATAN	2.21634	0.1121
PATAN does not Granger Cause PALI	37.9210**	0.0000
PALI does not Granger Cause PATAN	5.06563*	0.0073

Note: **Significant at 1 percent level; *Significant at 5 percent level

things follow similar patterns over time, this is known as market integration. Markets are said to be integrated when groups of goods move proportionally to each other. When this relationship is particularly apparent among diverse markets, the markets are said to be integrated. As a result, market integration is a statistic that illustrates how different markets are integrated with one another. Thus market integration is an indicator that explains how different markets are related to each other. Market integration shows the extent to which prices in different markets move together. Well integrated markets have very similar prices the difference being just the cost of transportation of the commodity from one market to another. If the markets are not integrated presents inaccurate picture about price information, which may

distort production decisions of the producers and contribute to inefficiencies in agricultural markets, harm the ultimate consumers and lead to low production and sluggish growth. Therefore, market integration plays a vital role in determining pattern and pace of diversification towards high value crops. Further, it becomes difficult to comprehend trade policy as several obstructions such as stocking limits, inefficient markets, weak supply chains and trade cartels often restrict the efficient functioning of the markets

Oilseed cultivation in India is undertaken mainly in high-risk areas with uncertain returns on investment. In the past, little attention was paid to managing production, marketing and price risks in oilseed cultivation. The

Table-3 : Johansen's multiple co-integration analysis for castor in selected markets unrestricted co integration rank test (Trace).

Trace statistics of Series Chitradurga, Haveri, Jodhpur, Mehsana, Pali and Patan				
No. of CE(s)	Eigen value	Statistic	Critical value	Probability
None	0.2221	159.25**	95.75	0.0000
At most 1	0.2057	115.28**	69.81	0.0000
At most 2	0.1591	74.98**	47.85	0.0000
At most 3	0.1165	44.64**	29.79	0.0005
At most 4	0.1072	22.96*	15.49	0.0031
At most 5	0.01799	3.16	3.84	0.0780

Note : Critical values based on MacKinnon (1999); LR test indicated 5 co-integrating equation **Significant at 1 per cent level, *Significant at 5 per cent level

Table-4 : Reduced form vector error correction estimates for castor markets.

Error Correction	D(Chitradurga)	D(Haveri)	D(Jodhpur)	D(Mehsana)	D(Pali)	D(Patan)
ECM	-0.0267 (0.0146) [-1.8242]	-0.0249 (0.0188) [-1.3227]	0.0246 (0.0076) [3.2276]	0.0477 (0.0079) [5.9871]	0.0280 (0.0079) [3.5478]	-0.018115 (0.00853) [-2.12251]
D(CHITRADURGH(-1))	-0.5803 (0.0924) [-6.2751]	-0.0737 (0.1188) [-0.6207]	-0.0029 (0.0481) [-0.0622]	-0.0662 (0.0502) [-1.3182]	-0.0325 (0.0498) [-0.6532]	-0.1228 (0.0537) [-2.2857]
D(CHITRADURGH(-2))	-0.4193 (0.0910) [-4.6038]	-0.1615 (0.1170) [-1.3799]	0.0250 (0.0474) [0.5294]	-0.0086 (0.0494) [-0.1748]	0.0149 (0.0491) [0.3038]	-0.0448 (0.0529) [-0.8462]
D(HAVERI(-1))	0.1078 (0.0716) [1.5058]	-0.4453 (0.0920) [-4.8397]	-0.0026 (0.0372) [-0.0705]	0.0073 (0.0389) [0.1877]	-0.0100 (0.0386) [-0.2603]	0.0500 (0.0416) [1.2036]
D(HAVERI(-2))	0.1637 (0.0712) [2.2971]	-0.0753 (0.0916) [-0.8222]	0.0025 (0.0371) [0.0688]	0.0486 (0.0387) [1.2567]	0.0089 (0.0384) [0.2337]	0.0926 (0.0414) [2.2368]
D(JODHPUR(-1))	0.1802 (0.2133) [0.8448]	-0.0861 (0.2742) [-0.3141]	-0.5275 (0.1110) [-4.7499]	0.1899 (0.1159) [1.6384]	0.0720 (0.1150) [0.6261]	-0.4229 (0.1240) [-3.4102]
D(JODHPUR(-2))	-0.2184 (0.2145) [-1.0183]	-0.3220 (0.2757) [-1.1678]	-0.2959 (0.1116) [-2.6505]	0.0149 (0.1165) [0.1284]	0.0380 (0.1156) [0.3286]	-0.0794 (0.1247) [-0.6368]
D(MAHESANA(-1))	-0.1789 (0.1959) [-0.9124]	-0.1036 (0.2518) [-0.4116]	0.3627 (0.1019) [3.5564]	-0.0511 (0.1064) [-0.4801]	0.3292 (0.1056) [3.1166]	-0.0981 (0.1139) [-0.8614]
D(MAHESANA(-2))	-0.0228 (0.1511) [-0.1514]	0.1185 (0.1943) [0.6099]	0.1390 (0.0786) [1.7667]	-0.0371 (0.0821) [-0.4528]	0.1277 (0.0815) [1.5678]	-0.1352 (0.0878) [-1.5388]
D(PALI(-1))	-0.0833 (0.2008) [-0.4152]	0.0744 (0.2581) [0.2885]	0.1411 (0.1045) [1.3504]	0.1391 (0.1091) [1.2748]	-0.4774 (0.1082) [-4.4100]	0.3525 (0.1167) [3.0202]
D(PALI(-2))	0.1034 (0.2021) [0.5117]	0.4143 (0.2597) [1.5950]	0.1023 (0.1051) [0.9734]	0.1970 (0.1098) [1.7943]	-0.1948 (0.1089) [-1.7879]	0.2855 (0.1174) [2.4306]
D(PATAN(-1))	0.2325 (0.2552) [0.9111]	0.2552 (0.3279) [0.7781]	0.0350 (0.1328) [0.2637]	-0.1445 (0.1386) [-1.0426]	0.0361 (0.1375) [0.2629]	0.1860 (0.1483) [1.2541]
D(PATAN(-2))	0.33341 (0.1944) [1.7148]	0.3748 (0.2498) [1.5000]	0.0205 (0.1012) [0.2029]	-0.1460 (0.1056) [-1.3826]	0.0980 (0.1048) [0.9351]	0.0751 (0.1130) [0.6648]
C	20.23	17.13	19.28	11.44	11.59	13.26
R-squared	0.33	0.26	0.37	0.42	0.32	0.17
AIC	15.1747	15.6765	13.8687	13.9547	13.9391	14.0895

Note : Bold and italics are the significant variable, Standard errors in () & t-statistics in []

present crisis must be altered. The importance of risk categorization and identification of essential risks along the supply chain has become increasingly apparent as stakeholders understand that successful risk management in production and marketing is critical for farmer's to continue production of oilseeds.

Materials and Methods

Selection of markets : In India, Gujarat and Rajasthan put together contributes more than 90 per cent of the country's total Castor production along with these states, Karnataka state chosen for to know price transmission impact, so markets from the above states were selected purposively. The study is based on monthly wholesale price data for six major castor markets namely, Mehsana, Patan, Pali, Jodhpur. Chitradurga and Haveri markets for the period from January 2005 to December 2020 were analysed. All the relevant data have been collected from Krishimaratavahini, Agmarknet and NIC.

Market integration : The area and production of castor is on the increase in India as confirmed by positive compound annual growth rates during 2005-2020. The growth rates during period are 1.52 per cent of area and 4.84 per cent for production. To maintain the growth rate, it is essential that a farmer should receive remunerative prices. They should get a better share of consumers? rupee paid for castor and its value added products. This is possible only when marketing efficiency is of high order. Market integration analysis over space and form are the major tools to verify the marketing efficiency

If price changes in one market are fully reflected in alternative market, these markets are said to be spatially integrated [Goodwin and Schroeder (1991)]. Prices in spatially integrated markets are determined simultaneously in various locations, and information of any change in price in one market is transmitted to other markets [Gonzalez-Rivera and Helfand (2001)]. Markets that are not integrated may convey inaccurate price signal that might distort producers marketing decisions and contribute to inefficient product movement [Goodwin and Schroeder (1991)], and traders may exploit the market and benefit at the cost of producers and consumers.

Price transmission analysis : Price transmission analysis measures the effect of prices in one market on prices in another market. This analysis can be used to study the relationship between domestic price and regional prices for soybean in six different local markets. The output of price transmission analysis helps to understand the following points - Is there a long-term relationship between the two markets, Do prices in market 'A' influence those in market 'B', the reverse, or do they both influence each other, If the price in one market

changes how much will it cause the other price to change in short run and if the price in one market changes how much will it cause the other price to change in the long run (Rivera, 2007). In the context of two domestic prices, it tells us whether market 'A' is influencing market 'B', or 'B' is influencing 'A', or if both are influencing each other. This causation analysis helps in understanding and describing trends in local prices.

ADF test : Prior to testing for co-integration, the price series are first tested for their order of integration, since a necessary condition for co integration is that the series are integrated of the same order. The augmented Dickey-Fuller (ADF) test is used to test for the order of integration. To test unit root, the ADF test is conducted based on the following regression equation :

$$Y_t - Y_{t-1} = \alpha + \beta_1 Y_{t-1} + \beta_2 Y_{t-2} + \dots + \beta_{t-1} Y_{t-t} + e_t$$

[t-1: 1 month lagged price and : differenced series]

Y_i denoted the price series of markets (Mehsana, Patan, Pali, Jodhpur. Chitradurga and Haveri castor price series).

If the coefficient α is not statistically different from zero, it implies that the series have a unit root, and, therefore, the series is non-stationary. To verify that the first differenced price series is indeed stationary, ADF unit root tests are used. The null hypothesis of non-stationary is tested using a t-test. The null hypothesis is rejected if the estimated variable is significantly negative. Once the variables are checked for stationary and are of the same order, integration between them can be tested.

Testing for market integration is central to the design of any agricultural price policy in many developing countries and has been an area of abiding research interest. This literature can be divided into three broad categories. Until recently two broad approaches had been used to investigate market integration: (i) that devised prior to the use of co integration techniques (ii) those using co integration methods of the Engle-Granger variety, and (iii) those using Johansen maximum-likelihood techniques (Johansen, 1988). To the extent that agricultural prices tested are non-stationary, the latter technique is more appropriate

Engle-granger causality : An autoregressive distributed lag (ADL) model for the Granger-causality test was developed following Engle and Granger (1987) specification provided below :

$$P_t^1 = \alpha_0 + \alpha_1 T + \sum_{j=1}^J \beta_j P_{t-j}^1 + \sum_{k=1}^K \gamma_k P_{t-k}^2 + e_t$$

Where, T is the time trend, e_t is the error term.

Lags for the ADL model were selected to minimize the Akaike's Information Criterion. Granger causality tests were specified as :

$$\begin{array}{c}
 P_t^1 \quad 0T \quad \sum_{j=1}^J P_{t-j}^1 \quad \sum_{k=1}^K h_k P_{t-k}^2 \quad t \\
 H_0: h_1 \quad h_2 \dots h_t \quad 0 \\
 P_t^2 \quad 0T \quad \sum_{j=1}^J P_{t-j}^1 \quad \sum_{k=1}^K h_k P_{t-k}^2 \quad t \\
 H_0: h_1 \quad h_2 \dots h_t \quad 0
 \end{array}$$

Co-integration : Co-integration means that despite being individually non-stationary, a linear combination of two or more time series can be stationary. The series that satisfy this requirement are said to be co-integrated. Following Granger (1981), a time series x_t which has a stationary, invertible, non-deterministic ARMA representation after differencing d times is integrated of order d and is denoted by $x_t - I(d)$. The components of the vector x_t are said to be co integrated of order d , b , denoted CI (d, b), if all the components of x_t are $I(d)$; there exists a vector x_t is $1(d-b)$, $b > 0$.

The vector is then called a co integrating vector. A necessary condition for co integration is that the data series for each variable involved exhibit similar statistical properties, that is, to be integrated to the same order with evidence of some linear combination of the integrated series.

Johansen (1988) developed a multivariate system of equations approach, which allows for simultaneous adjustment of both or even more than two variables. Johansen's approach is also widely used in many bivariate studies as it has some advantages to the single equation approach. First, the multivariate system of equations approach is more efficient than the single equation approach, i.e., it allows estimating the co integration vector with smaller variance. The second advantage of the multivariate approach is that in the simultaneous estimation it is not necessary to presuppose exogeneity of either of the variables.

Error correction model : Although price transmission analysis is a useful tool for understanding and predicting price trends, it only tells us about the relationship between two prices over time. It does not tell us why the price transmission is strong or weak, fast or slow (Engle and Granger, 1987). This interpretation can only be done with local knowledge of transportation routes, seasonal flows in staple foods, trade and agricultural marketing policies, the availability of foreign exchange and credit, the ease of obtaining permits, and the competition for overland freight, among other factors.

Results and Discussion

Market integration : To verify level and first differenced price series were indeed stationary, Augmented Dickey-Fuller (ADF) unit root test was used. The ADF test results are presented for the period Jan? 2005 to December 2020

(Table 1). The equations were estimated with an intercept and time trend. The results are presented in table 1 for Augmented Dickey-Fuller (ADF) unit root tests for each series. The null hypothesis of non-stationarity was tested based on the critical values reported by MacKinnon. All the price series appeared non stationary in the levels, but all the series were stationary after taking first differences. After confirming the currency exchange rates were stationary in their first differences, co integration between the commodity futures was tested using Johansen's maximum likelihood procedure. The bivariate co-integration technique of Engle and Granger was also tested for the presence of long run relationship existing between castor price in different states.

Granger casualty test : The causal relationship among the markets price of major castor markets in India were approached through Granger's Causality technique and presented in table 2. It could be seen that existence of mostly unidirectional causality as well as bidirectional causality among castor seed markets. The unidirectional relationship was found for the pair of Gujarat markets, indicates that price of Patan market influence the price of Karnataka and Rajasthan market. Similarly, bidirectional causality was exerted on Patan and Pali, Mehsana and Pali, Jodhpur and Mehsana markets of Gujarat and Rajasthan, evidencing the proximity of interstate price transmission (Fig. 1). Thus a strong integration of major castor seed markets in India is confirmed that the price of one market influence the price of other markets through the result of the study. The test for causality is based on F statistics that is calculated by using unconstrained and constrained forms,

$$F = \{SSE_r + SSE_f\} / m \quad / \quad \{SSE_f / (T-2m-1)\},$$

Where, SSE_r and SSE_f are residual sum of squares of the reduced and full models respectively; T = total number of observations, and m = number of lags.

Results of Jahansen's multiple co-integration analysis : Since all the price series are non-stationary at level form and stationary at first difference level, Johansen co-integration test can be applied to analyze the long run equilibrium among the castor seed markets. The results of the analysis show that there is at least five co-integration equations, at 5 per cent level of significant (Table 3). Hence, it is concluded that long run equilibrium exists among the six major markets. Any shocks in these markets would affect the prices of the other markets.

Vector error correction model : For the present study, the Vector Error Correction Mechanism (VECM) was adopted to analyze the long run association between the markets under co-integration framework. Accordingly, One month lag prices in Chitradurga market, any

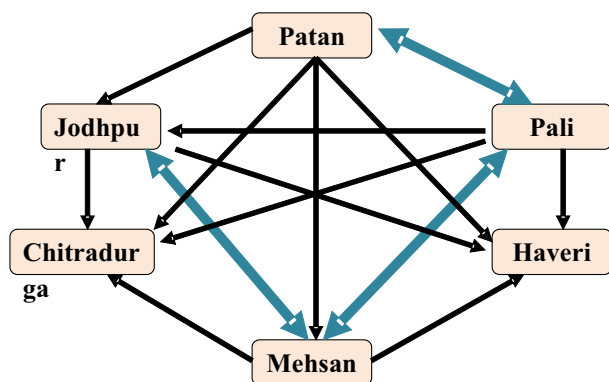


Fig-1: Pairwise granger causality of castor markets.

variations in the prices will get it corrected by itself within 58.03 percent of time and will also have an impact on the present prices in Patan market only to an extent of 12.28 per cent in opposite direction. Two month previous prices of Chitradurga market, any variations in the prices will get it corrected by itself within 41.93 per cent of time. One month previous prices in Haveri market, any variations in the prices will get it corrected by itself within 44.53 percent of time. Two month lagged prices of Haveri market will have impact on present prices in Chitradurga market only to an extent of 16.32 per cent and 9.26 per cent on the prices of Patan market in positive direction. One month previous prices in Jodhpur market, any variations in the prices will get it corrected by itself within 52.75 percent of time and also have impact on present prices in Patan market to an extent of 42.29 per cent in opposite direction. One month previous prices in Mehsana market will have impact on present prices in Jodhpur market to an extent of 36.27 per cent and 32.92 per cent on Pali markets in positive direction. One month previous prices in Pali market, any variations in the prices will get it corrected by itself within 47.74 percent of time and also have impact on present prices in Patan market to an extent of 35.25 per cent in positive direction. Two month lagged prices in Pali market will have impact on present prices in Patan market to an extent of 28.55 per cent in positive direction. In all other markets through there exists Co-integration between the prices but they were insignificant.

Conclusion

Castor plays a crucial role in the world economy particularly in Indian economy. In India considerable increase in castor seed production due to adoption improved varieties, moreover wider adaptability of crop for different agro-climatic conditions, also increase in demand for castor seed in international markets owing to favorable value chain access by many stakeholders. The domestic castor markets are highly integrated. Price transmission among domestic castor market is proved since it had long run association with the domestic markets. Results of the time series econometric analyses confirmed that domestic castor markets were integrated with international castor market and the world prices are transmitted to the domestic markets. Results of Johansens multiple co-integration tests revealed that the domestic castor markets of Mehsana, Patan, Pali, Jodhpur, Chitradurga and Haveri, are integrated with at least five co-integration vectors.

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Extent of Adoption of Gram Production Technology by ICT User and Non-User Farmers of Bikaner District of Rajasthan

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Abstract

Now a day's new technologies introducing in agriculture and it reduce the role of man power. This era is informative and Information and communication technology (ICT) play vital role to create awareness globally about new technologies in every fields as well in as agriculture. ICTs can make agriculture more remunerative and a fruitful occupation by providing latest information. In this study, ICTs is operationalized as the use of communication tools like, WhatsApp group, SMS, Telephone helpline. It saves money, time and efforts and reduces dependency on so many factors in the chain of extension. In this present studies it's found that Majority of respondents were having medium level of adoption of gram production technology.

Key words : Agriculture, communication, helpline, ICT, knowledge and technology, adoption.

Introduction

India holds second position among the countries with high population in the world having about 1.33 billion people. Amongst these, 70 per cent live in rural area and their main occupation is agriculture. The agriculture which continues to be the main occupation and way of life for more than half of Indian population even today making single largest contribution to the GDP 17.70 per cent (2019) of our nation. Sustainable prosperity of the farmers and the agricultural labours holds the key for improving the overall human resource development scenario in the country. There is a need to increase production and productivity of agriculture. Hence, the Indian farmers need to be updated and adopt the latest production technology about farming, new cultivars, farm machinery, market, trade situation regarding gram etc. The ICTs also provide the flexibility in providing information related to the various modes of farming practices including all the crops, specific commodities and enterprises, price information and all other information & regarding technological advances and tracking global competitiveness.

Thus, the ICT play an increasingly important role in linking the research- extension-market continuum towards developing professional competencies and entrepreneurial capabilities among specialists and farming communities respectively. Information and Communication Technology (ICT) is a global term that includes all technologies for the manipulation and communication of information encompassing: radio, television, computers, internet, cell phones, network hardware, satellite systems and so on, as well as various services and application associated with them. ICTs can

directly support farmers 'access to timely and relevant information, as well as empower the creation and sharing of knowledge of the farming community itself. ICTs in agriculture have the potential to facilitate greater access to information that drive or support knowledge sharing. ICTs essentially facilitate the creation, management, storage, retrieval, and dissemination of any relevant data, knowledge, and information that may have been already been processed and adapted (Batchelor 2002; Chapman and Slaymaker 2002; Rao 2007; Heeks 2002). In this study ICTs is operationalized as the use of communication tools like, WhatsApp group, Text Messages, Telephone helpline So, ICTs can make agriculture more remunerative and a fruitful occupation by providing latest information and motivate the farmers for adopt new technologies regarding gram. It saves money, time and efforts and reduces dependency on so many factors in the chain of extension. Keeping in mind the above background, the present study entitled "Extent of Adoption of Gram Production Technology by ICT user and non-user Farmers of Bikaner District of Rajasthan" has been taken.

Materials and Methods

For selection of respondents, district wise list of registered farmers during the year 2015 to 2017 received from the KVK Sardarsahar, Churu and IKSL Jaipur. From the list so prepared total 10 ICT users were selected randomly for each ICT tool from each selected panchayat samity. This way 40 ICT users were selected from each panchayat samiti comprising a sample of 80 respondents from selected district To constitute other half of sample (i.e.80 ICT non-users) same number of farmers were selected

Table-1 : Distribution of respondents according to extent of adoption about gram production technology. N=160

S. No.	Extent of Adoption	Gram Growers					
		ICT users (n=80)		ICT non-users (n=80)		TOTAL (n=160)	
		F	%	F	%	F	%
1.	Low (below 42.10)	06	07.50	27	33.75	33	20.62
2.	Medium (from 42.10 to 71.22)	49	61.25	46	57.50	95	59.38
3.	High (above 71.22)	25	31.25	07	08.75	32	20.00

Mean = 56.66, S.D.=14.56

Table-2 : Practice wise extent of adoption of ICT user and ICT non-user respondents about gram production technology. N=160

S. No.	Gram production practices	ICT users (n=80)		ICT non-users (n=80)		Total (n=160)	
		MPS	Rank	MPS	Rank	MPS	Rank
1.	Field Preparation	67.34	IV	52.96	III	60.15	IV
2.	Use of High Yielding Varieties	74.79	I	54.27	I	64.53	I
3.	Seed Sowing, Seed rate and Spacing	64.79	V	46.97	VI	55.88	VI
4.	Seed Treatment	50.17	IX	31.96	IX	41.06	IX
5.	Manure/Fertilizer Application	57.50	VIII	43.85	VII	50.67	VII
6.	Irrigation Management	70.93	II	53.28	II	62.10	II
7.	Weed Management	68.62	III	51.75	IV	60.18	III
8.	Plant Protection Measures	60.93	VII	39.84	VIII	50.38	VIII
9.	Harvesting, Threshing and Storage	62.03	VI	50.46	V	56.24	V
	Pooled	64.12		47.26		54.68	

rs = Rank Correlation

MPS = Mean Percent Score

Significant at 0.01% level of probability rs = 0.950
t = 8.050*

from the selected panchayat samities. While selecting ICT non-user farmers, the personal characteristics of ICT users were taken into consideration.

Results and Discussion

In this study ICT denotes four tools namely: WhatsApp, Message, KVK help line and IKSL help line. Based on the level of adoption regarding production technology of gram, respondents were categorized in three categories viz; low, medium and high.

In above table clearly depicted that 61.25, 31.25 and 07.50 per cent ICT user gram producers belonged to medium, high and low extent of adoption categories respectively. In case of ICT non-users 57.50, 33.75 and 08.75 per cent respondents belonged to medium, low and high categories respectively about adoption of gram production technology. Similarly in case pooled respondents (80 ICT users & 80 ICT non-users) 59.38, 20.62 and 20.00 per cent farmers comes under the medium, low and high extent of adoption categories respectively about gram production technology.

Results clearly shows that ICT user respondents had higher adoption of recommended production technology of gram as compared to ICT non-user respondents.

The similar results found in study of Vashishtha et al. (2011), Sarada and Kumar (2013) and Ghaswa (2018).

Practice wise extent of adoption of ICT user and ICT non-user respondents about gram production technology

The production technology of gram related to the field preparation, use of high yielding varieties, seed sowing seed rate & spacing, seed treatment, manure & fertilizer application, irrigation management, weed management, plant protection measures & harvesting, threshing and storage were studied. An effort was made to assess the practice-wise extent of adoption among ICT user and ICT non-user gram growers. The results of the study have been given in table 5.27.

The extent of adoption of ICT user and ICT non-user respondents regarding package of practices of gram production technology were calculated in terms of Mean Percent Score (MPS). Table 5.27 shows that ICT user respondent had very good adoption (Above 70.00 MPS) in practices like, "use of high yielding varieties" with 74.79 MPS and "irrigation management" with 70.93 MPS and awarded first and second ranks respectively. Good extent of adoption found in "weed management", "field preparation", "seed sowing", "seed rate & spacing" "manure & fertilizer application", "harvesting, threshing and storage", "plant protection measures" and "seed treatment" practices with 68.62, 67.34, 64.79, 62.03, 60.93, 57.50 and 50.17 MPS and third, ranked fourth, fifth, sixth, seventh and eighth respectively.

In case of ICT non-user respondents, good extent of adoption was found about "use of high yielding varieties",

Table-3 : Practice wise comparison between ICT user and ICT non-user respondents about extent of adoption of gram production technology. N=160

S. N.	Gram production practices	ICT users (n=80)		ICT non-users N=(80)		Z' Value
		Mean	S.D.	Mean	S.D.	
1.	Field Preparation	05.38	01.18	04.23	00.97	03.57**
2.	Use of High Yielding Varieties	08.97	01.84	06.51	02.01	12.47**
3.	Seed Sowing, Seed rate and Spacing	07.77	01.75	05.63	01.49	09.86**
4.	Seed Treatment	07.02	01.82	04.47	01.97	11.69**
5.	Manure/Fertilizer Application	06.90	01.81	05.26	01.68	07.82**
6.	Irrigation Management	05.67	01.41	04.26	01.42	07.49**
7.	Weed Management	06.81	01.24	05.17	00.75	10.35**
8.	Plant Protection Measures	09.75	02.47	06.37	02.39	13.66**
9.	Harvesting, Threshing and Storage	04.96	01.41	04.03	01.44	07.13**
	Pooled	07.02	01.66	05.10	01.57	09.34

** Significance at 0.01 percent level of probability, SD. = Standard Deviation

“irrigation management”, “field preparation” “weed management” and “harvesting, threshing & storage” with 54.27, 53.28, 52.96, 51.75 and 50.46 MPS and occupied first, second, third, fourth and fifth rank respectively in adoption of production technology of gram.

The table further shows that ICT non-users had poor extent of adoption in following practices of gram production namely, “seed sowing, seed rate & spacing”, “manure & fertilizer application”, “plant protection measures” and “seed treatment” with 46.97, 43.85, 39.84 and 31.96 MPS and occupied sixth, seventh, eighth and ninth ranks respectively.

Based on the above discussion, it can be concluded that the most of the ICT user farmers adopted more practices in comparison to ICT non-user farmers in all aspects of production technology of gram. The table further revealed that the range of adoption of ICT user farmers was from 50.17 to 74.9 MPS, while in case of ICT non-user farmers it was 31.96 to 54.27 MPS in all aspects of production technology of gram. To improve the adoption level in both (ICT users & ICT non-users) categories of farmers, we have to create more awareness about different ICT sources and approach must location specific.

Efforts were also made to laid down the relationship between the ranks assigned by ICT user and ICT non-user gram growers by enforcing rank order correlation. The value of rank correlation (rs) was 0.95 which shows positive correlation, the significance level of rs was tested through ‘t’ test and it was indicated that calculated ‘t’ value (08.05) was higher than its tabulated value means, there was similarity in rank assigned both categories of farmers. Though there is similarity in ranks assigned by ICT users and ICT non-users in various practices of gram production technologies, there was difference in magnitude of Mean Percent Score, with respect to adoption of gram production technology. The

ICT user had higher extent of adoption in comparison to ICT non-user gram producers.

The results of present study were similar with the results of Vashishtha et al. (2011), Samota (2011) and Ghaswa (2018).

In above table the shows that calculated ‘Z’ value was higher from the tabulated value at 0.01 per cent level of probability for all nine packages of practices of gram production technology, it shows that, ICT-user and ICT non-user respondents had wide distinctions in their extent of adoption for all nine package of practices. It means, ICT user respondents had more adoption level compared to ICT non-user. The ‘Z’ test was found highly significant in adoption level among all practices.

The mean value also indicated that ICT user respondents had higher extent adoption comparative to ICT non-users about production technology of gram. This difference in the extent of adoption of gram technology might be due to the reason that ICT user respondents had more contact with different sources of information through different ICT tools and aware more about the benefits of new technologies, which inspired them to adopt new technologies for increased production. The significant difference between ICT user and ICT non-user respondents about extent of adoption of recommended production technology of gram clearly indicated that there was positive effect of use of ICT tool on ICT user respondents with regard to enhanced adoption of recommended production technology of gram in the study area. Similar findings are reported by Vashishtha et al. (2010), Kumar (2013) and Ghaswa (2018).

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Sustainable Agriculture—Irrigation, Cropping Pattern and Crop Production

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Abstract

The expression “safeguard,” from the Latin *sustinere* (*sus*, from underneath and *tinere*, to keep up), to hold in life or keep, infers long-term period help or lastingness. Since it relates to horticulture, reasonable portrays cultivating frameworks which may be “equipped for holding their profitability and quality to society inconclusively. Practical horticulture is both reasoning and an arrangement of cultivating. It has its roots in an immovable of qualities that shows a perception of both natural and social substances. It includes plan and control methods that work with natural procedures to save all assets, diminish waste and ecological harm, even as keeping or enhancing ranch gainfulness. Working with characteristic soil systems is of exact noteworthiness. Economical farming structures are intended to take amplify advantage of ebb and flow soil supplement and water cycles, vitality streams, and soil life forms for nourishment producing. As pleasantly, such structures expect to give sustenance this is nutritious, without being polluted with stock that would harm human wellness.

Introcuccion

Agriculture is a widely and majorly practiced activity in India. The country is mainly known for it's agrarian economy. A majority of the rural population is closely related to agriculture in one or the other way.

In simplest phrases, sustainable agriculture is the manufacturing of meals, fiber, or exceptional plant or animal merchandise using farming techniques that protect the environment, public health, human groups, and animal welfare. The phrase sustainable has grown to be very popular in recent years and it's far now used to explain loads of things. Sustainable agriculture is a kind of agriculture that specializes in generating long-term plants and cattle at the same time as having minimum outcomes on the surroundings. This kind of agriculture tries to discover a top balance among the want for food production and the preservation of the ecological gadget inside the environment. In addition to generating meals, there are several general goals associated with sustainable agriculture, consisting of holding water, reducing the use of fertilizers and pesticides, and selling biodiversity in plants grown and the ecosystem. Sustainable agriculture additionally specializes in retaining monetary balance of farms and assisting farmers improve their techniques and satisfactory of existence.

The term Agroecology which can also be regarded as the science of sustainable agriculture. As researchers explore indigenous agricultures, which are modified relics of earlier agronomic forms, it is increasingly apparent that many locally developed agricultural systems routinely incorporate mechanisms to accommodate crops to the variability of the natural environment and to protect them

from predation and competition. These mechanisms make use of regionally available renewable inputs and ecological and structural features of the agricultural field, fallows, and surrounding vegetation. Agriculture in these situations involves managing resources other than the “target” crop. These production systems were developed to balance out environmental and economic risk and maintain the productive base of agriculture over time. While such agroecosystems can include infrastructure like terraces, trenches, and irrigation works, the decentralized, locally developed agronomic knowledge is central to the continuing performance of these production systems.

The dynamics of sustainable agriculture : Sustainable agriculture embraces several variants of nonconventional agriculture that are often called organic, alternative, regenerative, ecological or low-input. Just because a farm is organic or alternative does not mean that it is sustainable, however. For a farm to be sustainable, it must produce adequate amounts of high-quality food, protect its resources and be both environmentally safe and profitable. Instead of depending on purchased materials such as fertilizers, a sustainable farm relies as much as possible on beneficial natural processes and renewable resources drawn from the farm itself. To understand the rationale for sustainable agriculture, one must grasp the critical importance of soil. Soil is not just another instrument of crop production, like pesticides, fertilizers or tractors. Rather it is a complex, living, fragile medium that must be protected and nurtured to ensure its long-term productivity and stability. Healthy soil is a hospitable world for growth_ Air circulates through it freely, and it retains moisture long after a rain. A tablespoon of soil contains millions of grains of sand, silt and clay and has a vast

expanse of internal surface area to which plant nutrients may cling. That same tablespoon of soil also contains billions of microorganisms, including bacteria, actinomycetes, fungi and algae, most of which are principal decomposers of organic matter. Decomposition results in the formation of humus and the release of many plant nutrients. The microbes also produce sticky substances called polysaccharides that glue soil particles together and help the soil to resist erosion.

Sustainable agriculture does not represent a return to pre-industrial revolution methods; rather it combines traditional conservation minded farming techniques with modern technologies. Sustainable systems use modern equipment, certified seed, soil and water conservation practices and the latest innovations in feeding and handling livestock. Emphasis is placed on rotating crops, building up soil, diversifying crops and livestock and controlling pests naturally. Whenever possible, external resources—such as commercially purchased chemicals and fuels—are replaced by resources found on or near the farm. These internal resources include solar or wind energy, biological pest controls and biologically fixed nitrogen and other nutrients released from organic matter or from soil reserves. In some cases external resources may be essential for reaching sustainability. As a result, such farming systems can differ considerably from one another because each tailors its practices to meet specific environmental and economic needs. A central component of almost all sustainable farming systems is the rotation of crops—a planned succession of various crops growing on one field. When crops are rotated, the yields are usually from 10 to 15 percent higher than when they grow in mono culture. In most cases monocultures can be perpetuated only by adding large amounts of fertilizer and pesticide. Rotating crops provides better weed and insect control, less disease build up, more efficient nutrient cycling and other benefits. A typical seven-season rotation might involve three seasons of planting alfalfa and ploughing it back into the soil, followed by four seasons of harvested crops: one of wheat, then one of soybeans, then another of wheat and finally one of oats. The cycle would then start over. The first season of wheat growth would remove some of the nitrogen produced by the alfalfa; the soil's nitrogen reserves would be depleted much less by the soybeans, which are legumes. Oats are grown at the end of the cycle because they have smaller nutrient requirements than wheat. Regularly adding crop residues, manures and other organic materials to the soil is another central feature of sustainable farming. Organic matter improves soil structure, increases its water-storage capacity, enhances fertility and promotes the tilth, or physical condition, of the soil. The better the tilth, the more easily the soil can be tilled and the easier it

is for seedlings to emerge and for roots to extend downward. Water readily infiltrates soils with good tilth, thereby minimizing surface runoff and soil erosion. Organic materials also feed earthworms and soil microbes. The main sources of plant nutrients in sustainable farming systems are animal and green manures. A green manure crop is a grass or legume that is ploughed into the soil or surface mulched at the end of a growing season to enhance soil productivity and tilth. Green manures help to control weeds, insect pests and soil erosion, while also providing forage for livestock and cover for wildlife. By raising a diverse assortment of crops and livestock, a farm can buffer itself against economic and biological risks. Diversity results from mixing species and varieties of crops and from systematically integrating crops, trees and livestock.

What Is Agroecology? : The term agroecology has come to mean many things. Loosely defined, agroecology often incorporates ideas about a more environmentally and socially sensitive approach to agriculture, one that focuses not only on production, but also on the ecological sustainability of the production system. This might be called the “normative” or “prescriptive” use of the term agroecology, because it implies a number of features about society and production that go well beyond the limits of the agricultural field. At its most narrow, agroecology refers to the study of purely ecological phenomena within the crop field, such as predator/prey relations, or crop /weed competition.

The Ecological View : At the heart of agroecology is the idea that a crop field is an ecosystem in which ecological processes found in other vegetation formations such as nutrient cycling, predator/prey interactions, competition, commensalism, and successional changes also occur. Agroecology focuses on ecological relations in the field, and its purpose is to illuminate the form, dynamics, and function of these relations. Implicit in some agroecological work is the idea that by understanding these processes and relations, agroecosystems can be manipulated to produce better, with fewer negative environmental or social impacts, more sustainably, and with fewer external inputs. As a result, a number of researchers in the agricultural sciences and related fields have begun to view the agricultural field as a particular kind of ecosystem—an agroecosystem—and to formalize the analysis of the ensemble of processes and interactions in cropping systems. The underlying analytic framework owes much to systems theory and the theoretical and practical attempts at integrating the numerous factors that affect agriculture (Spedding 1975, Conway 1981a and 1981b, Gliessman 1982a, Conway 1985, Chambers 1983, Ellen 1982, Altieri 1983, Lowrance et al. 1984).

The Social Perspective : Agroecosystems have various degrees of resiliency and stability, but these are not strictly determined by biotic or environmental factors. Social factors such as a collapse in market prices or changes in land tenure can disrupt agricultural systems as decisively as drought, pest outbreak, or soil nutrient decline. On the other hand, decisions that allocate energy and material inputs can enhance the resiliency and recuperation of damaged ecosystems. Although human manipulations of ecosystems for agricultural production have often dramatically altered the structure, diversity, patterns of energy, and nutrient flux and mechanisms of population regulation within agricultural fields, these processes still operate and can be explored experimentally. The magnitude of the differences in ecological function between a natural and an agricultural ecosystem depends tremendously on the intensity and frequency of the natural and human perturbations that impinge on an ecosystem. The results of the interplay between endogenous biological and environmental features of the agricultural field and exogenous social and economic factors generate the particular agroecosystem structure. For this reason, a broader perspective is often needed to explain an observed production system. An agricultural system differs in several fundamental ways from a “natural” ecological system in its structure and function. Agroecosystems are semi-domesticated ecosystems that fall on a gradient between ecosystems that have experienced minimal human impact, and those under maximum human control, like cities. Odum (1984) describes four major characteristics of agroecosystems :

Agroecosystems include auxiliary sources of energy like human, animal and fuel energy to enhance productivity of particular organisms.

Diversity is greatly reduced compared with many natural ecosystems.

The dominant animals and plants are under artificial rather than natural selection.

The system controls are external rather than internal via subsystem feedback.

The Agroecology Challenge : Conventional agricultural scientists have been concerned primarily with the effect of soil, animal, or vegetation management practices upon the productivity of a given crop, using a perspective that emphasized a target problem such as soil nutrients or pest outbreaks. This means of addressing agricultural systems has been determined in part by the limited dialogue across disciplinary lines, by the structure of scientific investigation, which tends to atomize research questions, and by an agricultural commodity focus. There is no question that agricultural research based on this approach has been successful in increasing yields in favored

situations. Increasingly, however, scientists are recognizing that such a narrow approach could limit agricultural options for rural peoples, and that the “target approach” often carries with it unintended secondary consequences that have often been ecologically damaging and had high social costs. Agroecology research does concentrate on target issues in the agricultural field, but within a wider context that includes ecological and social variables. In many cases, premises about the purposes of an agricultural system may be at variance with the purely productionist or yield focus of some agricultural scientists. Agroecology can best be described as art approach that integrates the ideas and methods of several subfields, rather than as a specific discipline. Agroecology can be a normative challenge to existing ways of approaching agricultural issues in several disciplines. It has roots in the agricultural sciences, in the environmental movement, in ecology (particularly in the explosion of research on tropical ecosystems), in the analysis of indigenous agroecosystems, and in rural development studies. Each of these areas of inquiry has quite different aims and methodologies, yet taken together, they have all been legitimate and important influences on agroecological thought.

Irrigation management strategies for sustainable agriculture :

Irrigation has long played a key role in feeding the expanding world population and is expected to play a still greater role in the future. As supplies of good-quality irrigation water are expected to decrease in several regions due to increased municipal–industrial–agricultural competition, available freshwater supplies need to be used more efficiently. In addition, reliance on the use and reuse of saline and/or sodic drainage waters, generated by irrigated agriculture, seems inevitable for irrigation. The same applies to salt-affected soils, which occupy more than 20% of the irrigated lands, and warrant attention for efficient, inexpensive and environmentally acceptable management. Technologically and from a management perspective, a couple of strategies have shown the potential to improve crop production under irrigated agriculture while minimizing the adverse environmental impacts. The first strategy, vegetative bioremediation—a plant-assisted reclamation approach—relies on growing appropriate plant species that can tolerate ambient soil salinity and sodicity levels during reclamation of salt-affected soils. A variety of plant species of agricultural significance have been found to be effective in sustainable reclamation of calcareous and moderately sodic and saline-sodic soils. The second strategy fosters dedicating soils to crop production systems where saline and/or sodic waters predominate and their disposal options are limited. Production systems based on salt-tolerant plant species using drainage

waters may be sustainable with the potential of transforming such waters from an environmental burden into an economic asset. Such a strategy would encourage the disposal of drainage waters within the irrigated regions where they are generated rather than exporting these waters to other regions via discharge into main irrigation canals, local streams, or rivers. Being economically and environmentally sustainable, these strategies could be the key to future agricultural and economic growth and social wealth in regions where salt-affected soils exist and/or where saline-sodic drainage waters are generated.

Just 20% of the world's croplands are irrigated but they produce 40% of the global harvest which means that irrigation more than doubles land productivity (FAO, 2003). In developing countries, irrigation improves economic returns and can boost production by up to 400%. On the other hand, irrigation can have unwanted environmental consequences. About one-third of the world's irrigated lands have reduced productivity as a consequence of poorly managed irrigation that has caused water logging and salinity.

A sustainable strategy of agricultural water resources—An example from China : Deficit irrigation requires more accurate and real-time allocation of agricultural water resources, especially in arid areas. Sustainable water management for food security needs to include: (i) the optimal allocation of water resources; (ii) high efficiency of agricultural water use; (iii) prevention and control of water pollution; and (iv) countermeasures to combat extreme climate disasters and other considerations. In recent years, the Ministry of Water Resources of China put forward an agricultural water management strategy for 'increasing grain yield and water-saving' in north-east China, limiting groundwater abstraction for saving' in North China Plain, 'water-saving with high efficiency' in north-west China, and 'water-saving with drainage reduction' in south China. Research and the extension of efficient irrigation technology have developed rapidly in China. On the North China Plain, winter wheat yield increased significantly when crops received 3600m³ hm⁻² from microspray irrigation technology, with a WUE of 1.7kg m⁻³, while WUE under traditional border irrigation is 1.5kg m⁻³ (Zhang et al., 2013). Maize production in north-east China has reached 15000kg hm⁻² under drip irrigation; the average yield increment is 6000–7500kg hm⁻² compared with yields under conventional cultivation and surface irrigation. Fifty percent of the irrigation water is saved by using drip rather than sprinkler irrigation, and 86% is saved if drip irrigation is used rather than surface irrigation. There is a clear economic benefit of using drip irrigation in addition to the water-saving benefit. According to the survey data in north China, 8550 Renminbi (RMB)

hm⁻² of irrigation is required for the total cost of water supplies, irrigation equipment, plastic film, and conventional cultivation management for drip irrigation. If calculated on the basis of maize yield of 15 000kg hm⁻² and a local price of 1.2 RMB kg⁻¹, the income will be 18 000 RMB hm⁻², and the net income will be 9450 RMB hm⁻²; compared with the average net income of conventional maize, the efficient water-saving technology provides 6000 RMB hm⁻² in benefit to the local farmers. Optimizing water transport and distribution in the irrigation canal system is also necessary for achieving water-saving irrigation at the scale of an irrigation district or catchment. With the extension of high and new technology in agricultural water management, digital canal system management greatly promotes the practice of precision scheduling of water resources and precision irrigation. In order to meet the requirement of optimizing water distribution in canal systems, there is a need to apply computer and information technology to control water volume flow in real time. In order to optimize management of a canal system, automation of engineering control equipment, advanced systems software, and decision-making support are all needed in the large irrigation districts in north China. A sustainable strategy for management of agricultural water resources involving deficit irrigation based on physiological responses of crops needs to: (i) either reduce ET without yield reduction or improve yield with a similar ET; (ii) construct a compensatory mechanism for agricultural water-saving for farmers; (iii) improve water-saving efficiency by rural land circulation and scale operation; (iv) develop advanced practical water-saving technologies and economical, reliable, and durable equipment and facilities in the field; (v) construct and improve the system for water-saving technology extension and service; (vi) strengthen basic research on water-saving irrigation under changing environmental conditions; and (vii) establish national ET monitoring and an agricultural water-saving experimental research network.

Methods that may cut down irrigation are of considerable interest and should be explored further. Deficit irrigation methods have been assessed systematically by the irrigation community in different parts of the world and are now used widely in crop and fruit production in many countries. Much of this work is still relatively empirical, but through these efforts we have gained a good appreciation of what are the most drought-sensitive developmental stages of many important food crops. Cowan (1988) and others have argued that plants have evolved mechanisms to maximize carbon gain and growth in environments where rainfall is unpredictable. This suggests that crop plants should be able to regulate their water use according to the

water availability in the soil. Our understanding of the theoretical basis of active regulation of WUE has now increased to the point where physiological control mechanisms might be exploited to tune deficit irrigation methods for different crops and different environments. Such tuning might deliver increased WUE, yield, and crop quality. Further gains can be achieved if we also include in our manipulations accurate and real-time assessments of water availability that allow effective allocation of water resources.

Cropping pattern integrated farming systems : The components of a farm must be integrated for it to persist. A dynamic model for a farm is a simple mass flow model, which consists of two parallel paths of flow through the farm. One pathway is a socio-economic flow which has inputs of land, labor, capital, culture, and knowledge or information. Land, labor, and capital are the traditional inputs of economic models, and labor and capital-based inputs are often considered interchangeable, e.g. herbicides are substitutes for hand-weeding or cultivation (National Research Council (NRC), 1989). Tradition, information, and knowledge can also be substituted for labor and capital, e.g. appropriate intercropping can minimize weed problems. Outputs of the socio-economic pathway are fulfillment of livelihood needs and include income, health, knowledge, social stability, and a sense of community. Income is the most commonly recognized output of a farm, but livelihood goes well beyond income because farming is also a lifestyle. The formulation and perpetuation of values and the persistence of a community sense are probably equally important outputs. The importance of internal socio-economic processes on a farm are often overshadowed by the inputs from which they develop and the outputs they produce. The farm provides collateral for loans to cover capital expenditures and operating costs. Land appreciation is a hedge against inflation, provides money in the bank, and represents a retirement account. Farming provides a lifestyle that binds a household together and is a heritage that can be passed to future generations through inheritance of the farm. Indigenous knowledge is typically a product of generations of adaptation of farming practices to local environments. Family, tradition, and formulation of values are all processes that are facilitated on the farm. The biophysical flows run in parallel with the socio-economic flows. Physico-chemical inputs include energy for operations such as tillage, harvesting and storage, and agrochemicals for fertilization and pest control. Biological inputs include organic matter such as crop residues, animal manure, legume nitrogen, cover crops, rotations, and cropping patterns. Physico-chemical and biological inputs are familiar components of conventional agriculture, but their values have not usually been

optimized or integrated. Less obvious, but CA. Edwards et al. / *Agriculture, Ecosystems and Environment* 46 (1993) 99-121 103 of great importance is knowledge or information. Use of genetically improved varieties of crops and animals, management of farming practices, and biological pest control are examples of information. These inputs often provide substitutes, that are both cost effective and environmentally benign, for inputs of labor, energy, or chemicals. For example, seeds for a pest-resistant line of a crop costs a farmer little more than for one without resistance but eliminates the need for pesticides and the labor to apply them and stabilize production. The internal processes occurring within the farm are important in maintaining its natural resource base and its ability to support continued production. Nutrients are recycled and made available for plant growth through the soil decomposer community (Wild, 1973). The combined activities of the soil fauna and flora stabilize soil structure and increase the permeability, long term fertility, and resilience of the soil (Coleman et al., 1984). Nitrogen-fixing bacteria increase the soil stock of nitrogen (Miller, 1990). Soil organisms assist in control of pests through various mechanisms including competition, antagonism, predation, and allelopathy (Baker and Cook, 1974). Soil microorganisms can metabolize toxic organic compounds (Edwards, 1966). The maintenance of a healthy soil ecosystem provides for evolution and adaptation of the soil biota and community to changing conditions. Sustainable systems add greater biological diversity to nutrient cycles, thereby increasing their longevity and promoting interactions between the decomposer and consumer communities. The socio-economic and biophysical flows run in parallel and are interdependent. The ability of a farmer to produce food and income is tied directly to internal biological processes. Adoption of the best farm management practices and indigenous knowledge depend upon natural resources and are the results of interactions between farmers and their biophysical and socio-economic environments. Socio-economic and biophysical inputs can often substitute for one another. For example, weeds can be controlled by herbicides or by cover crops, rotations, hand-weeding or cultivations (NRC, 1989). It is the understanding of the pattern of parallel flows and the interdependence between the flows that defines an integrated farm or farming system. For a farm to be sustainable, the flows must be coupled. When either flow or the interaction between them is sufficiently disrupted, the system becomes unsustainable. Consequently, intervention by science and technology in an integrated farm requires consideration of the whole system and the socio-economic and biophysical flows within and through the system. Such an integrated farm model represents an

agroecosystem. Both agricultural sciences and ecology have contributed to our knowledge of agro-eco systems. The traditional agricultural sciences have developed a large body of information on the components of agroecosystems, and many of the current ecological theories were developed in agroecosystems. For example, much of the literature on insect ecology (e.g. Andrewartha, 1954) resulted from work 104 C.A. Edwards et al. / Agriculture, Ecosystems and Environment 46 (1993) 99-121 done in agricultural systems with a goal of pest control. Agroecology is a relatively new discipline that integrates the techniques and paradigms of ecology with the practices of agricultural sciences for the study of agroecosystems. We realize that a farm is only one level of an agroecosystem. The farm sits within a hierarchy of levels that includes, for example, fields; farms, households, watersheds and regions (Conway, 1985; Lowrance et al., 1986) In the interest of simplicity, we have restricted our discussion to the farm level, but many of the concepts apply equally to other subsystems and levels of the hierarchy.

Crop production for sustainable agriculture : A framework for the farmer that will ensure the sustainability of crop production—according to the definition outlined above—can be derived by following procedure;

Identification of actual emissions and releases resulting from crop production.

Determination of ambient concentrations, depositions and loads by assessing the corresponding impact pathways to ecosystem(s) and their components.

Selection of ecosystem indicators to describe the condition of the ecosystem and its components affected directly or indirectly by crop production practices.

Determination of threshold values for these indicators.

Determination of maximum tolerable emission and releases based on the threshold values identified above by tracing the impact pathways back to the farm level.

Derivation of farm-level indicators to describe those agricultural management practices relevant in the context of sustainable crop production.

Determination of critical uses of farm inputs as the threshold values for these indicators.

Identification of production schemes that adhere to the framework established by the threshold values for farm inputs, thus satisfying the criteria for sustainable crop production.

Conclusion

The lack of price supports for other crops effectively discourages farmers from diversifying and rotating their crops and from planting green manures. Instead it gives them powerful incentive to practice monoculture to achieve maximum yields and profits. The long-term economic benefits of sustainable agriculture may not be evident to a farmer faced with having to meet payments on annual production loans. Many conventional farmers are greatly in debt, partly because of heavy investments in specialized machinery and other equipment, and their debt constrains the shift to more sustainable methods. To date, society has neither rewarded farmers financially nor given them other incentives for choosing sustainable methods that would benefit the public. Then, too, there is little information available to farmers on sustainable practices. Government-sponsored research has inadequately explored alternative farming and focused instead on agri-chemically based production methods. Agribusinesses also greatly influence research by providing grants to universities to develop chemical intensive technologies for perpetuating grain monocultures. Shifting mainstream agriculture toward more sustainable methods will require more than new laws and regulations; it will also require more research and public education. A high research priority is the development of specific cropping systems that produce and consume nitrogen more efficiently. It is essential to learn how much nitrogen is fixed by legumes under various conditions, as well as the optimum means for integrating legumes into crop rotations. More must be learned about alternatives to fertilizers and the cycling of nutrients through the agricultural ecosystem. Effective strategies must be developed for controlling pests, weeds and diseases biologically. The strategies may rely on beneficial insects and microorganisms, allelopathic crop combinations (which discourage weed growth), diverse crop mixtures and rotations and genetically resistant crops. More research should also be done on the relative benefits of various cover crops and tillage practices and on integrating livestock into the cropping system. Well-managed collections of germ plasm will give plant breeders a broader genetic base for producing new crops with greater resistance to pests, diseases and drought. New breeds of crops being developed by biotechnology, such as grains that fix their own nitrogen, may eventually be included in sustainable cropping systems. But neither biotechnology nor any other single technology can fix all the problems addressed by a balanced ecological approach. The success of sustainable agriculture does not hinge on creating super crops: the system works with

crops that are available now. Better education is as important as further research. Farmers need to know clearly what sustainable agriculture means, and they must see proof of its profitability. One of the most effective methods for communicating practical information about sustainable agriculture is through farmer-to-farmer networks. Because such networks have aroused growing interest and proved effective, the land grant community should try to promote their development. Some scientists and environmentalists have recommended levying taxes on fertilizers and pesticides to offset the environmental

costs of agrichemical use, to fund sustainable agricultural research and to encourage farmers to reduce excessive use of agrichemicals. Agriculture is a fundamental component of the natural resources on which rests not only the quality of human life but also its very existence. If efforts to create a sustainable agriculture are successful, farmers will profit and society in general will benefit in many ways.



A study on Different Dimensions of Group Sustainability

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Abstract

Group sustainability is a complex thing. It has more than one dimension. Here, in this study, three dimensions of sustainability of SHGs were taken into consideration. The study was done to find out if the characteristics of the group have any association with the different dimensions of group sustainability as well as to analyse the managerial, financial and organisational sustainability of the groups. The study was done in Coochbehar district of West Bengal. The state, district and blocks were selected purposively and three villages namely Lotapata, Ruidanga Pratham khanda and Ruidanda Dwitiya khanda were selected randomly. Among different groups existing in the villages, SHGs were chosen for the study because of their presence in abundance. Total 100 members of SHG were selected as respondents. Organizational, managerial, financial and group sustainability were taken as dependent variable whereas, all socio-demographic characteristics of respondents as well as characteristics of the groups were taken as independent variables. The data were collected with the help of structured schedule by personal interview method. Statistical tools like frequency, percentage, mean etc were used. SPSS was used to analyze the data. Different dimensions of group sustainability were measured and found that the groups possess medium level of organisational, managerial and financial sustainability. The study recommends training for SHG members regarding organisational management, conflict management as well as training for leadership development in order to improve the level of organisational and managerial efficiency.

Key words : SHG, organizational sustainability, managerial sustainability, financial sustainability

Introduction

The term self-help group is being used in several countries to describe various types of non- financial and financial associations. However, in India it basically refers to association of 10-20 poor women who come together for any type of financial services. So, SHGs are autonomous bodies that lends small loans to its member. They are being governed by own members who are responsible to take decisions and choose their leaders as well as signatories. They maintain a compulsory system of savings. They decide on their own savings amount, interest rate to be charged on internal lending, lending norms and management of surpluses.

Concept of group sustainability : Group sustainability refers to long term continuation of the group and its activities. Sustainability of self-help group was measured with higher repayment rate, increased value of assets and saving rate, elimination of informal sources, easy access to institutional loans and social empowerment of rural women (Puhazhendi and Badatya 2002; Schreiner 1997, Srinivasan 2008). It can also be measured with the capability of SHGs to continue their group activities with subsidy or any external support (Dunford 2006; shelty and Madheswaran 2008; Thapa *et al.* 1992).

The present study was done to find out if the characteristics of the group have any association with the different dimensions of group sustainability as well as to

analyse the managerial, financial and organisational sustainability of the groups.

Materials and Methods

The multistage, purposive and random sampling techniques were used in the selection of area and the respondents of the study. The state, district and block were selected purposively. The four villages and 100 respondents were selected randomly. Though different types of group were available in the villages but due to the abundant number of SHGs available in the villages, the study has operationalised those as groups for the present study. The data were collected during the period of December 2019 to February 2020 with the help of structured schedule through personal interview method. Variables like Organisational sustainability, Managerial sustainability and financial sustainability were selected as dependent variables and were measure with following scales.

Organisational sustainability (Das and Guha 2019, index is used with modification) : Indicators like number of drop outs, grade of group and age of group were taken to measure the organisational sustainability of the group.

Managerial sustainability (Das and Guha 2019, index is used with modification) : Frequency of meeting, attendance of members in the meetings, maintenance of

group record, decision making process, rotation of group leadership, conflict resolving capacity of the group were taken as the indicators to measure managerial sustainability.

Financial sustainability (Das and Guha 2019, index is used with modification) : The financial and institutional sustainability of SHGs depends on the quantity and quality of financial services that the groups provide to their members, thrift fund mobilisation, credit facility from banks and other financial agencies and group corpus for on lending to the members (APMAS 2017).

The responses from the respondents were truly interpreted, analysed and the results were drawn out scientifically. Statistical tools like frequency, mean, coefficient of correlation and percentage were used and analysis was done with SPSS statistical package and data analysis tool of the Microsoft Excel.

Results and Discussion

Table-1 : Correlation Coefficient of Group characteristics with Organizational sustainability of the group.

Variables responsible for organizational sustainability	Coefficient of Correlation (r)
Social category of the group	0.259**
Age of the group	0.810**
Promoters	0.150
Size of the group	-0.039
Grade of the group	0.287**

The table shows the association between the organizational sustainability of the group and five variables namely social category of group, age of the group, promoters, size of the group, and grade of the group. It has been found that the variables like social category of the group, age of the group and grade of the group are positively and significantly associated with the dependent variable organizational sustainability as both age and grade bring experience and hence the organizational norms and face gets stability. However, the study could not establish any significant association between organizational sustainability and the promoter and size of the group.

Table-2 : Correlation Coefficient of Group characteristics with Managerial sustainability of the group.

Variables responsible for managerial sustainability	Coefficient of Correlation (r)
Social category of the group	-0.087
Age of the group	0.279**
Promoters	0.631**
Size of the group	-0.202*
Grade of the group	-0.315**

The table presents the association between the managerial sustainability and variables namely social category of group, age of the group, promoters, size of the group and grade of the group. It has been found that the variables like age of the group, promoters and grade

of the group are positively and significantly associated with the dependent variable managerial sustainability. Size of the group has found to be negatively but significantly related to Managerial sustainability as its difficult to manage a big group. However, the study could not establish any significant association between managerial sustainability and social category of the group. The grade of the group has shown a negative and significant relation which could not be explained as it was not felt realistic, the erratic result might have occurred probably due to the small size of the sample and it wouldn't have happened if the sample size was taken considerably big.

Table-3 : Correlation coefficient of Group characteristics with financial sustainability.

Variables	Coefficient of Correlation (r)
Social category of the group	-0.046
Age of the group	0.369**
Promoters	0.506**
Size of the group	-0.083
Grade of the group	-0.322**

Table reveals the association between the financial sustainability of the group and the five variables namely social category of the group, age of the group, promoters, size of the group and grade of the group. The result shows that the variables age of the group, promoters, and grade of the group are positively and significantly associated with the dependent variable financial sustainability. However, the study could not establish any significant association between financial sustainability and social category as well as size of the group. The grade of the group has shown a negative and significant relation which could not be explained as mentioned above.

Distribution of SHGs according to their Organizational, Managerial and financial Sustainability :

Table-4 : Distribution of groups according to their Organisational Sustainability level

Category	Frequency	Percentage
Low	11	11.0
Medium	61	61.0
High	28	28.0

The table indicates that the maximum number of groups (61%) have shown medium level of organizational sustainability followed by high level of organizational sustainability by 28% of the groups. However, 11% of the groups have also showed low organizational sustainability.

Table-5 : Distribution of group according to their Managerial Sustainability level

Category	Frequency	Percentage
Low	15	15.0
Medium	74	74.0
High	11	11.0

The table reveals that the maximum number of groups (74%) have shown medium level of managerial sustainability followed by low level of managerial sustainability by 15% of the group. However, 11% of the groups have also showed high managerial sustainability.

Table-6 : Distribution of group according to their Financial Sustainability level.

Category	Frequency	Percentage
Low	10	10.0
Medium	83	83.0
High	7	7.0

The table shows that the maximum number of groups (83%) have shown medium level of financial sustainability followed by low level of financial sustainability by 10% of the group. However, 7% of the groups have also showed high financial sustainability.

Conclusion and Recommendation

It can be concluded that the SHG studied in this study had shown medium level of organizational, managerial and financial sustainability. The group characteristics like age of the group and promoters of the group are positively and significantly related to the group's financial and managerial sustainability. However, group's organizational sustainability is positively and significantly related to social characteristics of group like age of group and grade of group.

The study recommends training as well as exposure for SHG members regarding organisational management, conflict management as well as leadership development in order to improve the level of organisational and managerial efficiency of the group. The study also recommends different skill development trainings for SHG members so, that they can start different economic activities and their grades get improved. Which would

further improve their economic status and contribute in their sustainability.

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Perceived Effectiveness of Indigenous Traditional Practices of Zone-8 and Zone-9 of Karnataka State

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Abstract

Climate change, increasing population and natural resource degradation including soil degradation and biodiversity loss are the biggest threats of this era. Efficient use of energy from different sources, conservation and its recycling of energy source for agriculture can only possible through traditional practices. Since some of the ITK practices have a significant bearing on profitability of farming. Since long ago, farmers have been silently innovating, testing, and refining various farming practices to make them relevant, efficient & cost effective. The present study was undertaken to ascertain the effectiveness of prevalent ITK. A study was conducted in Khanapur and Savanur taluk of Karnataka state. List of ITKs were collected using checklist and group discussion. These collected ITKs were further categorised into five ways that is weather forecasting (WF), crop(C), storage (ST), soil and water conservation (SWC) and fodder and livestock (FL) related. These collected ITKs were sent to 30 subject matter specialists for scientific rationality. Those ITKs which were found to be highly rational and observed scientific are considered for efficiency analysis. Questionnaire containing list of highly rational ITKs were prepared and surveyed for efficiency analysis. Eighty respondents from Khanapur and 80 from Savanur taluk were covered. Effectiveness of the ITKs was measured using Mean Perceived Effectiveness Index (MPEI). Relevancy weights developed by Sundarmari in 2001 were used for the study. Based on MPEI, ITKs were categorised into highly efficient, efficient and least efficient ITKs. Among the collected ITKs 12 ITKs were found to be highly efficient (17 WF, 26WF, 30WF, 6SWC, 5C, 6C, 17C, 18C, 19C, 6ST, 7ST, and 16FL). These ITKs received highest negative response with respect to complexity indicating they are very simple to adopt by the farmers and they have neutral response with respect to relative advantage and sustainability.

Key words : Effectiveness, indigenous technologies, index, relevancy weights,

Introduction

Climate change, increasing population and natural resource degradation including soil degradation and biodiversity loss are the biggest threats of this era. We the man kind is the reason for such inexcusable exploitation of our mother earth. Keeping in view of sustenance of biodiversity, as mankind is also the part of biodiversity it is the responsibility that sustainable management and conservation of resources for future use. Sustainable food production is one of the major challenges of the twenty-first century in the era of global environmental problems. Agriculture is one of the largest sectors that sustain livelihood to maximum number of people and contribute to climate change. Climate change is among the greatest threats to agricultural systems. According to Rockstrom et al. (2009), the boundaries in three systems viz., rate of biodiversity loss, human interference with the nitrogen cycle and climate change have already been overstepped. We are living in the anthropocene era where human-driven environmental changes deteriorate geographical and ecological resilience of the earth system (Crutzen 2002 and Rockstrom *et al.* 2009).

Efficient use of energy from different sources, conservation and its recycling of energy source for agriculture can only possible through traditional practices.

Traditional practices like agroforestry, intercropping, crop rotation, cover cropping, traditional organic composting and integrated crop-animal farming have potentials for enhancing crop productivity and mitigating climate change. Indigenous farmers and local people perceive climate change in their own ways and prepare for it through various adaptation practices (Tripathi and Singh 2013). Farmers due to dogged work and low profit shifted from traditional agriculture towards the modern one. Modern agriculture, however, enhanced food productivity but with the acceleration of several environmental problems.

ITK plays a predominant role in farming dominated by resource poor farm families. Their indigenous knowledge and incidental practice of the same in the farm help to manage the farming sustainably (Ponnusamy et al, 2009). Since some of the ITK practices have a significant bearing on profitability of farming. Since long ago, farmers have been silently innovating, testing, and refining various farming practices to make them relevant, efficient & cost effective. The present study was undertaken to ascertain the effectiveness of prevalent ITK. This treasures of ancient wisdom, beliefs and traditions as practiced by rural communities are eco-friendly, highly effective and sustainable in utilization

of available natural resources (Soam, S.K. and Hussain 2011).

ITKs play significant role in agriculture production. Das *et al.* (2003) compiled the ITKs practiced in agriculture in India. They found 1998 ITKs being practiced by the farmers in the area of veterinary and animal sciences, pest and disease management in crops, grain/seed storage, horticultural crops, and cropping systems and fisheries. Most of Assam's tribal people survive on local knowledge base (Kalita *et al.*, 2010). It is therefore important to identify and preserve these traditional technologies in order to sustain the productivity and protect the ecosystem. It is right time to rediscover and reimplement traditional practices to improve the socio-ecological integrity of agroecosystems. These are also readily available, socially acceptable, economically affordable, and sustainable, besides involving minimum risk to farmers and consumers, and above all, resource conserving (Grenier, 1998). Reintroduction of traditional agricultural practices, first of all it is necessary to know their socio economic effectiveness. Perceived effectiveness of ITKs is defined as the degree to which the farmers perceive that a positive outcome is obtainable by applying the ITKs in solving the problems (Sundaramari *et al.*, 2001).

Research Methodology

A study was conducted in Khanapur taluk of Belgaum district and Savanur taluk Haveri district of Karnataka state to know the efficiency of the Indigenous Technical Knowledge (ITK) practices among the farmers. Selection of study areas was made using rainfall data. Taluk wise rainfall data of two agro-climatic zones (Zone-8 Northern Transition zone and Zone-9 Hilly zone) for 30 years period 1989-2018 was collected from Karnataka State Natural Disaster Monitoring Centre, Bengaluru. Using this data, percent deviation from normal rainfall was computed by using the formula :

% RF deviation

$$= \frac{100 (\text{Average annual rainfall} - \text{Annual rainfall})}{\text{Average Annual Rainfall}}$$

In Zone-8, out of 11 taluks, Savanur taluk experienced consecutive 4 years drought with rainfall deficiency of -36.34 % (2015), -50.50% (2016), -32.52% (2017) and -31.62% (2018). So for Zone-8 Savanur taluk was selected for the study. Among taluks belong to hilly zone (Zone-9), Khanapur taluk was selected and from norther transitional zone (Zone 8) Savanur was selected as it experienced excess rainfall and droughts consecutively for three years, respectively. Hobli level rainfall data of selected taluks for last four years was collected from Kunimellihalli rain gauge station (Savanur)

and Amagoan rain gauge station (Khanapur). Based on highest rainfall deviation four villages each in Savanur (Kunamellihalli, Hullikopi, Mannangi and Mellagatti) and Khanapur (Jamboti, Abbanatti, Bailur and Devachhatti) were selected.

Documentation of ITKs : Checklist based on a very exhaustive review of literature was prepared to collect ITKs. Questions in checklist were aimed at understanding the traditional practices followed by farmers to store farm produce. Totally checklist had 25 questions. For collecting ITKs, facilitators of state agriculture department who work at village level and most of them basically hail from villages were contacted. They were briefed about the purpose of the study. With their help, group discussions in each selected villages were organized. Only those farmers who are above 50 years were involved in the group discussions. These discussions were guided by checklists and the ITKs emerged in discussions were documented. Approximately 25 farmers in each group (village) participated in the discussions. So across 8 villages around 200 farmers were part of the discussions.

These collected ITKs were sent to subject matter specialists for scientific rationality. Those ITKs which were found to be highly rational and scientific are considered for efficiency analysis. Questionnaire containing list of highly rational ITKs were prepared and surveyed for efficiency analysis. Eighty respondents from Khanapur and 80 from Savanur taluk were covered.

Effectiveness of the ITKs were measured using Mean Perceived Effectiveness Index (MPEI) constructed by Sundaramari(2001) involving 8 traits namely cost effectiveness, adoptability, observability, triability, complexity, relative advantage, sustainability and accuracy.

Sl. No.	Traits	Relevancy weights
1.	Cost effectiveness	0.88
2.	Adoptability	0.76
3.	Observability	0.80
4.	Triability	0.72
5.	Complexity	0.81
6.	Relative advantage	0.84
7.	Sustainability	0.86
8.	Accuracy	0.83

The farmers were asked to rate each i-ITK based on these traits, on a three point scale (Agree–3, Undecided–2, Disagree–1). The Perceived Effectiveness Index (PEI) score of a particular i-ITK was calculated using the

$$\text{PEI score} = \frac{(W_{ij}R_1 + W_{ij}R_2 + W_{ij}R_3 + \dots + W_{nm}R_n)}{(R_1 + R_2 + R_3 + \dots + R_n)}$$

R1, R2, R3,.....R8 indicates relevancy weights

Table-1 : List of highly rational ITKs used for efficiency analysis.

Code	ITK
6WF	Termite emergence indicate onset of monsoon
7WF	Movement of termites in rows - If both atmospheric and soil surface humidity are high, termites move in large numbers in rows. Since rain is expected when humidity is more, these termites are believed to indicate rain in a few hours
9WF	Emergence of root grub indicates time for land preparation activities for monsoon crops (Second fortnight of April to first fortnight of May)
12WF	Ants emergence from ground and transfer their eggs/pupae to other places indicates onset of monsoon
13WF	Frog cracking in chorus - There will be rain
17WF*	Blowing of wind East to West indicate onset of rabi rains /post monsoon rains
22WF	More heat from February – May then heavy rain in monsoon is expected
26WF*	Fog in the atmosphere indicates no rains.
28WF	High sweating during day time- Foretell rain in night
29WF	Morning cloud and evening thunder-Occurrence of rain
30WF*	When the clouds are thick and black in colour, and are arranged perpendicular to the orbit of the sun in the morning, it is said that rain is approaching
6SWC*	Summer ploughing is followed as it helps soil to hold more moisture in Kharif season and kill soil insects and weeds.
9SWC	In sloppy lands, terrace farms are formed. If slope is more, narrow terraces (10-12 or 15-20 feet width) are formed. If slope is less wider terraces of 25-30 feet or 30-35 feet width are formed. Along the walls of the terrace stone pitching is practiced to protect soil erosion.
10SWC	Incorporation of Paddy crop residue after harvest with the help of rotovator helps to improve soil health.
11SWC	Compartment bunding is followed for carrying easy crop handling activity and as a soil water conservation practice.
12SWC	Preparing trenches across field border to reduce soil erosion. Trench width 2 feet, length 3-4 feet and depth 2-3 feet.
2C	Chilli as main crop farmers take up relay cropping. They cultivate Cotton and Horse gram as relay crops in Kharif to overcome possible yield loss due to climate variability and to get continuous return.
203427	Earthingup of cashew tree planted in hill slopes to protect it from falling during heavy rains/floods
63C	
5C*	Sorghum, Wheat and Chickpea are resistant to low temperatures. So these crops are cultivated during Rabi.
6C*	Magi (August 17- August 30) rain is very useful it helps to retain moisture and planning for cultivation of rabi crops.
17C	Farmers practice cropping pattern as mentioned here. Between two rows of Chilli, two lines of Jaidhar cotton and between the two rows of cotton one row of horse gram i.e Chilli + Cotton + Horsegram + Cotton + Chilli 2:2:1:2:2 or Chilli + Horse gram + Cotton + Horsegram + Chilli ratio in 1:1:1:1:1 respectively. Growing of Horsegram between the rows helps in fixation of atmospheric nitrogen to the main crop which helps in increasing yield in main crop.
18C*	Practice of earthingup in Groundnut crop by using local hoe helps in fixation of more pegging in Groundnut.
19C*	Farmers were shifting to Maize crop whenever south west or north east monsoons get delayed by one month because of its wide weather adaptability. This practice followed in rainfed conditions.
3ST	Paddy seed selection and storage for next season- Healthy panicles are selected and seed is separated manually to avoid breakage. The same is subjected to sundry for 3-4 days and stored in a gunny bags by mixing leaves of Ningadagi (Lingadika) plant/tree to protect from the storage insects.
4ST1	Pulses are prone to storage pest infestation. So farmers use following methods to preserve pulses for seed purpose - Red soil slurry is prepared. Pulses are mixed in slurry such that they have mild mud coating. Dried under sun and then stored in gunny bags -Cowdung slurry is prepared. Pulses are mixed in slurry. Sundried and stored in gunny bags.
4ST2	Pulse storage for grain purpose Neem leaves are mixed with pulses and stored in gunny bags Dry ash is mixed with grains and stored in gunny bags.
6ST*	Groundnut kernel/seed are stored without removing shell. This protects seed from getting pest attack. Before harvest seed is removed and used for sowing.
7ST*	Storage structure for paddy grains Kanaja. It is erected using bamboo splits. Bamboo splits are arranged vertically in cylindrical shape and are plastered with mud slurry. Paddy kept in gunny bags are placed inside this structure. The top is covered with paddy straw and is in conical shape. The top diameter is larger extending on all sides. The diameter of this structure varies and maximum is up to 15 feet. It is constructed mainly to store paddy in the back yard of the house. It can store up to 190 quintals of paddy.
18ST	Farmers keep leaves of neem (Azadirachta indica) along with the stored pulses and oilseeds in gunny bags to protect from pulse beetles (Callosobruchus maculatus), lesser grain borers (Rhyzopertha dominica) and other borers
3FL	They rare only local cows and few goats because of their resistance and wide adaptability to any type of weather variabilities (especially tolerance to heavy rain and sever cold) even though their milk yield is less.
11FL	Fever: Wet nose is the indicator of good health and dry nose is the indicator of fever in animal. Putting or covering wet cloth across horns and on the forehead of the animal to reduce fever.
16FL*	In rainy season, wounds of livestock do not heal early mainly because of egg laying of green houseflies on wound. Maggots hatched start further infecting the wound. To control this farmers fill the wounds with the paste made up of marigold leaves, lime and tobacco. On the periphery of the wound, they apply solution of country camphor and coconut oil to repel houseflies.

Table-1 : Contd....

Code	ITK
22FL	Farmers preserve paddy straw for fodder using common salt (NaCl). Straw is heaped in layers and salt is put between them. For one cartload of straw, four to five kg salt is required. It keeps rodents away from the straw completely. Moreover, the straw becomes much more palatable to cattle compared to normal straw.
25FL	During severe drought, pods of babul (<i>Acacia nilotica</i>) are used as cattle feed. This usage solves two problems: First it meets the shortage of fodder and, secondly, the boiled pods help increase milk yields of cows and buffalos. Farmers boil pods of black babul in water in an earthen vessel or tin can, proportionate to the number of livestock to be fed. This mash of pods is allowed to be cooled and used as feed. Only boiled pods are used for feeding because raw pods could cause irritation in the animal mouth. Besides boiled mash is easy to chew and digest.
29FL	Melia tree (<i>Melia azedarach</i>) The trees are ready for pruning from third year onwards. Young tender leaves coming out of new shoots during the monsoon months (September to December) are bitter in taste and such leaves may not be fit for feeding the animals. The matured leaves can be harvested during summer months (March to June) that are relished by cattle. A cow can be fed with 10-15 kg of concentrated feed. Crossbred cows eat these leaves very well compared to buffaloes. Country cows (local breed), bullocks and goats also like this feed. These leaves also help to strengthen uterus of the cows and buffaloes.
34FL	For higher milk production- Pinda' a local feed prepared by mixing wheat flour in lukewarm water with 'Gur', butter (extracted from curd), rice, Jhingora (<i>Echinochola frumentacea</i>) etc. ; 'Bhimal' leaves + Bhatt (black Soybean) + Wheat, feeds combination of Binola (cotton seeds), Methi seeds, Dhalia and Jaggery.
44FL	Farmers prefer Maldandi Sorghum variety compare to local sorghum for food grain and fodder purpose as a Rabi crop. As per farmers observation the stover of Maldandi consist more of fibre, high yielding and can prepare soft Roti out of it. Whereas Local Sorghum stover consist more pith, low yielding and Roti made up of this are rough reduced store insect pest attack.

Note : (WF- Weather forecasting, SWC- Soil and water conservation, C-Crop cultivation, ST-Storage and FL-Fodder and livestock. * indicate highly efficient ITKs).

Wij indicates i^{th} ITK and j^{th} score

$i=1, 2, 3, \dots, n$

$j=1,2,3,\dots,m$

$$\text{MPEI} = \frac{\text{PEI score of a individual farmer for each ITK}}{\text{Total sample size}}$$

Based on MPEI all ITKs were categorised into three categories based on MPEI value between 2 to 2.5 were deliberated as effective ITKs and MPEI of 2.5 and above were considered as highly effective.

Table 1 reflects the list of highly rational ITKs which were further used for efficiency analysis. Out of 37 rational ITKs 11 were found to be efficient.

The table-2 illustrates that among the weather forecasting ITKs, blowing of wind East to West indicate onset of rabi rains /post monsoon rains, fog in the atmosphere indicates no rains and thick and black colour clouds arranging perpendicular to the orbit of the sun in the morning, it is said that rain is approaching are found to be highly efficient. ITK 7 WF, 9WF, 12 WF, 13WF and 29 WF were found to be least efficient in case of zone 8. Whereas in case of zone 9 12 WF and 13 WF were found to be least efficient. Fog in the atmosphere indicates no rains (93.75 %) received highest positive response with respect to observability at zone 9. Ants emergence from ground and transfer their eggs/pupae to other places indicates onset of monsoon (85.00 %) received highest negative response with respect to complexity at zone 9. With respect to relative advantage, ITK 17WF (65 to 80%) and 28 WF (73.75 %) received highest positive response. ITK 17 (63.75 and 75 %), 28WF(60 and 82.50 %) and 30WF (68.75 and 81.25 %) received highest response with respect to their sustaibility.

As mentioned in table 3, ITK 6SWC (2.6871), 5C (2.5788), 6C (2.5150), 18C (2.7129), 19C (2.5951), 6ST (2.5685), 7ST (2.5341) and 16FL (2.5232) are found to be highly efficient ITK. When pulses are storing for grain purpose they are mixed with neem leaves and dry ash (4ST2- 1.9189) was found to be least effective. ITKs 11 FC (96.25 %), 4ST (93.75%), 6C (90 %), 2C (86.25 %), 16FL (85 %), 18C (85 %), 5C (82.50 %) and 6ST (82.50 %) received highest positive response with respect to cost effectiveness. Since these ITKs are less cost consuming and more economical to adopt. With respect to adaptability ITK 6ST (92.50 %), 4ST1 (90 %), 6SWC (86.25%), 2C (83.75 %) and 5C (81.25 %) received highest positive response. ITK 6ST (88.75 %), 22FL (88.75 %), 11FL (82.50 %), 7 ST (70.00 %) and 44 FL (70%) received highest positive response with respect to observability. Farmers can try 6SWC (95%), 10SWC (90 %), 4ST1 (90 %), 19C (88.75 %), 6ST (85%) and 5C (80 %) without any side effects. Among the ITKs 16FL (61 to 90 %), 19C (87.50 %), 17C (82.50 %) and 18C (81.25 %) are found to be more relatively advantageous compare to other as reflected by highest positive responses. Farmers experiencing that ITK 18C (93.75 %), 19C (90 %), 5C (87.50 %), 6C (85 %), 6SWC (78.75%) and 9SWC (76.25 %) are giving sustainable results even today as they responded positively for these ITKs. These ITKs are giving sustainable results even today. Majority of the highly rational ITKs received neutral response with respect to relative advance. It might be due to more inclination of the respondents towards modern technologies and methods which give comparatively fast results. These results are in line with results obtained by Seetharam and Veluswamy in 2001.

Table-2 : Mean Perceived Effectiveness Index (MPEI) of weather forecasting ITKs.

Zone	Code		Observability	Complexity	Relative advantage	Sustainability	Accuracy	MPEI
Zone 9	6WF	DA	15.00	42.50	5.00	5.00	21.25	2.0523 (E)
		UD	41.25	57.50	62.50	68.75	67.50	
		A	43.75	0.00	32.50	26.25	11.25	
Zone 8	6WF	DA	1.25	47.50	18.75	13.75	21.25	2.0639 (E)
		UD	20.00	52.50	81.25	37.50	71.25	
		A	78.75	0.00	0.00	48.75	7.50	
Zone 9	7WF	DA	3.75	38.75	6.25	12.50	6.25	2.1937 (E)
		UD	37.50	38.75	57.50	65.00	68.75	
		A	58.75	22.50	36.25	22.50	25.00	
Zone 8	7WF	DA	16.25	57.50	20.00	61.25	75.00	1.6673 (LE)
		UD	57.50	42.50	41.25	38.75	25.00	
		A	26.25	0.00	38.75	0.00	0.00	
Zone 9	9WF	DA	3.75	61.25	2.50	0.00	3.75	2.2438 (E)
		UD	37.50	37.50	57.50	53.75	51.25	
		A	58.75	1.25	40.00	46.25	45.00	
Zone 8	9WF	DA	30.00	75.00	16.25	57.50	10.00	1.7028 (LE)
		UD	61.25	25.00	66.25	42.50	76.25	
		A	8.75	0.00	17.50	0.00	13.75	
Zone 9	12WF	DA	11.25	85.00	32.50	35.00	28.75	1.8053 (LE)
		UD	60.00	22.50	42.50	47.50	43.75	
		A	28.75	0.00	13.75	17.50	27.50	
Zone 8	12WF	DA	10.00	31.25	17.50	62.50	63.75	1.6985 (LE)
		UD	75.00	68.75	61.25	37.50	36.25	
		A	15.00	0.00	21.25	0.00	0.00	
Zone 9	13WF	DA	35.00	57.50	30.00	31.25	58.75	1.7343 (LE)
		UD	32.50	40.00	66.25	33.75	36.25	
		A	32.50	2.50	3.75	35.00	5.00	
Zone 8	13WF	DA	22.50	0.00	45.00	17.50	30.00	1.998 (LE)
		UD	61.25	23.75	55.00	67.50	61.25	
		A	16.25	76.25	0.00	15.00	8.75	
Zone 9	17WF	DA	0.00	2.50	0.00	1.25	6.25	2.6075 (HE)
		UD	20.00	57.50	35.00	35.00	28.75	
		A	80.00	40.00	65.00	63.75	65.00	
Zone 8	17WF	DA	0.00	26.25	0.00	1.25	0.00	2.5717 (HE)
		UD	33.75	55.00	20.00	23.75	28.75	
		A	66.25	18.75	80.00	75.00	71.25	
Zone 9	22WF	DA	0.00	46.25	0.00	1.25	0.00	2.4209 (E)
		UD	17.50	37.50	56.25	51.25	32.50	
		A	82.50	16.25	43.75	47.50	67.50	
Zone 8	22WF	DA	12.50	67.50	17.50	12.50	7.50	2.1845 (E)
		UD	18.75	32.50	82.50	70.00	72.50	
		A	68.75	0.00	0.00	17.50	22.50	
Zone 9	26WF	DA	0.00	48.75	0.00	0.00	0.00	2.5585 (HE)
		UD	6.25	46.25	26.25	28.75	15.00	
		A	93.75	5.00	72.50	71.25	85.00	
Zone 8	26WF	DA	0.00	26.25	8.75	16.25	11.25	2.2721 (E)
		UD	27.50	73.75	25.00	46.25	66.25	
		A	72.50	0.00	66.25	37.50	22.50	
Zone 9	28WF	DA	0.00	56.25	0.00	0.00	5.00	2.4484 (E)
		UD	16.25	33.75	26.25	40.00	38.75	
		A	83.75	10.00	73.75	60.00	56.25	
Zone 8	28WF	DA	0.00	43.75	7.50	3.75	11.25	2.4524 (E)
		UD	22.50	56.25	18.75	13.75	32.50	
		A	77.50	0.00	73.75	82.50	56.25	
Zone 9	29WF	DA	0.00	33.75	0.00	0.00	10.00	2.2626 (E)
		UD	40.00	42.50	71.25	63.75	63.75	
		A	60.00	23.75	28.75	36.25	26.25	
Zone 8	29WF	DA	20.00	11.25	17.50	15.00	17.50	1.9702 (LE)
		UD	30.00	72.50	70.00	68.75	73.75	
		A	12.50	16.25	12.50	16.25	8.75	
Zone 9	30WF	DA	0.00	22.50	0.00	0.00	0.00	2.6604 (HE)
		UD	31.25	30.00	35.00	18.75	11.25	
		A	68.75	47.50	65.00	81.25	88.75	
Zone 8	30WF	DA	5.00	13.75	0.00	0.00	0.00	2.4299 (E)
		UD	27.50	83.75	83.75	31.25	22.50	
		A	67.50	2.50	16.25	68.75	77.50	

Note: (WF- Weather forecasting, SWC- Soil and water conservation, C-Crop cultivation, ST-Storage and FL-Fodder and livestock. DA-Disagree, UD-undecided and A-Agree).

Table-3 : Mean Perceived Effectiveness Index (MPEI) of soil and water conservation, crop, storage and fodder and livestock related ITKs.

Zone			Cost effective- ness s	Adoptability	Observ- ability	Traibility	Complexity	Relative advantage	Sustain- ability	MPEI
Zone 8	6SWC	DA	0.00	0.00	0.00	0.00	0.00	38.75	0.00	2.6871 (HE)
		UD	21.25	13.75	13.75	5.00	0.00	60.00	21.25	
		A	78.75	86.25	86.25	95.00	100.00	1.25	78.75	
Zone 9	9SWC	DA	33.75	12.50	0.00	10.00	2.50	0.00	0.00	2.4632 (E)
		UD	48.75	42.50	16.25	37.50	53.75	33.75	23.75	
		A	17.50	45.00	83.75	52.50	43.75	66.25	76.25	
Zone 9	10SWC	DA	1.25	1.25	0.00	0.00	71.25	0.00	13.75	2.4532 (E)
		UD	18.75	21.25	33.75	10.00	21.25	52.50	45.00	
		A	80.00	77.50	66.25	90.00	7.50	47.50	41.25	
Zone 9	11SWC	DA	38.75	32.50	0.00	22.50	16.25	0.00	0.00	2.2537 (E)
		UD	42.50	31.25	52.50	35.00	45.00	38.75	57.50	
		A	18.75	36.25	47.50	42.50	38.75	61.25	42.50	
Zone 9	12SWC	DA	53.75	43.75	0.00	36.25	1.25	0.00	0.00	2.2314 (E)
		UD	45.00	38.75	26.25	53.75	17.50	46.25	45.00	
		A	1.25	17.50	73.75	10.00	81.25	53.75	55.00	
Zone 8	2C	DA	0.00	0.00	0.00	0.00	21.25	0.00	7.50	2.3754 (E)
		UD	13.75	16.25	86.25	28.75	72.50	76.25	81.25	
		A	86.25	83.75	13.75	71.25	6.25	23.75	11.25	
Zone 9	3C	DA	1.25	0.00	7.50	21.25	87.50	8.75	27.50	2.1986 (E)
		UD	25.00	26.25	36.25	18.75	6.25	71.25	61.25	
		A	73.75	71.25	56.25	60.00	6.25	20.00	11.25	
Zone 8	5C	DA	0.00	0.00	0.00	0.00	38.75	0.00	0.00	2.5788 (HE)
		UD	17.50	18.75	22.50	20.00	61.25	66.25	12.50	
		A	82.50	81.25	80.00	80.00	0.00	33.75	87.50	
Zone 8	6C	DA	0.00	0.00	0.00	0.00	60.00	0.00	0.00	2.515 (HE)
		UD	10.00	36.25	26.25	56.25	40.00	41.25	15.00	
		A	90.00	63.75	73.75	43.75	0.00	58.75	85.00	
Zone 8	17C	DA	1.25	0.00	0.00	0.00	26.25	0.00	21.25	2.4766 (E)
		UD	27.50	20.00	23.75	32.50	71.25	17.50	71.25	
		A	71.25	80.00	76.25	67.50	2.50	82.50	7.50	
Zone 8	18C	DA	0.00	0.00	0.00	0.00	1.25	0.00	0.00	2.7129 (HE)
		UD	15.00	22.50	21.25	31.25	86.25	18.75	6.25	
		A	85.00	77.50	78.75	68.75	12.50	81.25	93.75	
Zone 8	19C	DA	0.00	0.00	0.00	0.00	90.00	0.00	2.50	2.5951 (HE)
		UD	15.00	21.25	21.25	11.25	10.00	12.50	7.50	
		A	85.00	78.75	78.75	88.75	0.00	87.50	90.00	
Zone 9	3ST	DA	1.25	0.00	0.00	11.25	72.50	6.25	2.50	2.2989 (E)
		UD	23.75	40.00	62.50	42.50	23.75	51.25	61.25	
		A	75.00	60.00	37.50	46.25	3.75	42.50	36.25	
Zone 8	4ST1	DA	0.00	0.00	0.00	0.00	15.00	43.75	40.00	2.2715 (E)
		UD	6.25	10.00	85.00	10.00	85.00	48.75	56.25	
		A	93.75	90.00	15.00	90.00	0.00	7.50	3.75	
Zone 8	4ST2	DA	15.00	22.50	13.75	12.50	26.25	17.50	18.75	1.9189 (LE)
		UD	56.25	75.00	75.00	71.25	73.75	78.75	75.00	
		A	28.75	2.50	11.25	16.25	0.00	3.75	6.25	
Zone 8	6ST	DA	0.00	0.00	0.00	0.00	93.75	0.00	0.00	2.5685 (HE)
		UD	17.50	7.50	11.25	15.00	6.25	22.50	32.50	
		A	82.50	92.50	88.75	85.00	0.00	77.50	67.50	
Zone 9	7ST	DA	1.25	0.00	0.00	0.00	13.75	0.00	0.00	2.5341 (HE)
		UD	31.25	31.25	30.00	57.50	61.25	38.75	47.50	
		A	67.50	68.75	70.00	42.50	37.50	61.25	52.50	
Zone 8	18ST	DA	10.00	0.00	2.50	0.00	76.25	26.25	22.50	2.0798 (E)
		UD	55.00	35.00	72.50	22.50	23.75	73.75	73.75	
		A	35.00	65.00	25.00	77.50	0.00	0.00	3.75	
Zone 9	3FL	DA	41.25	18.75	6.25	35.00	41.25	0.00	0.00	2.2264 (E)
		UD	27.50	41.25	40.00	41.25	35.00	42.50	33.75	
		A	31.25	40.00	53.75	23.75	23.75	57.50	66.25	
Zone 9	11FL	DA	1.25	1.25	0.00	0.00	92.50	2.50	0.00	2.4757 (E)
		UD	2.50	17.50	17.50	23.75	5.00	36.25	67.50	
		A	96.25	81.25	82.50	76.25	2.50	61.25	32.50	
Zone 9	16FL	DA	0.00	0.00	0.00	0.00	8.75	0.00	0.00	2.5232 (HE)
		UD	41.25	42.50	32.50	41.25	56.25	38.75	62.50	
		A	58.75	57.50	67.50	58.75	35.00	61.25	37.50	

Table-3 : Contd...

Zone			Cost effective- ness s	Adoptability	Observ- ability	Traibility	Complexity	Relative advantage	Sustain- ability	MPEI
Zone 8	16FL	DA	0.00	7.50	17.50	0.00	25.00	0.00	22.50	2.3478 (E)
		UD	15.00	78.75	62.50	16.25	75.00	10.00	55.00	
		A	85.00	13.75	20.00	76.25	0.00	90.00	22.50	
Zone 9	22FL	DA	41.25	1.25	1.25	0.00	27.50	1.25	0.00	2.3841 (E)
		UD	32.50	31.25	10.00	32.50	61.25	42.50	66.25	
		A	26.25	67.50	88.75	67.50	11.25	56.25	33.75	
Zone 8	25FL	DA	0.00	17.50	2.50	21.25	2.50	10.00	20.00	2.1612 (E)
		UD	22.50	75.00	61.25	71.25	71.25	72.50	73.75	
		A	77.50	7.50	36.25	7.50	26.25	17.50	6.25	
Zone 8	29FL	DA	0.00	0.00	0.00	8.75	0.00	0.00	20.00	2.2870 (E)
		UD	22.50	72.50	73.75	71.25	57.50	67.50	80.00	
		A	77.50	27.50	26.25	20.00	42.50	32.50	0.00	
Zone 8	34FL	DA	0.00	0.00	1.25	0.00	42.50	1.25	22.50	2.2254 (E)
		UD	55.00	30.00	82.50	75.00	52.50	37.50	72.50	
		A	45.00	70.00	16.25	25.00	5.00	61.25	5.00	
Zone 8	44FL	DA	2.50	0.00	0.00	0.00	42.50	17.50	0.00	2.3812 (E)
		UD	35.00	23.75	30.00	22.50	57.50	68.75	63.75	
		A	62.50	76.25	70.00	77.50	0.00	1.25	36.25	

(Note: WF- Weather forecasting, SWC- Soil and water conservation, C-Crop cultivation, ST-Storage and FL-Fodder and livestock. DA-Disagree, UD-undecided and A-Agree)

Conclusions

ITK practices have a significant bearing on profitability of farming. Among the collected ITKs 12 ITKs were found to be highly efficient (17 WF, 26WF, 30WF, 6SWC, 5C, 6C, 17C, 18C, 19C, 6ST, 7ST, and 16FL). These ITKs received highest negative response with respect to complexity indicating they are very simple to adopt by the farmers and they have neutral response.

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Identification of Sources of Resistance Against *Cercospora* Leaf Spot of Mungbean in Kashmir

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Abstract

The investigations for identification of sources of resistance against *Cercospora* leaf spot of mungbean caused by *Cercospora canescens* Ellius and Martin, were conducted during at experimental plots of Division of Plant Pathology, SKUAST-K, Wadura. The prominent fifty mungbean genotypes were procured from Hissar Agricultural University. The experiment was laid in RBD with 03 replications. Each genotype was sown in 3m x 0.6m plots (2 rows) with inter-row and inter-plant spacing of 25 cm and 10 cm, respectively. One local susceptible cultivar was included in the screening programme and sown around the experimental blocks to ensure presence of abundant and uniform inoculum in the field. The genotypes were categorized on the basis of an established scale given by Sindhan *et al.*, 1999. The genotypes screened exhibited different response varying from resistant to susceptible reactions. The genotype SKAU-WMB-24 exhibited resistant reaction with a disease score of 1 while genotype, SKAU-WMB-25 was found moderately resistant with disease score of 2. Twenty four genotypes were found moderately susceptible with disease score of 3 while rest (24) genotypes were found susceptible with disease score of 4 and exhibited maximum disease incidence and intensity among the genotypes screened.

Key words : *Cercospora* leaf spot, Kashmir, mungbean, sources of resistance.

Introduction

Mungbean [*Vigna radiata* (L.) Wilczek] commonly known as 'Green gram' or 'Golden gram' is one of the most valuable short duration pulse crops grown in India (Pradhan *et al.*, 2017) and is next only to chickpea and pigeon pea in popularity (Sekar and Nalini, 2017). Mungbean is considered as the source of poor man's protein. The production of mungbean in India is approximately 1.5 to 2.0 million tonnes annually from about 3 to 4 million hectares of land with an average productivity of 0.5 t ha⁻¹ (Jadhav *et al.*, 2016). The important mungbean growing States in India are Orissa, Andhra Pradesh, Madhya Pradesh, Maharashtra and Jammu and Kashmir. The production of mungbean is about 84.10 thousand quintals and the productivity is 3.17 t ha⁻¹ in the State of Jammu and Kashmir (Jeelani and Choure 2015).

Mungbean is susceptible to several fungal diseases viz., *Cercospora* leaf spot, *Alternaria* leaf spot, anthracnose, charcoal rot etc (Pandey *et al.*, 2018). *Cercospora* leaf spot caused by *Cercospora canescens*, Ellius and Martin is considered as one of the most

important foliar diseases of mungbean due to its wide spread occurrence and susceptibility of many commercial varieties to this disease (Pandey *et al.*, 2018). In 1960, Munjal *et al.* first to reported mungbean leaf spot caused by *Cercospora canescens* from Delhi, India whereas Dar and Ghani (1997) reported it from Kashmir. This disease is prevalent in all parts of humid tropical areas of India, Bangladesh, Indonesia, Malaysia, Philippines and Thailand (Pandey *et al.*, 2009). Under natural epiphytotic conditions, yield loss ranging from 23 to 96 per cent has been reported by Kasno (1990) and Kaur (2007). In 2014, Bhat *et al.* reported leaf spot intensity ranging from 27.50 to 30.40 % and pod infection ranging from 34.00 to 35.40%.

In Jammu and Kashmir the incidence of *Cercospora* leaf spot disease has increased during last few years. Several techniques and methodologies including the use of chemical fungicides and botanicals have been investigated in order to manage the disease. However, one of the most economical and eco-friendly method of managing the disease, is the use of resistant varieties and to identify resistant germplasm(s), screening the available germplasm for identification of resistant sources

to this disease, *ipsofacto* has become the need of the hour and present investigations were carried on this aspect and the result are presented hereunder.

Materials and Methods

Screening of mungbean genotypes : The experiment was carried out during two consecutive years at FoA, Wadura. Fifty prominent genotypes of mungbean procured from Hissar Agricultural University, were screened and each genotype was replicated twice and the experiment was laid in CRBD design. Each genotype was sown in 3m x 0.6m rows (2 rows) with inter-row and inter-plant spacing of 25 cm and 10cm, respectively. On the basis of an established scale (Singh, 2001), the genotypes were categorized as follows :

Disease score	Disease intensity (%)	Category
0	0.00	Immune
1	0.1-5.0	Resistant
2	5.1-10.0	Moderately resistant
3	10.1-25.0	Moderately susceptible
4	25.1-50.0	Susceptible
5	Above 50.0	Highly Susceptible

(Singh, 2001)

Observations recorded : Disease incidence and intensity was recorded on ten plants representing each replication selected randomly at pod maturity stage. The formula used for calculations have been discussed are:

The per cent disease incidence on leaves was calculated by using the following formula :

$$\text{Disease incidence (\%)} = \frac{\text{Number of infected units}}{\text{Total no. of units examined}} \times 100$$

The disease intensity on leaves was calculated by using the following formula :

$$\text{Disease Intensity (\%)} = \frac{(n \times v)}{N \times G} \times 100$$

Where,

n = number of leaves in a category

v = numerical value of category

N = total of leaves examined and

G = maximum category value

The disease intensity on leaves was recorded using 0-7 scale.

0-7 Disease Intensity Scale

Disease Score	Description
0	No infection
1	up to 20% diseased area
3	21-40% diseased area
5	41-60% diseased area
7	> 60%

(Bhat, 2011)

Table-1 : Disease reaction of mungbean genotypes to *Cercospora canescens* under natural epiphytotic field conditions.

S. No.	Genotype	Disease Score	Disease Intensity* (%)	Response
1.	SKAU-WMB-1	4	40.14	S
2.	SKAU-WMB-2	4	31.58	S
3.	SKAU-WMB-3	4	49.47	S
4.	SKAU-WMB-4	3	22.77	MS
5.	SKAU-WMB-5	4	40.43	S
6.	SKAU-WMB-6	3	10.12	MS
7.	SKAU-WMB-7	3	17.39	MS
8.	SKAU-WMB-8	3	13.53	MS
9.	SKAU-WMB-9	4	29.96	S
10.	SKAU-WMB-10	4	25.18	S
11.	SKAU-WMB-11	3	23.19	MS
12.	SKAU-WMB-12	4	32.36	S
13.	SKAU-WMB-13	3	22.68	MS
14.	SKAU-WMB-14	3	19.96	MS
15.	SKAU-WMB-15	4	44.17	S
16.	SKAU-WMB-16	3	12.54	MS
17.	SKAU-WMB-17	3	23.48	MS
18.	SKAU-WMB-18	4	30.15	S
19.	SKAU-WMB-19	4	39.54	S
20.	SKAU-WMB-20	3	11.04	MS
21.	SKAU-WMB-21	4	27.98	S
22.	SKAU-WMB-22	3	13.57	MS
23.	SKAU-WMB-23	3	20.76	MS
24.	SKAU-WMB-24	1	4.88	R
25.	SKAU-WMB-25	2	8.89	MR
26.	SKAU-WMB-26	4	30.16	S
27.	SKAU-WMB-27	4	40.21	S
28.	SKAU-WMB-28	3	18.00	MS
29.	SKAU-WMB-29	3	21.69	MS
30.	Shalimar Mung-1	3	14.7	MS
31.	SKAU-WMB-31	3	11.14	MS
32.	SKAU-WMB-32	3	15.95	MS
33.	SKAU-WMB-33	4	33.64	S
34.	SKAU-WMB-34	4	26.42	S
35.	SKAU-WMB-35	3	17.76	MS
36.	SKAU-WMB-36	3	20.59	MS
37.	SKAU-WMB-37	4	32.72	S
38.	SKAU-WMB-38	4	29.08	S
39.	SKAU-WMB-39	4	41.10	S
40.	SKAU-WMB-40	4	30.6	S
41.	Local cultivar	4	27.45	S
42.	SKAU-WMB-42	4	25.65	S
43.	SKAU-WMB-43	3	20.44	MS
44.	SKAU-WMB-44	3	20.76	MS
45.	SKAU-WMB-45	3	12.35	MS
46.	SKAU-WMB-46	4	30.33	S
47.	SKAU-WMB-47	4	28.98	S
48.	SKAU-WMB-48	4	39.68	S
49.	SKAU-WMB-49	3	19.08	MS
50.	SKAU-WMB-50	3	20.70	MS

*mean of two years



Plate-1 : Screening of mungbean germplasm under field conditions.

Diseased samples showing typical symptoms were also collected from all the locations surveyed, placed between the folds of blotting paper after proper labelling and immediately taken to laboratory for further studies.

Results and Discussion

Fifty genotypes screened for resistance against *Cercospora* leaf spot under field conditions (Table-1, Plate-1) at experimental plots of FoA, Wadura exhibited different responses, ranging from resistant to susceptible reactions. The genotype SKAU-WMB-24 showed resistant reaction with a disease score of 1 on 0-5 evaluation scale and disease intensity of 4.88 per cent while one genotype namely SKAU-WMB-25 was found moderately resistant with disease score of 2 and disease intensity of 8.89 per cent. Twenty four genotypes viz., SKAU-WMB-4, SKAU-WMB-6, SKAU-WMB-7,

SKAU-WMB-8, SKAU-WMB-11, SKAU-WMB-13, SKAU-WMB-14, SKAU-WMB-16, SKAU-WMB-17, SKAU-WMB-20, SKAU-WMB-22, SKAU-WMB-23, SKAU-WMB-28, SKAU-WMB-29, Shalimar Mung-1, SKAU-WMB-31, SKAU-WMB-32, SKAU-WMB-35, SKAU-WMB-36, SKAU-WMB-43, SKAU-WMB-44, SKAU-WMB-45, SKAU-WMB-49 and SKAU-WMB-50 were found moderately susceptible with disease score of 3 and maximum per cent disease intensity of 10.12 to 23.48 per cent. The rest of genotypes viz., SKAU-WMB-1, SKAU-WMB-2, SKAU-WMB-3, SKAU-WMB-5, SKAU-WMB-9, SKAU-WMB-10, SKAU-WMB-12, SKAU-WMB-15, SKAU-WMB-18, SKAU-WMB-19, SKAU-WMB-21, SKAU-WMB-26, SKAU-WMB-27, SKAU-WMB-33, SKAU-WMB-34, SKAU-WMB-37, SKAU-WMB-38, SKAU-WMB-39, SKAU-WMB-40, Local cultivar, SKAU-WMB-42, SKAU-WMB-46,

SKAU-WMB-47 and SKAU-WMB-48 were found susceptible with disease score of 4 with maximum per cent disease intensity of 25.18 to 41.10.

However, no genotype was found highly susceptible. The response of different genotypes to *Cercospora canescens* under natural epiphytotic field conditions may be due their genetic variability. The resistant genotype identified in the present investigations, SKAU-WMB-24, may be used as direct introduction in Kashmir valley or a sources of resistance in hybridization programme.

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Screening of Tomato Varieties Against Root-Knot Nematode, *Meloidogyne incognita* in Poly-House

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Abstract

An experiment was conducted in poly-house to find out the source of resistance against *Meloidogyne incognita* in different tomato varieties for feasible and economic management of phytoparasitic nematodes, and to avoid chemical hazards for human health, cost of application etc. Ten varieties of tomato viz., Arka Abha, Badshah, Dev, Sarathi, Avtar, Shanshah, Polyana, Navuday, Emerald and Rajesh were screened for their reactions against root-knot nematode *Meloidogyne incognita* under poly house condition. Results revealed that out of 10 varieties of tomato, Rajesh, Emerald and Sarathi found moderate resistant. Badshah, Dev, Polyana, Avatar and Shanshah found susceptible and varieties Arka Abha and Navuday observed as highly susceptible to root-knot nematode.

Key words : *Meloidogyne incognita*, tomato, resistant, poly house and varietal screening.

Introduction

Tomato (*Solanum lycopersicum* Mill.) is one of the most important vegetable crop in the world. It is known to be one of the “protective foods” because of its special nutritive value only next to potato and onion. It belongs to family Solanaceae, has diploid chromosome number 24 and it is a self-pollinated crop. Tomato is rich in vitamin A and C and is a popular vegetable in the tropics and considered as an important cash crop for small farmers. It tops the list of industrial crops because of its outstanding processing qualities. Tomato is known to be originated from Peru, Ecuador and Bolivia on the basis of availability of numerous wild and cultivated relatives exist in this area. It is cultivated in both temperate and tropical regions of the world. It is used in both fresh and processed forms. It is consumed in a various way like fresh in salad and sandwiches, cooked or processed in ketchup, sauce, juice or dried powder. Tomato plays an important role in human nutrition by providing essential amino acids, vitamins and minerals. It also contains lycopene, which is very important antioxidant and can prevent cancer (Agarwal and Rao, 2000).

Tomato is a rich source of minerals, vitamins, organic acid and antioxidants, 100 g of edible portion of tomato contains 94.1 g of water, 1.0 g of protein, 0.3 g of fat, 4.0 g of carbohydrates, 0.6 g of fibre, vitamin A (1100 IU), vitamin B (0.20 mg), vitamin C (23 mg), malic acid (150 mg), citric acid (390 mg), oxalic acid (3.5 mg), potassium (268 mg) and phosphorus (27 mg). Several processed products like paste, puree, syrup, juice, ketchup, sauce, soup, drinks etc. are prepared by tomato on large scale. Sometimes, it is called poor man's orange.

Tomato is a very good appetizer and its soup is said to be a good remedy for patients suffering from constipation. It is used for treating chronic dyspepsia, bronchitis, asthma and also used as a blood purifier. Three flesh colours in tomato are available namely red (Lycopene pigment), yellow (carotenoid) and tangerine (prolycopene) present in tomato, are act as good antioxidant (Menzies *et al.*, 1992).

The major tomato growing countries are China, India, USA, Turkey, Egypt and Italy. In India the total area under tomato cultivation is 0.79 million hectares with annual production of 19.40 million tonnes (NHB, 2018-19) while major tomato production states are Bihar, Orissa, Andhra Pradesh, Karnataka, Utter Pradesh, Maharashtra, and Tamilnadu. In terms of Rajasthan, total area of under production of tomato is nearby 0.08 million hectares with production 0.09 million tonnes and productivity 5010 kg/ha. The area of tomato production in Udaipur district is 111 hectares with production 301 tonnes and productivity 2750 kg/ha of tomato. (Horticulture Department, Jaipur, 2018-19).

In India Damage to plants is influenced by root penetration, development, reproduction potential and inoculums density of *M. incognita* in adjacent soil (Shahab, Sharma 2011). It also alters the host physiology and on severe infestations can kill the tomato plant outright (Kamran *et al.*, 2010). Various approaches such as chemical application, good agricultural practices (GAP), resistance breeding etc. have been devised to manage RKN. It has been found that root-knot nematodes may enter susceptible and resistant tomato varieties in about equal numbers. Hence breaking of resistance in tomato cultivars to *M. incognita* may occur naturally or by

selection of tomato plants with one or more resistant genes (Khan and Nirupma, 2000). The primary objective of the current research was to evaluate the available tomato genotypes by screening method against root knot nematode *M. incognita*.

Materials and Methods

Ten varieties of tomato were obtained from Rajasthan Agriculture Research Institute (RARI) Durgapura, Jaipur (Rajasthan) Seeds of these varieties were treated with fungicide (Thirum 3g/kg) to avoid seed borne pathogens and sown in plastic glass which having steam sterilized soil. Three seeds of each variety were sown in each glass and after germination only one healthy established plant was kept and others were uprooted carefully. After 15 days of germination each variety and each experiment were inoculated through freshly hatched 1000 2nd stage larvae of root-knot nematode per ml suspension were estimated by counting under the binocular stereoscopic microscope. The measured suspension was poured in the holes made around the plant roots and then the holes were plugged immediately. Each variety was replicated three times. Plastic pots were kept in poly-house and watered regularly every day.

After 30 days of inoculation plants were uprooted gently with soil from the glass and roots were washed gently under running tap water for removing adhering soil particles. These roots were then stained in 0.1 per cent acid fuchsin lactophenol at 80 °C for 1-2 minutes, washed with tap water and kept in plain lactophenol. After 24 hours these roots were examined under stereoscopic binocular microscope for counting the number of galls per plant, number of egg masses per plant and number of eggs and larvae per egg mass. For counting number of eggs and larvae per egg mass, three well developed egg masses from each variety were detached carefully and kept in a drop of lacto-phenol on glass slide covered with a cover slip and pressed gently, so that egg mass was well spread and eggs were counted with the help of telecounter. On the basis of number of galls per plant, the varieties were graded by an arbitrary root-knot infection index suggested by (Taylor and Sasser, 1978).

Host susceptibility designation

Scale	Particulars	Reactions
1	No galls/plant	highly resistant
2	1-10 galls/plant	Resistant
3	11-30 galls/plant	moderately resistant
4	31-100 galls/plant	Susceptible
5	above 101 galls	highly susceptible

Results and Discussion

Number of galls per plant : Data presented in table-1 showed that all the varieties screened, root-knot

nematode had an average number of galls (61.36) with the range of 17 to 145.00 galls per plant. Out of ten varieties none was found immune, resistant and highly resistant, however three varieties viz., Rajesh, Sarthi, and Emerald showed moderately resistance reaction by producing 18.67, 24.33, and 21.00 galls per plant. Five varieties namely Dev, Shanshah, Polyana, Avatar and Badshah showed susceptible reaction by producing 71.33, 90.33, 88.66, 90.00 and 50.00 galls. Remaining two varieties are highly susceptible Arka Abha and Nav Uday producing 107.66, 136.67 galls, respectively.

Number of egg masses per plant : Results presented in Table-1 showed that all the varieties screened root-knot nematode had an average number of egg masses (43.97) with the range of 17.50 to 110.0 egg masses per plant. Out of ten varieties screened three varieties namely; Rajesh, Sarthi and Emerald showed moderately resistance reaction by producing 15.25, 18.50, and 17.50 egg masses per plant. Five varieties namely; Dev, Shanshah, Polyana, Avatar and Badshah showed susceptible reaction and produced 52.50, 57.75, 61.00, 65.25 and 35.00 egg masses per plant. While remaining two varieties viz., Arka Abha and Nav Uday reaction was highly susceptible produced 67.00 and 110.00 egg masses per plant, respectively.

Number of larvae per egg mass : Results presented in Table-1 showed that all the varieties screened root-knot nematode had an average number of egg and larvae (249.73) with the range of 240.00 to 265.50 larvae per egg mass. Out of ten varieties screened three varieties namely; Rajesh, Sarthi and Emerald showed moderately resistance reaction by producing 256.00, 253.25 and 255.25 larvae per egg mass. Five varieties namely; Dev, Shanshah, Polyana, Avatar and Badshah showed susceptible reaction and produced 245.00, 248.19, 244.75, 265.50 and 246.25 eggs and larvae per egg mass. While remaining two varieties viz., Arka Abha and Nav Uday reaction was highly susceptible produced 243.16 and 240.00 larvae per egg mass, respectively.

Gurjar *et al.* (2021) evaluated the ten varieties of tomato against *Meloidogyne incognita* under greenhouse conditions. Results showed that out of 10 varieties of tomato Arka-rakshak, Sikandar, Emerald and Sarathi found moderate resistant. Badshah, Dev, Subriyano and Shanshah found susceptible and varieties Kanak and Navoday observed as highly susceptible to root-knot nematode.

Bhargava and Sharma (2001) also screened twenty chilli and twenty one tomato out of which, 11 cultivars were resistant and two tomato cultivars were moderately resistant against root-knot nematode. Sant *et al.* (2004) reported that Cultivars Punjab Chhuhara, NF-31,

Table-1 : Screening of tomato varieties against root-knot nematode, *Meloidogyne incognita* in poly-house.

S. No.	Name of variety	Nematode reproduction						Root-Knot Index (1-5)	Reaction
		Number of galls per/plant				Number of egg masses/plants	Number of larvae/egg masses		
		R ₁	R ₂	R ₃	Range				
1.	Dev	75.00	71.00	68.00	70-75	52.50	245.00	4	S
2.	Arka Abha	110.00	105.00	108.00	105-110	67.00	243.16	5	HS
3.	Shanshah	87.00	90.00	94.00	85-94	57.75	248.19	4	S
4.	Rajesh	19.00	20.00	17.00	17-20	15.25	256.00	3	MR
5.	Polyana	84.00	92.00	90.00	84-92	61.00	244.75	4	S
6.	Sarathi	25.00	22.00	26.00	22-26	18.50	253.25	3	MR
7.	Emerald	22.00	20.00	21.00	20-22	17.50	255.25	3	MR
8.	Avatar	95.00	83.00	92.00	83-95	65.25	265.50	4	S
9.	Badshah	55.00	50.00	45.00	45-55	35.00	246.25	4	S
10.	Nav udav	130.00	145.00	135.00	130-145	110.00	240.00	5	HS

Initial Nematode Population 525 larvae/ 200 cc Soil

S= susceptible HS= highly susceptible MR= Moderate Resistant

NF-315-10 and VFN-8 showed resistant reaction and cultivars H-88 and H-88-78 showed moderately resistant reaction against root-knot nematode.

Naidu *et al.* (2006) screened six tomato, 5 brinjal, 3 okra and 13 chilli cultivars including one local control for each crop, for resistance to the *Meloidogyne incognita*, moderate resistance was recorded in brinjal cv. Syamala, okra cv. Parbhani Kranthi, and chilli cultivars Wonder Hot, Teja and LCA 206. All the other cultivars showed susceptible to highly susceptible reaction. Gitanjali *et al.* (2007) screened nine tomato varieties, including variety Sel-2 as a susceptible check where all the varieties/lines were found susceptible to *Meloidogyne incognita*.

Rai *et al.* (2010) also screened thirty five genotypes of tomato and observed none of them resistant to root-knot nematode. Only one genotype, EC-520070 (*Lycopersicon pimpinellifolium*) was recorded moderately resistant reaction to the nematode while, rest of the genotypes were found susceptible to root-knot nematode, *Meloidogyne incognita*. Ibrahim *et al.* (2014) also evaluated eight tomato and six potato cultivars to the root knot nematode in the greenhouse. The tomato cultivars Asala, Castle Rock, Edkawy and Giza 80 were susceptible or highly susceptible to root-knot nematode, *Meloidogyne incognita*. The potato cultivars Edward were susceptible to *Meloidogyne incognita*.

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Compositional Effects on Room Temperature Electrical Properties of Modified MgFe_2O_4 Spinel Ferrites

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Abstract

There has been a significant amount of work done on AB_2O_4 compounds because they show interesting structural, electrical and magnetic properties. The properties of these compounds can be easily tailored by substitution of different ions and their distribution amongst tetrahedral and octahedral sites. In the same way, to achieve some favourable modifications in the properties of $\text{Mg}_{0.5}\text{Ni}_{0.5}\text{Fe}_2\text{O}_4$ spinel ferrite, Bi_2O_3 was selected as modifying oxide material. The material series of spinel ferrites with compositional formula $\text{Mg}_{0.5}\text{Ni}_{0.5}\text{Fe}_{2-x}\text{Bi}_x\text{O}_4$, with $x = 0.06, 0.08, 0.10$ were prepared by solid-state reaction method. Dielectric behaviour was studied as a function of frequency range 5kHz to 1MHz at room temperature (30°C). Effect of Bi-substitution on dielectric constant (ϵ'), tangent loss ($\tan \delta$) and electrical conductivity (σ_{ac}) was observed and discussed here.

Key words : Dielectric; spinel ferrite; ac conductivity

Introduction

The basic properties of spinel ferrites (AB_2O_4) such as structural, magnetic and electrical etc. have been the subject of tremendous interest for investigators [1]. These materials are basically ferromagnetic dielectric materials, which shows both magnetic and electrical properties such as high permeability and saturation magnetization, high electrical resistivity and low power losses which makes them usable in different applications [2]. Spinel ferrite with general formula AFe_2O_4 (A= Mn, Ni, Mg, Zn or Co) are the most important class of magnetic materials due to their alluring properties such as low melting point, high specific heat, large expansion coefficient and low magnetic transition temperature [3-4]. Magnesium ferrite (MgFe_2O_4) is one of the most important ferrites. Particularly, it is the distribution of the cations among the spinel tetrahedral and octahedral sites that determine many of the magnetic properties [5-6]. Due to its low melting point (below 1000°C) Bi_2O_3 has been always helpful for sintering aid. It has been investigated that Bi_2O_3 is useful in the grain growth, densification of Ni-Zn ferrites prepared by solid state reaction route. It is also reported that Bi_2O_3 promotes grain growth via liquid phase sintering and addition of optimum content of Bi_2O_3 enhances density and reduces porosity. Bi^{3+} substituted Ni-Cu ferrites have been also studied for their structural, electrical and magnetic properties [7]. This paper addresses the effects of Bi^{3+} substituted on the electrical properties of $\text{Mg}_{0.5}\text{Ni}_{0.5}\text{Fe}_{2-x}\text{Bi}_x\text{O}_4$, with $x = 0.06, 0.08, 0.10$ by solid state reaction method.

Materials and Methods

Ferrites with the general formula $\text{Mg}_{0.5}\text{Ni}_{0.5}\text{Fe}_{2-x}\text{Bi}_x\text{O}_4$ ($x = 0.06, 0.08, 0.10$) were prepared by solid state reaction method. Analytical reagent (AR) grade metal oxide such as MgO, NiO, Bi_2O_3 and Fe_2O_3 are used as the raw material. The oxides are weighed in required molar proportion satisfying the stoichiometry of the composition and mixed in distilled water. The samples were ball milled for 12 hours using zirconia balls and distilled water as milling media. The slurry was dried in hot air oven. The dried powder was calcined at 850°C for 4 hours in a conventional furnace. The calcined powder was ball milled for 12 hours again. Small amount of dilute polyvinyl alcohol (PVA) binder was added to the dried powder and then it was uniaxially pressed into pellets of (10 mm diameter and 2 mm thickness) using hardened die at pressure of 10 tons. The compacted discs were sintered at 1100°C for 4 hours with constant heating rates of 5°C per min. The sintered pellets were lapped using micro-grit powder on a flat glass surface and then samples were cleaned in ultrasonic cleaner. High temperature silver paste was applied on flat surfaces of the samples for electroding. The dielectric properties were measured these frequencies range from 5kHz to 1MHz, using a Wayne Kerr LCR Meter at 30°C for all the samples.

Results and Discussion

The variation of dielectric constant (ϵ') with frequency for $\text{Mg}_{0.5}\text{Ni}_{0.5}\text{Fe}_{2-x}\text{Bi}_x\text{O}_4$ ($x=0.06, 0.08, 0.10$) is shown in figure-1. We observed that the dielectric constant decreases with increase in frequency which shows the dielectric dispersion behaviour [8]. Small substitution of

bismuth doesn't lead to quality results because of its low melting point, so there is need to add sufficient amount of Bi in this composition to get the desired result. The dielectric constant decreases abruptly up to 100kHz and small decrease can be noticed in it at frequencies above 100kHz. At small frequencies all type of polarizations such as space polarization, orientational and electronic polarization contribute to the dielectric constant where as at higher frequencies the contribution due to space polarization decreases [9]. Therefore, above 100 kHz a small decrease can be observed. Maximum value of dielectric constant can be observed for samples with $x=0.08$. The values of dielectric constant at 10kHz and 1MHz are given in table-1. The decrease in dielectric constant with frequency clearly shows that substitution of Bi^{3+} introduces inhomogeneities in the material.

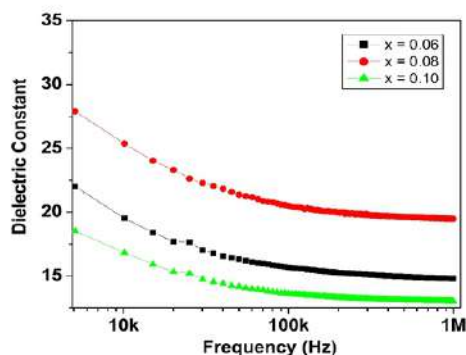


Figure-1 : Variation of dielectric constant with frequency for all the samples.

The variation of tangent loss ($\tan \delta$) as a function of frequency for all the samples is shown in figure-2. The tangent loss shows similar decreasing trend with increase in frequency. It can also be observed from the graph that $\tan \delta$ decreases with increases in Bi-contents. The value of $\tan \delta$ at 10kHz to 1MHz are given in table-1. Small values of $\tan \delta$ for all the samples show that substitution of Bi^{3+} for Fe^{3+} reduces the hopping between Fe^{3+} to Fe^{2+} , which is result decrease in $\tan \delta$ [10].

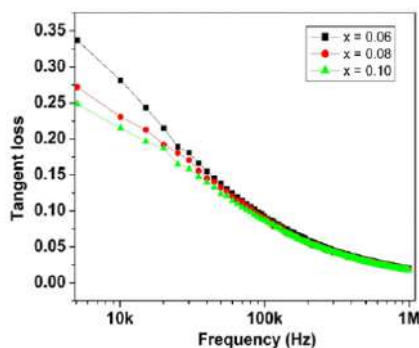


Figure-2 : Variation of tangent loss ($\tan \delta$) as a function of frequency for all the samples.

Figure-3 shows the variation of ac conductivity (σ_{ac}) as a function of frequency at 30°C for all the samples. σ_{ac} was calculated by using the formula :

$$\sigma_{ac} = \omega \epsilon_0 \tan \delta$$

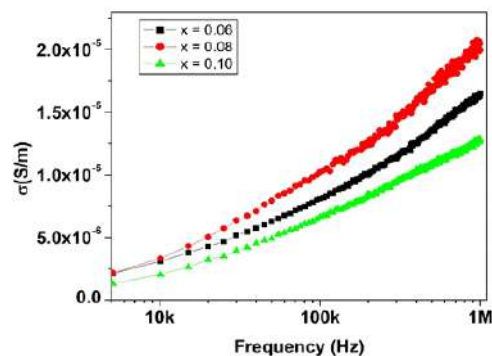


Figure-3 : Variation of Conductivity ' σ_{ac} ' with frequency for all the samples.

Table-1 : The values of ϵ , $\tan \delta$ and σ_{ac} for all the samples at 10 kHz and 1MHz.

x	at 10kHz			at 1MHz	
	ϵ	$\tan \delta$	σ_{ac}	$\tan \delta$	σ_{ac}
0.06	20	0.28	3.09×10^{-6}	0.02	1.65×10^{-5}
0.08	25	0.23	3.29×10^{-6}	0.01	1.99×10^{-5}
0.10	17	0.22	2.03×10^{-6}	0.01	1.28×10^{-5}

Variation of σ_{ac} with frequency show typical behaviour of conductivity of ferrites as described by Koop's Theory. It increases with increase in frequency. It can be noticed from the graph that variation of σ_{ac} with substitution of Bi^{3+} at Fe^{3+} ions is different at different frequencies. The value of σ_{ac} at 10kHz and 1MHz for all the samples are given in table-1. At low frequencies (below 10kHz) there is small variation in σ_{ac} can be noticed while at the high frequencies (above 10 kHz) it varies abruptly with Bi^{3+} substitution. However, in overall the samples show low values of σ_{ac} (order of 10^{-5}) which shows that the prepared samples are having high resistivity and hence low dielectric constant [11].

Conclusions

Polycrystalline ferrite sample with composition is $\text{Mg}_{0.5}\text{Ni}_{0.5}\text{Fe}_2\text{O}_4$ ($x=0.06, 0.08, 0.10$) prepared by solid state reaction route. The prepared samples show low value of dielectric constant and $\tan \delta$. Sample with $x=0.08$ show maximum dielectric constant whereas $\tan \delta$ decreases monotonically with increase in x .

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Study of Nutritional, Sensory Quality and Storage Stability of Wood Apple (*Limonia acidissima* L.) Burfi

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Abstract

The present study conducted during 2019-20 and 2020-21 at laboratory Department of Horticulture, Collage of Agriculture, Gwalior (M.P.). This was aims to prepare different product with using wood apple pulp which is botanically known as (*Limonia acidissima* L.) and evaluated its shelf- life conditions. In study wood apple khoa burfi prepared from semi-dehydrated milk (khoa), which was blended with wood apple by weight 30%, 40% and 50% of khoa. Prepared product i.e. burfi is found delicious, sweet khoa based dish. Wood apple is nutrient rich fruit which contains high amount of protein and low amount of sugar, carbohydrates, compared to other underutilized fruit crops. The present study found that nutritional, chemical components, quality and sensory evaluation of wood apple burfi and the best result found in T1 i.e. wood apple blend in khoa in ratio of (30:70).

Key word : Wood apple, khoa burfi, nutrients, chemical, and sensory evaluation, stability.

Introduction

Wood apple is botanically known as (*Limonia acidissima* L.) belongs to the family Rutaceae. It is one of the most important underutilized indigenous fruit of India and a very hardy fruit crop found all over the plains of Southern Maharashtra, West Bengal, Uttar Pradesh, Chhattisgarh and Madhya Pradesh. Wood apple is nutrient rich fruit which contains high amount of protein and low amount of sugar, carbohydrates, compared to other underutilized fruit crops. Wood apple fruit contains flavonoids, glycosides, saponins and tannins. There are reports that some coumarins and tyramine derivatives were also isolated from this fruits. (Ilango and Chitra, 2009). The ripe fruit pulp makes excellent chutney and it is also consumed afresh along with sugar (Veeraraghavathatham *et al.*, 1996, 2008). The ripe fruit is used as a dessert and source of beverage, cream, jelly, jam, RTS, chutney etc. Burfi has been as one of the most popular khoa based sweets all over India. The unique adaptability of khoa in terms of its flavor, body and texture to blend with a wide range of food adjuncts is permitted in the development of an impressive array of burfi varieties. Among these fruit, nut, chocolate, coconut, saffron and rawa burfi are popular one. The artful ingenuity of the sweet maker in creating special qualities in burfi fetches the highest consumer price e.g. burfi prepared with cashew nut (kaju katli) almond, pistachio, coconut, mango, orange, mud apple, bottle gourd and potato (Shelke *et al.*, 2008)

Materials and Methods

In the study fresh and uniform size of wood apple fruits were purchased from the local market of Gwalior (M.P.). Fruits were selected by taking into consideration of various factors such as soundness, firmness, cleanliness, size, maturity, weight, shape and freedom from foreign matters. Unripe and ripe fruits of wood apple were classified and use for preparation of various value added products. The fruits of wood apple were graded to select fruits according to treatment having uniform maturity. Fruits were first washed to remove the dirt. The fruits of wood apple were broken into small pieces with the help of small hammer and scoop out the pulp with the help of spoon, after that cook with water until very soft and gently grind.

Treatments combinations and statistical analysis :

T₁- Wood apple khoa burfi – pulp : khoa :: 30 :70

T₂- Wood apple khoa burfi – pulp : khoa :: 40 :60

T₃- Wood apple khoa burfi – pulp : khoa :: 50 :50

The experiment carried with CRD design with 3 treatments and 3 replications.

Wood apple-khoa burfi preparation :

Wood apple burfi is now getting popularity. The use of wood apple pulp in burfi not only enhance flavor, but also helpful in utilizing this perishable acidic fruit in its production season and ultimately storage cost become less. For preparing wood apple burfi first khoa heated

gently till pat formation and when the product started to leave the sides of *karahi* (within 5 to 8 min) the wood apple pulp was added and further heated on low flame till the product again started to leave the side of *karahi*. Finally prepared product taken off the flame and transferred into a ghee smeared tray and allowed to cool for 10-20 hours and cut into desirable size. Flowchart of preparation of wood apple burfi illustrated in Figure-1.

Proximate analysis of burfi:

Phosphorus (g) : The phosphorus was estimated Colorimetrically by using vanadomolybdate as indicator (Koeing and Johnson, 1942).

Pectin content (g) : It was determined by method described by Mazumder and Manickam (2008).

Total mineral-Ash (g) : Ash represents the inorganic residue as total minerals, determined as per AOAC (2000).

Crude protein (g) : Determined as per AOAC (2000) method.

Crude fiber (g) : Determination as per AOAC (1984) method.

Crude fat (g) : Determined by Chloroform-Methanol Method of AOAC (1984).

Carbohydrate (g) : Carbohydrate estimated by the phenol sulphuric acid method.

Calcium (g) : Calcium was estimated by the method of Sadasivam and Manickam (2008).

Total Phenol content (g) : Total phenol content was determined by Folin Ciocalteu reagent (McDonald *et.al.*, 2001).

Moisture (%) : Determined as per AOAC (1984).

Total Soluble Solids (%) : Measured by using digital hand refractometer (Model: Atazo, Japan) at room temperature and results were expressed in degree Brix (°B).

pH : The pH of pulp was determined by using digital pH meter (Model: Elico).

Titrateable Acidity (%) : The titrateable acidity was determined by titrating N sodium hydroxide solution using phenolphthalein as indicator by method suggested by AOAC (1980).

Ascorbic acid : Estimated by using 2, 6- Dichlorophenol-indophenol visual titration (Ranganna, 1986).

Reducing Sugar : It was estimated by the method of AOAC (1980).

Non-Reducing Sugar : The amount of non-reducing

sugar was calculated by subtracting reducing sugars from total sugar and multiplying the difference by factor 0.95 as suggested by AOAC (1980).

Total Sugar : Estimated by the standard method of AOAC (1980).

Sensory Evaluation : The quality of wood apple products was judged by offering the sample to the panel of 5 judges in each trial separately. Score card method for sensory evaluation of products as suggested by Pal and Gupta (1985) was adopted as details below.

Characters	Score
1. Color	9
2. Flavor	9
3. Texture	9
4. Taste	9
5. Overall acceptability	9

Overall acceptability was determined by a trained sensory panel (minimum of 5 members) on a 9-point hedonic scale as prescribed by Nelson and Trout (1964). Details given below.

Hedonic rating		
Remarks	Score	
1. Like extremely	9	
2. Like very much	8	
3. Like moderately	7	
4. Like slightly	6	
5. Neither like nor dislike	5	
6. Dislike slightly	4	
7. Dislike moderately	3	
8. Dislike very much	2	
9. Dislike extremely	1	

Note : Score of 5.5 and above indicates acceptability within the score of 1 to 9.

Results and Discussion

Nutritional analysis of fresh wood apple revealed that it contains 6.72 g crude protein, 0.85 g crude fibre, 3.88 g crude fats, 18.17 g carbohydrates, 1.78g total minerals, 0.24 g calcium and 0.66g phosphorous per 100 g of pulp respectively. Similarly, these levels of nutritional composition of wood apple pulp was also reported and reviewed by Hemalatha and Parameshwari (2019) & Mani and Mitra (2020). When compared with fresh wood apple pulp, wood apple khoa burfi was found to be more nutritious containing 12.67, 11.00 and 10.08 g crude

Table-1 : Nutritional composition of wood apple pulp and burfi.

Nutrients content	T ₀	T ₁	T ₂	T ₃
Crude protein	6.72	12.67	11.00	10.08
Crude fiber	0.85	0.97	0.92	0.88
Crude fat	3.88	12.20	10.42	8.92
Carbohydrate	18.17	19.50	21.33	22.17
Total mineral	1.78	2.42	2.33	2.45
Calcium	0.24	0.71	0.62	0.50
Phosphorous	0.66	0.22	0.20	0.19

Table 2 : Quality of wood apple pulp and burfi during storage.

Chemical content (DAS)	T ₀		T ₁		T ₂			T ₃		
	1	1	30	60	1	30	60	1	30	60
Moisture (%)	69.33	15.83	15.00	11.50	16.67	16.00	12.50	17.67	17.00	13.17
pH	4.07	4.42	4.00	3.40	4.25	3.87	3.30	3.92	3.85	3.18
TSS	12.48	85.33	86.33	87.33	84.67	85.33	86.50	83.17	84.33	85.17
Acidity (%)	3.25	1.33	1.50	1.68	1.88	2.13	2.35	2.20	2.40	2.58
Reducing sugar (g)	2.23	18.58	19.42	20.42	21.00	22.00	23.00	21.00	22.33	23.50
Non reducing sugar (g)	5.63	32.42	32.59	32.59	31.84	31.84	31.84	33.33	33.00	32.83
Total sugar (g)	7.87	51.00	52.00	53.00	52.83	53.83	54.83	54.33	55.33	56.33
Non enzymatic browning	00	0.25	0.29	0.31	0.26	0.27	0.29	0.27	0.28	0.30

DAS-Days of storage

protein in T₁, T₂ and T₃ respectively, 0.97, 0.92 and 0.88 g crude fiber in T₁, T₂ and T₃ respectively, 12.20, 10.42 and 8.92 g crude fats in T₁, T₂ and T₃ respectively, 19.50, 21.33 and 22.17 g carbohydrates in T₁, T₂ and T₃ respectively, 2.42 g, 2.33g and 2.45g total minerals in T₁, T₂ and T₃ respectively, 0.71g, 0.62g and 0.50g calcium in T₁, T₂ and T₃ respectively and 0.22g, 0.20g and 0.19g phosphorous in T₁, T₂ and T₃ respectively as per 100 g of khoa burfi respectively (Table-1). The nutritional level of khoa burfi had been increased due to the addition of other ingredients.

Moisture percent (%) 15.83, 15.00 and 11.50 in T₁, 16.67, 16.0 and 12.50 in T₂ and 17.67, 17.00 and 13.17 in T₃ as per 100g at 1, 30 and 60 DAS respectively. Moisture content decrease with increasing storage period due to increasing TSS of khoa burfi. Similar result also quoted by Kumar and Deen (2017). pH value recorded 4.42, 4.0 and 3.40 in T₁, 4.25, 3.87 and 3.30 in T₂ and 3.92, 3.85 and 3.18 as per 100g 1, 30 and 60 DAS respectively. Decrease in pH can be attributed to increase in acidity 1.33, 1.50 and 1.68% in T₁, 1.88, 2.13 and 2.35% in T₂ and 2.20, 2.40 and 2.58% in T₃ at 0, 30 and 60 days of storage respectively (Table-2). Remarkable increase in percent acidity was observed during 60 days of storage period, irrespective of recipe used. Maximum acidity was reported in khoa burfi at 60 days of storage. The increased acidity is due the fermentation of sugars to acids with course of time, which also prevents the growth of harmful bacteria and moulds increasing the self-life of khoa burfi. Similar results were also obtained by Gadekar *et al.*, (2018).

Total sugar content in khoa burfi gradually increased

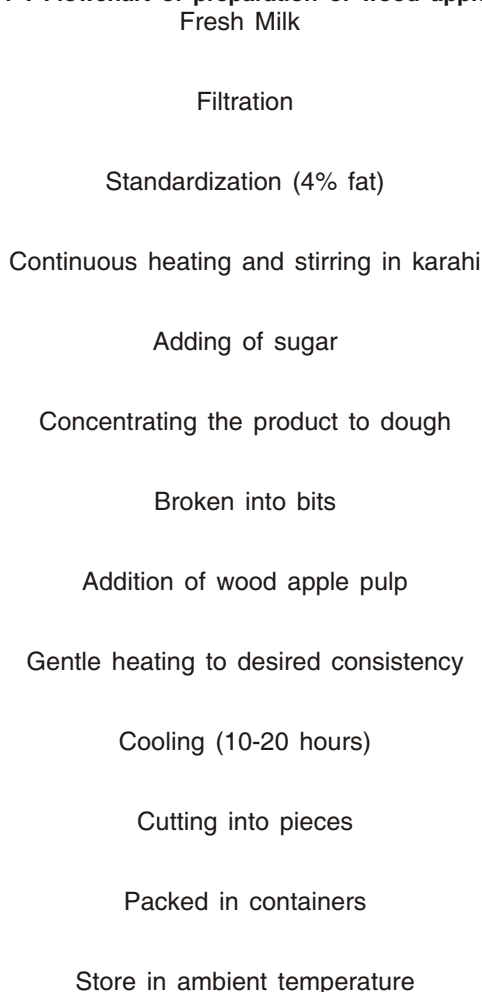
as 51.00, 52.00 and 53.00% in T₁, 52.83, 53.83 & 54.83% and 54.33%, 55.33% & 56.33% at 0, 30 and 60 days of storage respectively (Table-2). The increase in sugar would be attributed to conversion of starch and other insoluble carbohydrate into sugars. These results were also observed by Pota *et al.*(1987). Slight chemical change during storage like moisture content decreased with increasing storage period from 15.83, 15.0 and 11.50% in T₁, 16.67, 16.0 and 12.50% in T₂ and 17.67, 17.0 and 13.17% in T₃ as per 100g at 1, 30 and 60 DAS respectively. (Table-2). Moisture content decrease with increasing storage period due to increasing TSS of khoa burfi. The decrease in moisture content is due to the dehydration phenomenon. Similar result also recorded by Kumar and Deen (2017).

The organoleptic evaluation shows, gradual reduction in mean score for overall acceptability after 60 days of storage. Consistency remains same and the taste declined, flavor change was observed, reduction in appearance and taste of khoa burfi in storage occurred after 60 days of storage. Hence, maximum storage at 60 days at freezing temperature may give better acceptability. Over the storage month sensory evaluation of khoa burfi revealed fewer amounts of change in colour, flavor, texture, test, and overall acceptability (Table-3). Browning of khoa burfi with time is the possible cause of slight colour and flavor change. Significant increased sourness of khoa burfi with storage time might be one of the possible reasons for flavor changes and reduction in overall acceptability. Similar result also quoted by Gadekar *et al.* (2018). Freshly made wood apple khoa burfi showed high overall acceptability which reduced with time of storage.

Table-3 : Sensory evaluation of wood apple pulp and burfi during storage.

Sensory evaluation DAS	T ₁			T ₂			T ₃		
	1	30	60	1	30	60	1	30	60
Colour	6.5	5.8	4.2	6.8	5.2	3.8	6.2	5.1	3.9
Flavor	8.2	6.5	4.0	7.5	6.0	4.2	6.7	4.3	2.8
Texture	8.0	6.9	5.0	8.1	6.2	4.9	7.0	5.9	4.2
Taste	7.8	6.0	4.8	7.4	5.3	3.3	7.1	5.0	3.1
Overall acceptability	8.1	6.1	4.3	7.2	5.1	4.0	7.0	5.1	3.9

DAS-Days of storage

Figure-1 : Flowchart of preparation of wood apple burfi

Conclusions

A wood apple fruit has high nutritive property. Wood apple khoa burfi is a nutrient rich and tasty product and their organoleptic evaluation revealed that wood apple khoa burfi can be consumed 60 days of storage without major organoleptic and nutra- chemical changes and is a good source of protein, fiber, calcium and phosphorous. Overall acceptability of wood apple khoa burfi was very good and its consumption is safe for human health.

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Genetic Variability and Correlation Analysis of Morphological, Yield and Fiber Traits in Desi Cotton (*Gossypium arboreum* L.)

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Abstract

The yield potentiality of the cotton genotypes can be enhanced through genetic analysis of diverse genotypes. In the present investigation, 25 diverse set of breeding lines were evaluated for morphological, yield and fiber quality traits in desi cotton. The analysis of variance showed that the presence of significant differences among the genotypes for nine evaluated traits. Correlation analysis clearly indicated the significant and positive correlation between seed cotton yield and boll weight. Among the nine evaluated traits, seed cotton yield, bolls per plant and boll weight are the three key traits needs to be considered for improvement of yield in desi cotton. Further, based on seed cotton yield, the genotypes NDLA-3104-4, NDLA-3113, NDLA-3116-4, NDLA-3111-5 and NDLA-3115-2 were found five efficient genotypes and can be exploited in crop improvement programmes in desi cotton.

Key words : Mungari cotton, seed cotton yield, fiber traits and correlation.

Introduction

Cotton (*Gossypium spp.*) is the world's leading natural textile fibre crop and plays a significant role in industrial and agricultural economy of the country. Globally, cotton is cultivated over an area of 32.20 m ha with a production of 1133.15 (lakh bales) and a productivity of 766 Kg ha⁻¹ (AICRP on Cotton Project Coordination report, 2020-21). In India, it has grown in an area of 129.59 lakh hectares with a production of 371 lakh bales and a productivity of 487 Kg ha⁻¹ (AICRP on Cotton Project Coordination report, 2020-21). Cotton is the most important fibre crop as it provides the basic raw material (cotton fibre) to cotton textile industry. There are 4 cultivated species of cotton viz., *Gossypium arboreum*, *Gossypium herbaceum*, *Gossypium hirsutum* and *Gossypium barbadense*. The first two species are diploid and are also known as Asiatic cottons. The last two species are tetraploid and are also referred to as New world cottons. Among these, desi cotton (*Gossypium arboreum*) has naturally inherited stress tolerant characters such as drought tolerance and tolerance to several pests like hopppers, white flies, thrips and aphids (Sun *et al.*, 2017). Besides, natural *Gossypium arboreum* fibres display various colours including white, off-white and tan and some of the accessions produce fibres with very high strength (Ashraf *et al.*, 2018).

The important parameters of desi cotton are seed cotton yield per plant, ginning percentage, halo length, bolls per plant and boll weight. Nawaz *et al.* (2019) reported that presence of significant differences among

the genotypes for yield contributing traits will provides the efficient selection of genotypes in crop improvement. Correlation analysis revealed that seed cotton yield had a significant positive correlation with plant height, number of bolls per plant, ginning percentage and staple length (Rehman *et al.*, 2020). Specifically in cotton, the significant correlation between seed cotton yield, fiber traits, biotic and abiotic stress tolerance traits will adds the additional advantage in genetic improvement of economic traits. Correlation for various seedling traits including root length, shoot length, root dry weight, fresh shoot weight and total plant weight were positively and significantly correlated with yield traits in advanced cotton lines (Riaz *et al.*, 2013). Therefore, the presence of significant variability coupled with positive correlation among the yield and fiber traits is the criteria for genetic improvement in cotton. Keeping this in mind, the present study was framed with objectives of assessment of genetic variability among the desi cotton genotypes for yield and fiber traits as well as the correlation analysis among the yield and fiber traits in desi cotton genotypes.

Materials and Methods

The present investigation was carried out using 25 diverse desi cotton advanced breeding lines developed at Regional Agricultural Research Station, Nandyal including NDLA-3020, NDLA-3094, NDLA-3104-4, NDLA-3113, NDLA-3115-2, NDLA-3116-4, NDLA-3091, NDLA-3116-3, NDLA-3106-2, NDLA-3109-4, NDLA-3111-5, NDLA-3114-3, NDLA-3109, NDLA-3139-3, NDLA-3128-2, NDLA-3105-5, NDLA-3129-1, YAGANTI, NDLA-3146-1, NDLA-3145-1,

Table-1 : ANOVA table of nine morphological traits in cotton.

Variables	Mean sum of squares			CV%	h ²
	Genotype	Replication	Error		
Degrees of freedom	24	2	48		
Days to 1 st flowering	3.16*	14.56***	1.32	2.28	0.32
Days to 50% flowering	3.45*	16.33***	1.78	2.28	0.42
Days to maturity	3.16*	14.56***	1.32	1.15	0.36
Plant height	961.52***	2.58	17.95	3.96	0.95
Bolls plant ⁻¹	48.37***	33.46	11.87	18.94	0.51
Boll weight	0.32***	0.08	0.06	9.50	0.60
Seed cotton yield	258472.16***	25196.86	26092.75	12.19	0.75
Ginning percentage	16.23	5.32	9.55	8.73	0.19
Halo length	17.46***	3.70	5.85	11	0.40

Table-2 : Descriptive statistics of nine morphological traits in cotton.

Variables	Mean	Standard deviation	Skewness	Kurtosis	Maximum	Minimum
Days to 1 st flowering	50.44	1.03	-0.25	-0.33	52.00	48.33
Days to 50% flowering	58.51	1.07	0.08	-0.06	60.67	56.33
Days to maturity	100.44	1.03	-0.25	-0.33	102.00	98.33
Plant height	106.89	17.90	0.21	-0.35	142.00	75.00
Bolls plant ⁻¹	18.19	4.02	-0.11	-0.70	24.33	10.00
Boll weight	2.52	0.32	0.11	-0.65	3.15	2.00
Seed cotton yield	1325.23	293.53	0.16	-0.84	1869.33	829.33
Ginning percentage	35.40	2.33	1.95	4.73	43.33	33.33
Halo length	21.99	2.41	-0.48	-0.44	26.00	17.00

NDLA-3141-2, NDLA-3142-1, NDLA-3143-1, NDLA-3143-2 and NDLA-3139-2. The experiment was carried out at Regional Agricultural Research Station farm, Nandyal, Andhra Pradesh, India using Randomized Block Design with three replications per genotype. Further, each genotype was grown in 2 rows with row length of 5m and spacing of 60cm between the rows and 30cm between the plants. All need based plant protection measures were taken up during the experimental period.

The data on days to first flowering, days to 50% flowering, days to maturity, plant height, bolls per plant, boll weight (g), seed cotton yield (Kg ha⁻¹), ginning out turn (%) and halo length (mm) were recorded on five random plants from each genotype in all three replications. Further, the recorded data were subjected to the analysis of variance, descriptive statistics and correlation analysis using STAR (Statistical tool for Agricultural Research) 2.1.0 software (Gulles *et al.*, 2014).

Results and Discussion

The set of 25 desi cotton advanced breeding lines were evaluated for morphological, yield and fiber quality traits under field conditions. The Analysis of variance revealed the presence of significant differences for all the traits except ginning percentage among the genotypes (Table 1). Besides, there is no significant difference for days to 1st flowering, days to 50% flowering and days to maturity in all the replications. Khokar *et al.* (2017) observed the

presence of significant differences for yield and fiber quality traits except fibre fineness. Kaleri *et al.* (2021) reported the presence of significant differences among all studied traits and highlighted the importance of genetic diversity among the genotypes for crop improvement based on the evaluation of 24 Bt and non Bt-cotton genotypes for yield, yield related and fibre traits. The percentage of coefficient of variation is highest for bolls per plant (18.94) and lowest for days to maturity (1.15). Whereas as broad sense heritability ranges from 0.95 (plant height) to 0.19 (ginning percentage). Reddy *et al.* (2020) reported that presence of traits with sufficient genetic variation and high heritability is a prerequisite for making genetic gain under selection.

The descriptive statistics of nine evaluated traits pertaining to 25 studied genotypes were presented in Table 2. Highest mean value was observed for seed cotton yield (1325.23) and lowest for boll weight (2.52). Standard deviation values range from 0.32 for boll weight to 293.53 for seed cotton yield. Negative skewness is seen for days to 1st flowering (-0.25), days to maturity (-0.25) and bolls per plant (-0.11). While, positive and highest skewness value was seen for ginning percentage (1.95). Negative kurtosis is seen among all the morphological traits except ginning percentage. Maximum mean values of the traits ranges from 3.15 for boll weight to 1869.33 for seed cotton yield. Whereas minimum mean values of the traits ranges from 2.0 for boll weight to 829.33 for seed cotton yield. In a study

Table-3 : Mean values of evaluated 25 genotypes for economic traits in cotton.

S. No.	Entry	Bolls plant ⁻¹	Boll weight	Seed cotton yield	Ginning percentage	Halo length
1.	NDLA-3020	21.00	2.41	1428.67	33.67	18.00
2.	NDLA-3094	17.33	2.00	1568.67	34.67	24.33
3.	NDLA-3104-4	17.33	2.70	1869.33	34.67	25.33
4.	NDLA-3113	14.67	3.10	1804.67	36.00	18.33
5.	NDLA-3115-2	10.00	2.75	1577.33	43.33	17.00
6.	NDLA-3116-4	20.67	3.15	1802.67	38.67	23.33
7.	NDLA-3091	15.67	2.40	1254.00	37.33	23.00
8.	NDLA-3116-3	16.00	2.70	1467.33	39.33	21.67
9.	NDLA-3106-2	24.33	2.05	1197.33	35.67	22.00
10.	NDLA-3109-4	23.67	2.70	1546.67	34.33	20.00
11.	NDLA-3111-5	24.33	2.70	1585.33	34.33	23.67
12.	NDLA-3114-3	11.67	2.20	829.33	36.33	21.00
13.	NDLA-3109	22.33	2.40	1213.00	36.33	20.00
14.	NDLA-3139-3	20.67	2.90	1187.67	33.33	24.00
15.	NDLA-3128-2	16.33	2.50	1451.33	33.33	22.00
16.	NDLA-3105-5	22.00	2.50	924.00	35.33	18.00
17.	NDLA-3129-1	15.33	2.90	1538.67	34.00	21.00
18.	YAGANTI	17.67	2.10	936.67	33.33	21.00
19.	NDLA-3146-1	23.67	2.50	1064.00	33.33	24.00
20.	NDLA-3145-1	17.67	2.35	1017.33	33.67	23.00
21.	NDLA-3141-2	16.33	2.35	947.33	35.67	25.00
22.	NDLA-3142-1	21.00	2.20	1263.33	33.33	22.00
23.	NDLA-3143-1	16.00	2.80	1314.67	35.33	26.00
24.	NDLA-3143-2	16.67	2.60	1253.33	35.67	23.00
25.	NDLA-3139-2	12.33	2.00	1088.00	34.00	23.00

conducted by Ibrahim *et al.* (2018), lint cotton is graded based on the highest mean values of cotton fibre properties. Naghera *et al.* (2021) carried out an experiment using analysis of variance for six generations in interspecific crosses of diploid cotton and the results showed significant differences among all six generation means for all the traits under study except leaf area.

The detailed mean values of evaluated 25 genotypes for economic traits in cotton were presented in Table-3. For bolls per plant, the genotypes NDLA-3115-2 and NDLA-3106-2 recorded highest mean value of 24.33 bolls per plant, while the genotype NDLA-3111-5 recorded lowest mean value of 10.0 bolls per plant. For boll weight, the genotype NDLA-3116-4 recorded highest boll weight of 3.15 g and lowest boll weight (2.0 g) was recorded by NDLA-3094 and NDLA-3139-2. The highest and lowest mean seed cotton yield was recorded by genotypes NDLA-3104-4 (1869.33 kg ha⁻¹) and NDLA-3114-3 (829.33 kg ha⁻¹), respectively. Mean value of ginning percentage ranges from 33.33 in five genotypes NDLA-3139-3, NDLA-3128-2, NDLA-3142-1, Yaganti and NDLA-3146-1 to 43.33 in NDLA-3115-2. Minimum Mean halo length of 17.00 was observed in NDLA-3115-2 and maximum mean value of 26.00 was recorded in NDLA-3143-1. Based on seed cotton yield, the genotypes NDLA-3104-4, NDLA-3113, NDLA-3116-4,

NDLA-3111-5 and NDLA-3115-2 were found to be top five high yielding genotypes. Yehia *et al.* (2019) reported the best values of mean performances in certain parental combinations for most yield, yield related components, fibre traits and these crosses were considered the most promising to be used in breeding programmes for hybrid cotton production. The study conducted by Orawu *et al.* (2017) showed that genotypes with above average means of seed cotton yield, good fibre traits and stability were considered for development of cotton cultivars.

The Pearson's correlation coefficients between the evaluated nine morphological traits in 25 desi cotton breeding lines were presented in Table 4. From the correlation analysis, it is observed that the trait seed cotton yield showed significant and positive correlation ($r = 0.62$) with boll weight. The trait halo length recorded significant and positive correlation with plant height ($r = 0.49$). Interestingly, ginning percentage reported significant and negative correlation with plant height ($r = -0.56$) and bolls per plant ($r = -0.42$). The correlation coefficients between morphological traits including days to 1st flowering, days to 50% flowering and days to maturity were significant and positive with each other. From the study it is clear that seed cotton yield is mainly depends on the boll weight. Hampannavar *et al.* (2020) reported that the seed cotton yield is mainly significantly

Table-4 : Pearson's correlation coefficients between the evaluated nine morphological traits in cotton.

Variables	Days to 1 st Flowering	Days to 50% flowering	Days to maturity	Plant height	Bolls plant ⁻¹	Boll weight	Seed cotton yield	Ginning percentage	Halo length
Days to 1st flowering	1	0.94***	1***	0.01	0.07	-0.10	-0.01	0.13	0.35
Days to 50% flowering	0.94***	1	0.94***	0.01	-0.01	-0.05	-0.09	0.17	0.33
Days to maturity	1***	0.94***	1	0.06	0.07	-0.10	-0.01	0.13	0.35
Plant height	0.06	0.02	0.06	1	0.38	-0.36	-0.36	-0.56**	0.41
Bolls plant ⁻¹	0.07	-0.01	0.07	0.38	1	0.03	-0.00	-0.42*	0.08
Boll weight	-0.10	-0.05	-0.14	-0.36	0.03	1	0.62**	0.31	-0.07
Seed cotton yield	-0.01	-0.08	-0.01	-0.36	-0.00	0.62**	1	0.27	-0.04
Ginning percentage	0.14	0.17	0.14	-0.56**	-0.42*	0.30	0.27	1	-0.32
Halo length	0.35	0.34	0.36	0.49*	0.08	-0.08	-0.04	-0.32	1

and positively correlated with number of bolls and boll weight based on the study conducted using 222 recombinant inbred lines in cotton. Eldessouky *et al.* (2021) conducted an experiment with 17 different genotypes of cotton and reported that correlation analysis showed positive correlations between seed cotton yield and lint cotton yield, seed index and embryo index, oil % and embryo index oil percentage. In a study conducted by Khalid *et al.* (2018) using ten parental genotypes and their 45 F₁ hybrid progeny, positive correlation of seed cotton yield with plant height, number of sympodial branches per plant, number of bolls per plant, boll weight and number of seeds per boll suggested that during selection, priority should be given to these traits and careful selection should be done for those traits which was associated negatively with seed cotton yield.

Conclusion

In this study, results of genetic analysis of 25 diverse advanced breeding lines showed the presence of significant differences among the genotypes for evaluated traits. The presence of traits with sufficient genetic variation and high heritability is a prerequisite for making genetic gain under selection. Descriptive statistics and correlation analysis clearly indicated that three traits seed cotton yield, bolls per plant and boll weight are key traits yield enhancement in cotton. Among the genotypes, five genotypes namely NDLA-3104-4, NDLA-3113, NDLA-3116-4, NDLA-3111-5 and NDLA-3115-2 are efficient genotypes based on seed cotton yield. These genotypes can be utilized in future breeding programmes for genetic yield improvement in desi cotton. Altogether, the obtained results from the study will be able to provide the valuable information about variability and correlation analysis of yield and fiber quality traits. It will help to develop high yielding cotton cultivars with improved fiber quality traits in future.

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Evaluation of Azotobacter Inoculation and Nitrogen Fertilization in Relation to Fodder Production of Oat (*Avena sativa* L.)

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Abstract

The field experiment on farmer's field comprising of two levels of Azotobacter inoculation (inoculated and uninoculated) and four levels of nitrogen (0, 40, 60 and 80 kg N/ha) was conducted in randomized block design with three replications in Bareilly district during rabi 2000-2001 and 2001-2002. The higher yield of green fodder, dry matter and crude protein of oat (cv. UPO-94) compared with no inoculation were obtained by inoculation of oat seed with Azotobacter chroococcum. Inoculation on an average increased the green fodder, dry matter and crude protein yields to the tune of 8.7, 8.5 and 9.3 percent, respectively, over the uninoculation. Application of 80 kg N/ha gave significantly higher green forage, dry matter and crude protein yields over the control, 40 and 60 kg/ha treatments. The trial was repeated in 2009-10. Seed yield (20.4q/ha - 25.3 q/ha), seed quality, dry matter (89.3%), neutral detergent fiber (12.2%) and acid detergent (14.1%) were registered higher at higher doses of N alongwith inoculation of seeds before sowing. Azotobacter is economic inoculants as results indicated.

Key words : Azotobacter, nitrogen, oat, fodder, seed quality.

Introduction

Oat is one of the most important cereal fodder crops of rabi season in north, central, and west zone of the country. Hey is highly palatable to each type of livestock including sheep. Oats are one of the crops grown during the Rabi season. It is an important cereal crop as well as fodder crop. Oats offer health benefits like they are rich in protein and fiber. So it is helpful in reducing weight, controlling blood pressure and increases immunity. Oats are used as straw for livestock as well. Temperate and subtropical climates are best for growing this winter crop. Oats needs temperature in between of 15⁰ to 25⁰C. for its cultivation. Sowing time temperature should be 20-25⁰C. Harvesting temperature should be higher 25⁰-30⁰C. Rainfall between 80-110 mm is sufficient. Oat can be cultivated on all type of soil. Prefable loamy soils, having pH 5.5-6.5. Sowing time October-November is most sustainable. Oat may be considered as maintenance quality fodder containing about 6-9% protein can be increased upto 11% by nitrogen fertilizer. It may be considered as a productive fodder. The grains are very much relished by horses, sheep, poultry and oat meal by human being.

Materials and Methods

The experiment was conducted on farmers' field during 2000-2002 and 2009-10 in rabi seasons. The soils was sandy loam having neutral, pH, mediums in organic carbon content percent. Cultivar UPO-94 was grown with recommended dose of fertilizers (except nitrogen) and irrigation. The farmers were interested in cultivation of forage oat crop for dual purpose. They used crop for

forage as well as for its grain yield. Azotobacter is cheap source of seed inoculants and easily available in SAU's and local markets. Nitrogen is costly input for crop cultivation. Hence, it was tested at 40, 60 and 80 N kg/ha levels. Two treatments inoculated with azotobacter (Second Treatment) and uninoculated were tested in randomized block design with three replications. The plot size was convenient to the farmers field conditions varying 4 x 4 sq. meter to 5 x 5 sq. meters. Observations were recorded with the help of farmers and analysed with the average mean value for the trial in the relevant years. The trials were also used as on farm demonstrations for technology transfer in six adopted villages surrounding Rithora. Soil samples were tested at soil testing laboratory of State Government, Agricultural Department, Bilwa Farm, Bareilly (UP).

Results and Discussion

The data collected and analysed. The results are depicted in table 1 and 2. Results reveals that 80 kg N/ha significantly increased the growth attributes leading to higher dry matter and crude protein yields. Seed inoculation with Azotobacter increased dry matter and crude protein yields by 8.9 and 9.0% over uninoculated control. Azotobacter inoculation and N 80 kg/ha registered higher values of above parameters. Similar results were reported by Sharma, K.C. (2009) and Tomar et.al. (2001).

Effect of Azotobacter : Azotobacter inoculation was found beneficial in terms of increased grain and straw yield. Higher nitrogen use efficiency was recorded in

Table-1 : Forage yield as affected by azotobacter and N applications (2001-02).

Treatment	Given Fodder (q/ha)		Dry Fodder (q/ha)		Crude Protein %	
	Non Ino.	Inoculant	Non-Inc.	Inoculant	Non-Inc.	Inoculant
0	305.2	327.4	27.3	29.8	8.1	7.1
40	403.4	436.0	36.5	38.5	9.0	8.3
60	454.1	498.4	41.1	43.1	9.3	8.7
80	551.5	588.6	45.5	47.5	10.0	9.4
Mean	428.5	462.6	37.6	39.7	9.1	8.3

Table-2 : Seed yield (q/ha) and quality as influenced by N and Azotobacter during 2009-10.

N Kg/ha Treatment	Azotobacter				No Azotobacter			
	Seed yield	D.M. %	NDF-1	ADF%	Seed yield	D.M. %	NDF %	ADF %
0(C)	11.3	81.2	11.7	13.7	10.3	85.9	80.3	13.3
40	20.2	84.7	12.1	14.0	18.6	86.1	81.2	13.7
60	22.4	88.6	12.6	14.3	20.3	87.3	82.2	14.1
80	24.3	89.7	12.7	14.8	22.1	88.1	82.4	14.5
Mean	19.5	86.5	12.2	14.2	17.8	86.8	81.5	13.9



Figure : On Farm Trials on Farmers' Field.

Inoculation over the uninoculated treatments. Azotobacter promotes plant growth as well as nitrogen fixation. Azotobacter inoculation increased, the forage yield by 7.8% (Mean yield) compared to with no inoculation.

Effect of Nitrogen : The green forage yield of oat increased significantly with increment of N dose upto 80 kg/ha. Mean data of two years revealed that green forage yield increased by 55.1%, 85.5% and 105.2% with 20, 40 and 80 kg/ha respectively compared to no N application. Decreases in yield was less at lower N levels compared

with that at higher levels. Yadav *et al.*, (2008) and Singh and Gupta (2003) also reported similar results.

Effect on seed yield and quality : During 2009-10 seed yield increased with increased in nitrogen dose. Highest grain yield (24.3 q/ha) was reported with 80 kg/ ha and seed treatment with Azotobacter. It might be due to better growth and development of yield attributing characteristics. Followed by 60 kg N and 40 kg N per hectare. Results are shown in table-2. Seed quality also influenced by the inoculation application.

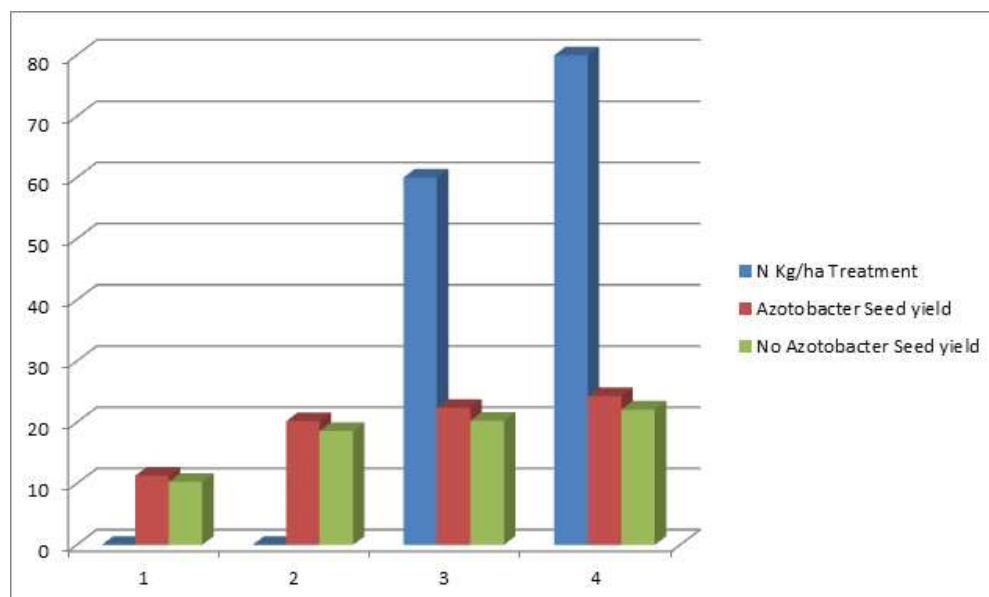


Figure : Seed yield (q/ha) influenced by N application and inoculation with Azotobacter in 2009-10.

This data shows that yield was increased with increase in Nitrogen levels from 40 kg/ha to 80 N/ha (20.2q, 22.4q and 24.3q/ha) and azotobacter inoculation.

Conclusions

Oat variety UPO-94 gave maximum yield of green fodder, dry matter, yield, grain yield at 80 kg N/ha alongwith Azotobacter inoculation. Quality of fodder and grain was also increased with increase in N application (Singh and Gupta, 2002).

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Influence of Green Manuring and Biofertilizers on Forage Maize (*Zea mays*) Production

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Abstract

The field experiment was conducted on farmer's field in Bareilly district of Uttar Pradesh during 2002-2003 and repeated in 2009-2011 to study the effect of crop sequences for green manuring and Biofertilizers application in maize production. Wheat variety U.P.-2338 was sown in November with and without inoculation. Kharif leguminous cum-green manuring crops were sown in May after harvest of wheat crop. After 75 days of sowing of green manuring crops were incorporated in situ. Forage Maize Cultivar African Tall was sown in August and harvested in two months. Green manuring with dhaincha increased maximum green forage yield of maize 850.3q/ha followed by cowpea 825.6 q/ha. Mung bean cropping sequence recorded lowest 750.4 q/ha yield of African tall maize on farmer's field. This increase in the yield may be due to production of higher biomass and N fixation by leguminous crop nodules. Azotobacter seed Inoculation of combination with PSB gave higher yields of maize forage (800.5 q/ha) over the wheat-maize-maize crop sequence (640.8q/ha). However, inoculation did not show significant variation in yields as compared to yields recorded in maize forage, sown after green manure crop sequencing. All crops were grown with recommended dose of fertilizers.

Introduction

Maize an important crop which has huge adoptability to varied agro climatic conditions world wide. Maize may be called as the most important cereal amongst the cereals due to its highest genetic potential. Maize is the third most important after rice and wheat in India. The application of synthetic fertilizers on maize and other crops have adverse effects on soils plants, animals and human health. Biofertilizers, organic and green manures are living micro-organisms which establishes symbiotic relationship with plant and increase supply of nutrients to the plants. After nitrogen, phosphorus (P) is an essential mineral fertilizer for plant growth and development. It is world's second largest agricultural chemicals. Soluble P is often the limiting mineral nutrient for biomass production in natural ecosystems. Plant utilize fewer amount of phosphatic fertilizers that are applied. Rest is rapidly converted into insoluble complexes in the soil (Vassileva and Vassileva, 2003). This need to frequent application of phosphate fertilizers, but its use on a regular basis has become a costly affair and also environmentally undesirable (Reddy *et al.*, 2002). Natural phosphate rocks have been recognized as valuable alternative for fertilizers. In India, it is estimated that there are almost 40 million tons phosphatic rock deposits. This material provide a chief source of phosphatic fertilizer for crop production. Micro-organism that dissolve poorly soluble CaPs are termed as mineral phosphate (MPs). Phosphate solubilising micro-organisms (PSMs) convert this insoluble phosphates into soluble forms through the process of acidification, chelation, exchange reactions and production of gluconic acid (Chung *et al.*, 2005).

Maize (*Zea mays* L.) is one of the most versatile emerging crop having wider adaptability under varied agro-climatic conditions. Globally, maize is known as queen of cereals because it is highest yield potential among the cereals. The United States of America (USA) is the highest producer of maize contributes nearly 35% of the total world production. In India, maize is third most important food crop after Rice and Wheat with productivity 24 q/ha. Green fodder fed to milch cattle to boost the milk production. African tall maize is best suited variety for fodder. The ability of maize fodder is higher than sorghum, bajra and other non-leguminous forage crops. Vijay composite, Medium, yellow, flint to semiflint grain , medium maturing, composite (100-110days) which has wider adaptability. Possess considerable resistance to foliar diseases, was sown under trial.

Materials and Methods

A study was conducted on farmer's field in Bareilly district in western Uttar Pradesh during 2002-2003 to study the effect of crop sequences for green manuring and seed inculcation of Azotobacter and PSB on forage maize production. The treatments consisted of 5 crops viz. dhaincha, cowpea, mung, urd and maize after wheat, and dual inoculation of Azotobacter and PSB. The field experiment was laid out in RBD with 3 replications. The soil of experimental plot was silty loam, and medium in OC (0.65%), available N (200 kg/ha), P (40kg/ha) and K (280 kg/ha) with pH 7.2. The wheat variety 'UP-2338' was sown in November with or without inoculation and Kharif leguminous crop-cum-green manuring crops were sown in May. Cowpea, mung, urd and maize, and dhaincha

Table : Effect of Cropping Sequence on green forage maize yield mean (2002-03) and -seed yield (2009-11).

Crop sequence 1 st crop	2 nd Crop	3 rd Crop (Maize) Fodder q/ha	Seed yield q/ha	Protien %
Wheat control	Maize (C)	640.8	21.3	10.8
Wheat + Biof.	Maize + Biof.	800.5	27.6	11.1
Wheat	Sesbania	850.3	28.1	11.2
Wheat	sCowpea	825.6	27.8	11.2
Wheat	Mung	750.4	27.1	10.9
Wheat	Urd	695.2	26.8	10.9
Mean	-	760.46	26.45	11.01
CD0.05		7.03	1.23	1.18

**Figure : On Farm Trials on Farmers' Field.**

were harvested after 75 days and incorporated into soil. Third crop of forage maize ('African tall') was sown in third week of August and harvested in two months. The trial was repeated in 2009-11 for seed production and seed quality assessment.

Results and Discussion

Green manuring with dhaincha significantly increased green forage yield (850.3 q/ha) followed by cowpea (825.6 q/ha) and mung (750.4 q/ha). This improvement in yield with green manuring with dhaincha could be due to production of higher biomass and N_2 fixation. It could be ascribed to its favourable effect on chemical-physical and biological properties of soil. The results are in close agreement with Vaidya and Gabhane (1998) and Singh and Singh (1987) inoculation of Azotobacter combination

with PSB to wheat and maize seeds significantly increases the yield (800.5 q/ha) of the third crop over third crop taken after green manuring with dhaincha and cowpea. Azotobacter and PSB might have increased available N and P alongwith other plants nutrients to the crop, which in turn increased the yield (Tomar *et al.*, 1998, Das *et al.*, 1995).

Effect of Biofertilizers : Biofertilizers present realistic option for sustainable intensification of maize production with good potential to increase yields 15%-18. Multi strain biofertilizer formulations represents an intermediate between single strain. Inoculation in situ enhancement of soil microbial communities or rhizosphere engineering (Ryan *et al.*, 2009). Biofertilizers effects on yields and biomass. P solubilization (4.4% - 15.3%), Pseudomonas

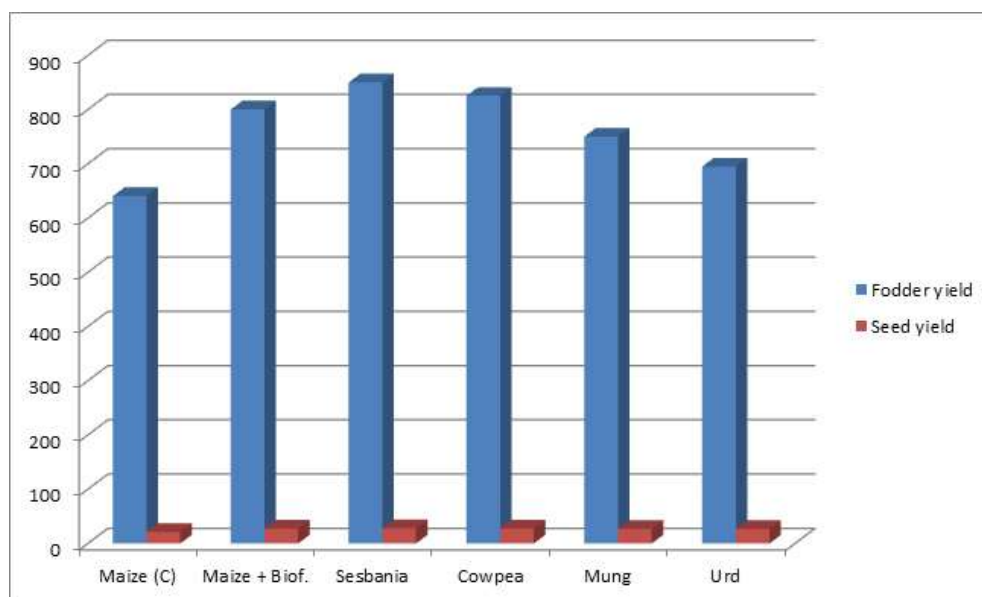


Figure : Effect of Cropping Sequence on maize-forage and seed yield (2009-11).

(11.8%-13.11). Strains, belonging to this genus azotobacter increased yield on an average of 3.1 to 34.4%. Biofertilizers comprised of azotobacter, azospirillum and Pseudomonas species were pursued. Azotobacter increased and maize yield more than pseudomonas.

Starting of soil N content influenced the outcome of inoculation, more effective and widely variable when starting soil N was low. In a study, biofertilizers increase maize yield by an average of 15.3% in field and 18.4% green house studies using field soil. Biofertilizers increased plant productivity by an average of 18.4% and 15.3% in pot and field, respectively. Inoculation had more variable effect in pot. Studies with yield increase ranging from 9.2% to 28.7% as compared to 12.5% to 18.1% in field condition. With increasing concerns about the environment, better use of the natural resource base. Less use of chemicals and efficient use of irrigation water is increasingly an important goal of sustaining agriculture. Expanding eco-friendly approaches to improve plant growth and productivity is of great importance for sustainable agriculture.

Conclusion

It was concluded that green manuring with dhaincha, cowpea and mung after wheat crop could be advantageously used to produce higher yields. Dual seed

inoculation with Azotobacter and PSB was also found to be beneficial and economical.

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Productivity and Profitability of Greengram with Improved Practices (ICM) under Rainfed Conditions of North Coastal Zone of Andhra Pradesh

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Abstract

The CFLD on Greengram was conducted in 50 locations during two consecutive years 2019-20 and 2020-21 in 3 villages namely K.P. Valasa, Kongaram and Ambavilli of Srikakulam district, Andhra Pradesh, during Rabi season 2019-20 and 2020-21 under rainfed conditions to demonstrate production potential and economic benefit of improved production technologies comprising, nutrient management and adoption of complete package of practices for greengram. The findings of the study revealed that improved technology (ICM) recorded a mean yield of 494 kg/ha which was 30.8 per cent higher than obtained under farmers' practice (377.5 kg/ha). Higher mean net income of Rs. 19390 /ha with a Benefit: Cost ratio of 2.2 was obtained with improved technologies in comparison to farmers' practices (Rs. 12758/ha). Further, it was found that the adoption of improved technologies significantly increased the yield as well as yield attributing characters of greengram crop and also the net returns to the farmers. Hence, there is a need to disseminate the improved technologies among the farmers with effective extension methods like training and demonstrations. The farmers' should be encouraged to adopt the recommended package of practices for realizing higher returns.

Key words : *Adoption, cluster frontline demonstration and greengram.*

Introduction

India's economy has been dominated by agriculture. However, Indian agriculture is severely depends on monsoons to yield sufficient agricultural returns. In a country like India, pulses are the cheapest and concentrated Source of dietary amino acids, where protein demand of vegetarian population is fulfilled through pulses, so it is also considered as "A poor man's meat. Pulses occupy a unique position in the world of agriculture by virtue of its high protein content which is almost double than that of cereals. They have a special role in meeting the protein requirement of predominantly vegetarian population. In addition to protein, pulses are also contain good quality lysine, tryptophan, ascorbic acid and riboflavin.

Over a period of time, a number of improved pulses varieties and production technologies have been developed, but full potential of these varieties as well as technologies could not be exploited due to low rate of adoption and low yields. Thus, factors limiting the productivity cannot be overlooked. Research and extension programmes need to be diverted to produce value additive pulses. It may emphasize on quality attributes, adoption and popularization of new agro technology, evolving better varieties for stress conditions and improving present yield potential. The aim of these demonstrations in general is to raise production through transfer of farm technology. The efforts were taken with planning, execution and follow up action of the pulses production technology through front line demonstrations

(Samant, 2014). Cluster front line demonstrations (CFLDs) is a novel approach to provide a direct interface between researcher and farmer for the transfer of technologies developed by them and to get direct feedback from farming community. 'National Food Security Mission (NFSM) is to operationalize the production of rice, wheat and pulses. The concept of Cluster first line demonstrations was put forth under this mission. The scheme implemented in a mission mode through a farmer centric approach. The scheme aims to target the select districts by making available the improved technologies like promotion of Integrated Nutrient Management (INM) Integrated Pest Management (IPM), Integrated Crop Management (ICM), and Extension, training and mass media campaign. These demonstrations are conducted under the close supervision of scientists of Krishi Vigyan Kendras.

In Andhra Pradesh (13 districts) the area under greengram is 1.03 lakh hectares in 2019-20 which accounted for 0.79 lakh tonnes production with a productivity of 771 , whereas the same in 2020-21 is 0.94 lakh hectares 0.81 lakh tonnes production with a productivity of 867. There is reduction in area of greengram among total food crops area which is very low or stagnated over 5 years. Hence there is need for expansion of area and production in pulses in Andhra Pradesh (Agriculture Statistics 2019-20 & 2020-21).

In Srikakulam district the area under greengram is 19,901 hectares in 2019-20 which accounted for 14000 M tonnes production with a productivity of 529 kgha⁻¹ ,

Table-1 : Comparison between demonstration under CFLD and farmers practices of Greengram.

Particulars Farming situation	Greengram	
	Demonstration	Farmers Practice
Variety	IPM-2-14	Local
Farming type	Rainfed	Rainfed
Method of sowing	Broadcasting	Broadcasting
Seed rate	12 kg/ac	12 kg/ac
Seed treatment	Imidacloprid	-
Fertilizer	13-0-45	-
Herbicide	Imazithpyr	-
Plant protection	Acephate	-
Whole package	Seed 12kg, Imidacloprid @ 5ml/kg seed Imazithpyr @ 250ml/ac 13-0-45 and Acephate	Farmers are cultivating the Greengram crop without adoption of any improved technology/practices.

Table-2 : Details of Need Based Input Given for Greengram under CFLD.

Year	No of demonstrations	Variety	Technology demonstrated	Need based inputs provided
2019-20	25	IPM-2-14	Integrated Crop Management	Seed 12kg, Imidacloprid, Imazithpyr, 13-0-45 and Acephate
2020-21	50	IPM-2-14	Integrated Crop Management	Seed 12kg, Imidacloprid, Imazithpyr, 13-0-45 and Acephate

Table-3 : Yield attributes of Greengram under CFLD.

Parameter	2019-20		2020-21		Mean	
	Demonstration	Farmers Practice	Demonstration	Farmers Practice	Demonstration	Farmers Practice
Plant height (cm)	46.48	43.20	49.24	44.15	47.9	43.7
No of branches per plant	4.40	3.21	4.61	3.95	4.5	3.6
No of pod per plant	13.20	10.53	14.10	11.24	13.7	10.9
No of seeds per pod	10.4	9.6	11.2	10.5	10.8	10.1
Test weight (g)	3.65	3.47	3.74	3.68	3.7	3.6

whereas the same in 2020-21 is 24,901 hectares 20837 M tonnes production with a productivity of 610 kgha⁻¹. There is increase in area of green gram crop in rice fallows in the district. Cluster Front Line Demonstrations (CFLDs) under National Food Security Mission (NFSM) playing key role in introduction of improved varieties and production technologies in pulses reported by Venkata Subbaiah P and Jyothi V (2020).

Materials and Methods

Cluster frontline demonstrations were conducted by the Krishi Vigyan Kendra, Amadalavalasa, Srikakulam district of Andhra Pradesh in Rabi seasons in the farmer's fields during 2019-20 and 2020-21 with evaluation of the performance of new varieties and package of practices (ICM) on production and productivity of pulses demonstrated for Greengram. A group of cooperative farmers were identified with the objective to demonstrate the improved technologies of pulses production potential in different villages. A total area of 20 hectare in every year was fixed for the demonstration of technologies in Green gram along with farmers practice as control plot. Assessment of gap in adoption of recommended technology before laying out the cluster frontline demonstrations (CFLD's) through personal discussion

with selected farmer's. The awareness programme (pre-season training) was organized for selection of farmers and skilled development about detailed technological intervention with improved package and practice for successful cultivation. Critical inputs for the technologies to be demonstrated (Table 1, 2 and 3) were distributed to the farmers after the training of improved high yielding variety, recommended chemicals and literature and regular visit, monitoring and pest and disease advisory services management by the KVK scientist to the demo farmers. Finally field day was conducted involving demonstration holding farmers, other farmers in the village, Scientists from University and ATARI, officials from Department of Agriculture and local extension functionaries to demonstrate the superiority of the technology for each crop. Crop yield was recorded from the demonstration and control plots for the crops at the time of harvest.

The most feasible way by which this could be achieved is by demonstrating the recommended improved technology on the farmer's fields through front line demonstrations with the objectives to work out the input cost and monetary returns between front line demonstration and farmers methods, to identify the yield gaps between farmer's practices and front line

Table-4 : Technological gap analysis of cluster frontline demonstrations on Greengram under CFLD.

Yield & Season	No. of locations	Potential yield (kg/ha)	CFLD yield (kg/ha)	FP Yield (kg/ha)	Percent increase	EG (kg/ha)	TG (kg/ha)	TI (kg/ha)
2019-20 Rabi	25	650	538	430	25.1	108	112	17.2
2019-20 Rabi	50	650	450	325	38.5	125	200	30.7
Average	50	650	494	377	31.0	117	156	24.0

EG= Extension gap; TG= Technology gap; TI= Technology index; FP= Farmers practices

Table-5 : Yield and economics of Greengram under CFLD.

Parameter	2019-20		2020-21		Mean	
	Demonstration	Farmers Practice	Demonstration	Farmers Practice	Demonstration	Farmers Practice
Yield (kg/ha)	538	430	450	325	494.0	377.5
Cost of cultivation	14900	11500	15900	12500	15400	12000
Net Return	22298	14630	16482	10887	19390	12758
B:C ratio	2.40	1.92	2.04	1.87	2.2	1.9

demonstrations. The basic information were recorded from the farmer's field and analyzed to comparative performance of cluster frontline demonstrations (CFLD's) and farmer's practice.

The following formula were used to calculate the parameters.

Extension gap = Demonstration yield – Farmers' practice yield

Technology gap = Potential yield – Demonstration yield

Technology index = $\frac{\text{Potential yield} - \text{Demonstration yield}}{\text{Potential yield}}$

Net returns = Gross returns – Cost of cultivation

B: C ratio = Net Returns / Cost of cultivation

Results and Discussion

Growth and yield attributes of Greengram : The growth and yield attributing parameters like plant height, number of branches per plant, number of pods per plant, number of seeds per pod and test weight were higher in greengram under demonstrated field than farmer's practice is presented in table-3.

The results revealed that the mean plant height, number of branches per plant, number of pods per plant, number of seeds per pod and test weight for two consecutive years of 2019-20 and 2020-21 for Greengram under cluster frontline demonstrations is 47.9 cm, 4.5, 13.7, 10.8 and 3.7 as compare to 43.7 cm, 3.6, 10.9, 10.1 and 3.6 recorded in farmer's practice respectively. These results also supported by Samant *et al.*, (2014) and also Lalit (2014) in greengram crop.

The grain yield and gap analysis of greengram in demonstrated field and farmer's practice is presented in table 5. The results revealed that the grain yield for two consecutive years of Greengram under cluster frontline demonstrations were 538 and 450 kg ha⁻¹ as compare to

430 and 395 kg ha⁻¹ recorded in farmer's practice and average yield increase of 28.1 and 38.5 per cent, respectively. These results also supported by Jayalakshmi *et al.*, (2018) and also Venkata Rao (2020) in pulse crop. The extension gap 108 and 125 kg ha⁻¹ technology gap 112 and 200 kg ha⁻¹ and technology index 17.2 and 30.7 was recorded.

Economic performance of Greengram under cluster frontline demonstration was explained in table 5. The economics revealed that the Greengram recorded higher net return from recommended practice (CFLD's) were Rs.22,298 ha⁻¹ in 2019- 20 and Rs.16,498 ha⁻¹ in 2020-21 as compared to Rs.14,630 ha⁻¹ and Rs.10,887 ha⁻¹ in farmer's practice respectively. It was economically observed that additional returns were Rs.7668 and Rs.5595 ha⁻¹ through recommended practice in both the years. The benefit cost ratio also recorded higher in recommended practice with 2.40 and 2.04 as compared to 1.92 and 1.87 in farmer's practice in both the years. These results in accordance with the findings Gaur V and Jadav P (2020) and Siddeswari *et al.*, (2017).

Conclusions

It is concluded from the above findings of CFLDs on Greengram var. IPM-2-14, that the technology gap can be reduced to a considerable extent by adopting scientific methods of greengram cultivation thus leading to increase productivity of greengram in the district. It was observed that potential yield can be achieved by imparting scientific knowledge to the farmers, providing the quality need based inputs and their proper utilization. Horizontal expansion of improved technologies may be achieved by implementation of various extension activities like training programmes, field days, exposure visits etc. organized in CFLD programmes in the farmer's fields. Moreover, Krishi Vigyan Kendra in the district played the lead role in

providing proper technical support to the farmers through different extension activities to reduce the extension gap for better pulse production in the district.

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Influence of NPK on Yield and Quality Parameters of Ash Gourd (*Benincasa hispida* Thumb. Cogn.)

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Abstract

A field experiment was conducted during Kharif 2015-16 at vegetable research field, Department of Horticulture, Allahabad School of Agriculture, Sam Higginbottom Institute of Agriculture Technology and Sciences, Allahabad. The experiment was laid out in a Randomized Block Design (RBD) with 13 treatments and each replicated thrice. The result revealed that maximum fruit weight (2.82 kg), minimum days for fruit set (67.67), length of the green fruit (22.64 cm), maximum diameter of fruit (14.87 cm), more number of fruits per vine/ plant (2.00) and total fruit yield kg/ha (116.12 kg/ha) was recorded with T₆ (150N+100P+150 K ha⁻¹) through FYM 50 % NPK in the form of urea, SSP, MOP. Maximum total soluble solid (9.33) was recorded with T₁₀ (150 kg N ha⁻¹) where as Vitamin C content (3.57) was recorded with T₁₂ (110 kg N ha⁻¹). It can be concluded that T₆ (150N+100P+150K ha⁻¹) has recorded best in yield parameters.

Key words : Ash Gourd, NPK, yield, quality.

Introduction

Ash gourd is also known as wax gourd, Chinese preserving melon, white gourd (pethakaddu) Petha in Hindi, Boodida gummadikaya in Telugu, Pooshnikai in Tamil. Ash gourd is actually a fruit but it is referred to as vegetable because it is cooked and eaten as vegetable. It is cultivated for its immature as well as mature fruits crop comes very well in humid and high rainfall areas, in North India it is grow mainly in summer and rainy seasons.

Ash gourd is a annual hispid (rough white bristle like hairs), climbing herbaceous and monoecious plant. Ash gourd fruit is mainly purchased by the confectioners who use them to prepare? petha'. Ash gourd can be stored longer than any other cucurbits. Crop originated in Asia specifically Ayurvedic preparation kooshmanda Rasayana is made of Ash gourd fruits, it is good for people suffering from nervousness, Chinese preserving melon, white gourd (pethakaddu) Petha in Hindi, Boodida gummadikaya in Telugu, Pooshnikai in Tamil. Fruit at maturity have white waxy surface. The fruit is mainly purchased by confectioners who use them to prepare petha. A 100g of raw Ashgourd contains 13 Kilo calories, 0 g fat (negligible), 3g carbohydrates, 2.9g fibre content, 4 gm protein, 10 mg vitamin A, 13 mg vitamin C, 0 mg Thiamine, and 1 mg riboflavin. Ash gourd is loaded with nutrients. It's an excellent source of Vitamin B₁ and also a good source of vitamin B₃ (Niacin) and vitamin C. It is also rich in many minerals like calcium it is high in Potassium and Iron. It is used to cook vegetables as well as clinically helps to arrest high blood pressure in human being

The major producing countries of Ash gourd in the world are India, Bangladesh, Indonesia, Brazil, China, and Nigeria. India is the second largest producer of Ash gourd after China. In India it is extensively grown in U.P, TamilNadu, Andra Pradesh 117 ha with a production of 2816 MT with a productivity of 12.21 tonnes /ha (According to the date base of NHB, 2015)

Nutrient management is a critical issue that determines quantity and quality of the harvested produce. Although, plant takes the essential nutrients throughout its life cycle, the nutrients are applied at different dosage at one or more stages of the crop growth, depending on the requirement of the crops

Fertilizer is a major part of the crop expenses for Ash gourd production, and it is critical for successful crop yields and high fruit quality. Fertilizer requirements of ash gourd are quite high due to its high yielding potential per unit area and time. Accordingly, mineral nutrition with suitable levels of Nitrogen (N), Phosphorus (P) and Potassium (K) had a key role for improving the growth and fruit yield of cucumber, as well as influencing the ash gourd plant's ability to withstand negative effects from pests, water, temperature, and other stresses. N, along with P and K, are classified as primary macronutrient, which are needed in relatively large quantities and are often deficient in crops not receiving fertilizer application (Sheshadri and Shinde) (1983).

Phosphorus (P) is an essential part of the process of photosynthesis. Effects rapid growth, Encourages blooming and root growth Phosphorus has pronounced effect on cucumber plant. High level of available

phosphorus throughout the root zone is essential for root development and good utilization of water and other nutrients by the plant. Potassium is absorbed by plants in larger amounts than any other mineral element except nitrogen and, in some cases, calcium helps in the building of protein, photosynthesis, fruit quality and reduction of diseases the main aim of the present investigation was to find the effect of NPK on yield and quality of ash gourd.

Materials and Methods

The present investigation Effect of NPK on plant growth, fruit yield and fruit quality of Ash gourd (*Benincasa hispida*) was conducted with 13 treatments with three replications adopting Randomized Block Design (RBD). The experiment was carried out at Vegetable Research Field, Department of Horticulture, Allahabad School of Agriculture, Sam Higgin Bottom Institute of Agriculture and Technology and Science, Allahabad (U.P.) The soil of the experimental field was sandy loam in texture, poor in Nitrogen, comparatively rich in phosphorous and medium in potash with slightly alkaline reaction.

About 250 to 300 quintals of farmyard manure (FYM) was added at the time of field preparation and in addition to it 60 kg Nitrogen (N), 80 kg Phosphorus (P_2O_5) and 60 kg Potash (K_2O) per hectare were added through chemical fertilizers.

Half dose of nitrogen and full dose of phosphorus and potash were given at the time of sowing. Rest half dose of Nitrogen will be given by top dressing in two splits of doses, first at 25 days after sowing and second at flowering stage. Observations were recorded for following characters yield and quality Parameters like

Yield parameters : Days to first fruit set, Days to first fruit harvest, Fruit length (cm), Fruit diameter (cm), Fruit weight (g) , No of fruits per plant, Fruit yield per hectare (t).

Quality parameters : Estimation of total soluble solid (%), Estimation of vitamin c (mg/100g).

Treatment details :

S. No.	Treatment Symbol	Treatment combination NPK (Kg/ha)
1.	T ₀	Control
2.	T ₁	100 N+150 P+100K
3.	T ₂	125 N+75 P+125K
4.	T ₃	150 N+100 P+150K
5.	T ₄	110 N+100 P+110K
6.	T ₅	150 N +100 P+150K
7.	T ₆	170 N+120 P+170K
8.	T ₇	170 N+120 P+170K
9.	T ₈	100 N+100 P+100K
10.	T ₉	150 N+80 P+80K
11.	T ₁₀	120 N+60 P+90K
12.	T ₁₁	120 N+80 P+100K
13.	T ₁₂	110N+70K+80K

Results and Discussion

Yield Parameters : The data in respect of yield parameters was found to be significantly different among different fertilizer treatments and are presented in Table-2.

The response of time period to fruit setting due to different fertilizer treatments had differed significantly minimum days to first fruit setting (67.67) and first fruit harvest (98.33) was observed in treatment T₆ (150N + 100P + 150 K ha⁻¹) with increased rate of N application caused the earlier fruit setting. Maximum period of (88.00) of days for fruit setting and fruit harvest (133.33) were recorded in treatment T₀ (control N, P, K). Similar results were reported by Hafiz and Mahmoud (2003) in squash and also in cucumber and Kirnak *et al.* (2005) in muskmelon and Maurya *et al* (1985) in Pointed Gourd.

The maximum fruit length (22.64 cm), fruit weight, (2.82 cm), and fruit diameter (15.70 cm), was recorded in T₆ followed by T₄ (20.48 cm, 2.38 Kg and 14.87 cm) through SSP and MOP respectively while the minimum fruit length (14.97 cm), weight of the fruit (1.14 Kg) and fruit diameter (10.80 cm) were recorded in T₀ (control NPK). Increased fruit length, fruit weight attributed due to NPK application might enhance photosynthesis, accumulation of carbohydrates and favourable effect on vegetative growth which increased the fruits parameters. The fruit length, fruit weight and fruit diameter was significantly effected by NPK the similar result has been obtained by Patil *et al* (1993) in Bottle Gourd and Singh *et al* (1986) In Muskmelon.

The number of fruit increased with increased rate of nitrogen application up to 150 kg /ha. Phosphorous addition by 100 kg P_2O_5 /ha has increased the number of fruit per plant the maximum number of fruit per plant (2.00 kg) and fruit yield in kg /vine (7.00 kg) and fruit yield in kg /ha (116.12 kg) was recorded in T₅ (2.00) followed by T₄ (2.00 kg, 6.33 kg and 99.96 kg/ha). While the minimum number of fruit per plant in (0.67) and fruit yield in kg /vine (3.30 kg) and fruit yield in kg/ha (61.14 kg) was recorded in T₀ through FYM, SSP, and MOP respectively. Similar results were obtained by Jacksunarno and Akali (2001), Singh *et al.* (2007) in Pointed Gourd and Singh *et al.* (2003) and Shantappa *et al.* (2006), Reddy *et al.* (2004) and Singh *et al.* (2003) in Pointed Gourd.

On the other hand the increase in number of fruits was also due to increase in number of nodes on account of increased number of primary and secondary branches either due to increased nitrogen or potash. Marked increase in fruit characters of crop under application of 150 kg N + 100 kg P_2O_5 kg ha⁻¹ appears to be account of vigorous growth in individual plant as reflected by

Table-1 : Variable and total cost of cultivation for different treatments for Ash gourd.

Treatments	Cost of cultivation (Rs/t)	Total yield	Selling Rate (Rs/t)	Gross Return (Rs/ha)	Net Return (Rs/ha)	Benefit cost Ratio
T ₀	57623.00	61.14	20,000	1222800	1165177	2.02:1
T ₁	57713.00	99.96	20,000	1999200	1941487	3.36:1
T ₂	57685.00	55.47	20,000	1109400	1051715	1.82:1
T ₃	57694.00	99.96	20,000	1999200	1941506	3.36:1
T ₃	57322.00	83.60	20,000	1672000	1614678	2.80:1
T ₃	57821.00	99.96	20,000	1999200	1614678	3.31:1
T ₃	57668.00	116.62	20,000	2332400	1941379	3.94:1
T ₃	57728.00	61.14	20,000	1222800	2274732	2.01:1
T ₃	57735.00	88.79	20,000	1775800	1165072	2.97:1
T ₃	577756.00	88.79	20,000	1775800	1718065	2.97:1
T ₃	57782.00	77.80	20,000	1556000	1718044	2.51:1
T ₃	57645.00	90.72	20,000	1814400	1498218	3.04:1
T ₃	577395.00	105.45	20,000	2109000	1756755	3.63:1

increasing height, Besides these, increased uptake of nutrients (N and P) clearly suggests better availability. This improvement seems to have facilitated plants to express their genetic capabilities for yield formation. It was also reported by Parmar *et al.*, (2011) in bitter gourd and Singh *et al* (2005) in pointed gourd .The higher number of branches and nodes per plant could be also attributed to the higher fruit number.

Nitrogen increased the synthesis of protoplasm and primarily in the manufacture of amino acid and increased auxin activity. The increase in yield and yield attributes due to NPK application might be attributed to enhanced photosynthesis, accumulation of carbohydrates, development of cell wall and cell differentiations as they boost up overall vegetative growth, biological activity of the plants and retention of more flowers and fruits which increased number of fruits per vine and size of fruits besides increasing the yield.

Higher yield of Ash gourd in the present study is also related to the influence of luxurious supply of nitrogen, phosphorus, potash, and their effect of absorption which the various physiological and metabolic processed especially protein metabolism. The translocation of these nutrients to the fruiting nodes results in higher fruiting and fruit development and ultimately yield.

Quality Parameters : The data in respect of quality parameters was found to be significantly different among different fertilizer treatments and are presented in Table-2.

Maximum total soluble solid (9.33) and Vitamin C content (3.57 mg) was recorded with T₁₀ (150 kg N ha⁻¹) which was significantly superior with T₉ (120 kg N ha⁻¹) and (8.67%) and 2.39 mg) and the minimum (6.33% and 1.76 mg) was obtained with T₀ (0 kg N ha⁻¹). Similar

results were obtained by Patil *et al* (1993) in Bottle Gourd and Singh *et al.* (1992) in Musk Melon, swaider *et al* (1998) in Musk melon and Umamaheshwarappa and Krishnappa (2004).

The 75 and 50 percent dosage of N and K, might have resulted in better accumulation of assimilates, leading to improved quality. Potassium is responsible for energy production in the form of ATP and NADPH in chloroplasts by maintaining balanced electric charges, which resulted in higher production of photosynthates.

Economics of different treatments : The economics of different treatments viz., yield (t ha⁻¹), cost of cultivation, gross return, net return and benefit cost ratio has been worked out and presented in Table-2. Maximum yield (116.62 t ha⁻¹) was recorded with treatment combination T₆ (150 kg N ha⁻¹ + 100 kg P ha⁻¹) followed by 105.45 t ha⁻¹ with T₁₂ (110 kg N ha⁻¹ + 70 kg P ha⁻¹), and the minimum (61.14 t ha⁻¹) was recorded with T₀ (control). Treatment combination T₆ (150 kg N ha⁻¹ + 100 kg P ha⁻¹) recorded maximum gross return (Rs.2332400 ha⁻¹) followed by Rs. (2109000) ha⁻¹ with treatment combination T₁₂ (110 kg N ha⁻¹ + 70 kg P ha⁻¹), while the minimum gross return (Rs. 122280 ha⁻¹) was recorded with T₀ (control).

Maximum net return (Rs. 2274732 ha⁻¹) was recorded with treatment combination T₆ (150 kg N ha⁻¹ + 100 kg P ha⁻¹) followed by Rs. (2108894 ha⁻¹) with treatment combination T₁₂ (80 kg N ha⁻¹ + 60 kg P ha⁻¹), and the minimum net return of Rs. 1165177 ha⁻¹ was recorded with T₀ (control). Highest Benefit cost ratio (3.94:1) was recorded with treatment combination T₆ (150 kg N ha⁻¹ + 100 kg P ha⁻¹) followed by (3.63) with treatment combination T₁₂ (110 kg N ha⁻¹ + 70 kg P ha⁻¹) while the minimum Benefit cost ratio (2.02:1) was recorded with T₀ (control). Above results clearly show

Table-2 : Effect of NPK on fruit length, fruit weight (kg), fruit diameter (cm), number of fruits per plant (kg) fruit yield in kg /ha and total soluble solids (obrix) and vitamin c content (mg).

Treatment combinations Npk (kg/ha)	Days to first fruit set	Days to first fruit harvest	Fruit parameters						TSS (Brix)	vitamin c (mg/100g)
			Length of fruit (cm)	Fruit weight (kg)	Fruit Diameter (cm)	Fruits per plant (kg)	Yield kg/ vine	Fruit yield kg/ha		
T ₀ (000N+000P+000K)	88.00	133.33	14.97	1.14	10.80	0.67	3.30	61.14	6.33	1.45
T ₁ (100N+150P+100K)	80.00	110.00	19.03	1.94	13.99	2.00	5.62	99.96	7.67	2.01
T ₂ (125N+75P+125K)	75.00	113.33	16.34	1.67	14.63	1.00	4.67	55.47	7.33	1.92
T ₃ (150N+100P+150K)	81.67	110.00	17.78	1.25	13.75	1.67	5.33	99.96	8.62	2.05
T ₄ (170N+120P+170K)	80.00	118.33	20.48	1.95	14.87	2.00	6.33	99.96	6.67	2.36
T ₅ (110N+100P+110K)	74.00	111.67	16.73	1.51	13.91	2.00	7.00	116.62	7.00	1.94
T ₆ (150N+100P+150K)	67.67	98.33	22.64	2.82	15.70	1.67	5.00	83.60	7.00	1.49
T ₇ (100N+100P+100K)	76.67	116.67	19.35	1.21	14.44	1.67	3.67	61.28	7.30	1.93
T ₈ (150N+80P+80K)	74.33	115.00	15.03	1.62	12.35	1.33	6.00	88.79	8.33	1.94
T ₉ (120N+60P+90K)	75.00	113.33	16.32	1.32	13.65	1.33	5.33	88.65	8.67	2.39
T ₁₀ (150N+75P+100K)	75.00	103.33	16.47	1.58	11.87	1.33	3.33	77.80	9.33	3.57
T ₁₁ (120N+80P+100K)	73.33	115.00	17.07	2.38	11.59	2.00	5.67	90.72	7.67	2.05
T ₁₂ (110N+70P+80K)	76.67	105.00	19.12	1.46	13.57	1.00	6.00	105.45	8.32	1.76
SEM (+)	4.374	7.245	2.091	0.440	1.352	0.403	0.904	0.942	0.823	0.499
C.D. (0.05%)	9.028	14.953	4.316	0.907	2.791	0.832	2.183	2.183	1.698	1.030

that out of the 16 interacting combinations of nitrogen and phosphorus, treatment combination T₂ P₃ (80 kg N ha⁻¹ + 80 kg P ha⁻¹) emerged as superior over all other treatment combinations in relation to growth, yield, quality and economic returns for commercial production of Ash gourd (*Benincasa hispida*) under the agro-climatic conditions of Allahabad.

Conclusion

On the basis of research findings it may be concluded that treatment (T₅) (110N+100P+110K) was found to be most suitable treatment combination in respect of highest yield (14.16 q)/ha and quality parameters was better recorded with treatment T₁₀) (150N+75P+100K). However these results are based on one year experiment. Therefore, it should be repeated to substantiate the finding.

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Effect of Mercury Vapor and Ultraviolet Lamp as a Light Source Against Major Insect Species of Vegetables Ecosystem during Rabi Season in District Chhindwara under Satpura Plateau Region of Madhya Pradesh

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Abstract

An experiment was conducted during Rabi 2020-21 under the comparison between 125 watt mercury lamp and 15 watt Ultraviolet lamp used as light source collected in light trap against major insect species of vegetable at district Chhindwara under Satpura Plateau Region of Madhya Pradesh. A Comparative studies of trap catches revealed that Mercury vapour 125 watt has given a higher response than Ultraviolet 15 watt in the following species- *Helicoverpa armigera*, *Plutella orichalsia*, *Spodoptera litura*, *Earias vitella*, *Leucinodes orbonalis* and *Plutella xylostella*, while Ultraviolet watt has given higher response than Mercury vapour in following species- *Chrysodeixis chalcites*, *Aulacophora foveicollis*, *Dysdercus koenigii* and *Nezara viridula*. Since, all these six species differences in trap catches were statistically non-significant shows that trapping efficiency of MV was at par with UV light source and another four species differences in trap catches were statistically non-significant shows that trapping efficiency of UV with MV light source. In other words Mercury vapour light source can be successfully used for the operation of light trap as survey and pest control tool against lepidopterous insects but the total wattage of electricity consumption in 125 watt MV v/s 15 watt UV, the Ultraviolet 15 watt seems to be a much cheaper & economic light source than MV. The trapping efficiency of Mercury vapour light source is also at par with Ultraviolet in majority of the species as stated above. In view of these observations, Mercury vapour light source can be successfully used against lepidopterous insects but Ultraviolet light source (15 watt) also seems to be a very good alternative source for Coleoptera and Hemiptera to MV 125 watt for operation of light traps for monitoring activity and pest control device.

Key words : light trap, mercury vapor, ultraviolet, insect pest.

Introduction

In India there exists a diverse climate which ensures availability of all types of vegetables. In the world India ranks second in vegetable production, after China. In India the total area of vegetables is 10353 thousand ha with production 191769 thousand MT and productivity of vegetables 17.97 MT/ha. In Madhya Pradesh it was cultivated in 967.23 thousand ha with production 19144.37 thousand MT during 2019-20 second estimate (Anonymous, 2020). In district Chhindwara of Madhya Pradesh total cultivated area of vegetable was 65.04 thousand ha with production 1513.11 thousand MT during 2019-20 (Anonymous, 2020).

Phototactic insects square measure those that is attracted towards a light supply. Seven colours in the light spectrum viz; violet, indigo, blue, green, yellow, orange and red make up visible lights. every colour features a completely different wavelength and frequency. Red has the longest wavelength and also the lowest frequency whereas violet has the shortest wavelength and also the highest frequency. The wavelengths of visible lights vary from 400-700 nanometres. As so much as temperature is

bothered red light is that the coolest and blue is that the warmest. White light is that the combination of all visible colours. It seems white as a result of none of the sunshine is absorbed and everyone is mirrored back to the human eye. Black light consists of long wavelengths of UV and is visible to insects, however to not humans. Light becomes visible to insects round the yellow a part of the spectrum and ends at UV ((Ashfaq *et al.*, 2005). "Nocturnal insects are often attracted to light sources that release a lot of UV radiation, and devices that take use of this behaviour, such as light traps for predicting pest outbreaks, and electrical insect killers, are developed" (Shimoda and Honda, 2013). Garris and Snyder (2010) according that "phototactic behavior toward UV varies among nocturnal flying insects". light trap has been accustomed supplement the data of the pest fauna of a given neck of the woods, geographical distribution and their seasonal activity etc.

Materials and Methods

The experiment was conducted at two different farmers' fields of Chhindwara (MP) during rabi 2020-21. The experiment was conducted by using Jawahar light trap

Table-1 : Major insect species of vegetables trapped in Jawahar Light trap by use of different light sources, during 2019-20 and 2020-21.

Sr. No.	Common Name	Scientific Name	Family
1.	Tomato fruit borer	<i>Helicoverpa armigera</i> (Hubner)	Noctuidae
2.	Cabbage semilooper	<i>Plucia orichalsia</i> (Fabricius)	Noctuidae
3.	Tobacco caterpillar	<i>Spodoptera litura</i> (Fabricius)	Noctuidae
4.	Okra shoot & fruit borer	<i>Earias vitella</i> (Linnaeus)	Noctuidae
5.	Green semi looper	<i>Chrysodeixix chalcites</i> (Esper)	Noctuidae
6.	Brinjal shoot and fruit borer	<i>Leucinods orbonalis</i>	Pyraustidae
7.	Diamond back moth	<i>Plutella xylostella</i>	Plutellidae
Order–Coleoptera			
8.	Red pumpkin beetle	<i>Aulacophora foveicollis</i> (Lucas)	Chrysomelidae
9.	Red cotton bug	<i>Dysdercus skoенigii</i> (Fabricius)	Pyrrhocoridae
10.	Green stink bug	<i>Nezara viridula</i> (Linnaeus)	Pentatomidae

Table-2 (a) : Comparative response of insect species towards light sources, Rabi 2020 21.

S. No.	Observation period (weekly)	Species wise weekly total catches (corrected to seven day) and mean per day/trap									
		<i>Helicoverpa armigera</i>		<i>Plucia orichalsia</i>		<i>Spodoptera litura</i>		<i>Earias vitella</i>		<i>Chrysodeixix chalcites</i>	
		T1	T2	T1	T2	T1	T2	T1	T2	T1	T2
1	Nov I wk	7.25	6.5	0	0	0	0	0	0	0	0
2	Nov II wk	6.25	5.15	0	0	0	0	0	0	0	0
3	Nov III wk	8.5	15.25	19.25	35.25	6	9	0	0	0	0
4	Nov IV wk	8	7.15	24.75	30.75	5	8	0	0	0	0
5	Dec. I wk	20.12	15.14	20.15	16.11	2.5	6.5	0	0	0	0
6	Dec. II wk	12.88	20.16	22.16	18.39	12.5	10.5	0	0	0	0
7	Dec. III wk	15.25	14.5	18.5	38	14	12	0	0	0	0
8	Dec. IV wk	15.75	12.14	19.25	16.5	16.5	15.5	0	0	0	0
9	Jan. I wk	22.17	14.67	15.75	11.5	16	9.75	7	6.25	0	0
10	Jan. II wk	12.88	19.5	11.75	9.88	8.5	16	8	3.5	3.5	4.25
11	Jan. III wk	13.83	11.66	16.5	12.66	16.75	12	6.65	1.5	4	2.83
12	Jan. IV wk	26.75	14.12	13.62	11.37	12	22	7	2.13	2.25	5.87
13	Feb. I wk	14.43	13.29	37.55	28	14.55	14	5	9	4.35	6
14	Feb. II wk	13.12	17.25	45	36.13	10.25	8.65	4.5	5.75	4.75	4.37
15	Feb. III wk	15.72	16.15	38.58	57.71	13.5	12.65	3.5	7.14	5.89	4
16	Feb. IV wk	15	16.66	44.44	52.16	19.5	28	4.35	2.56	3.26	4.75
17	Mar. I wk	15.15	14.5	202.55	195.55	45.5	42.55	8.85	10.5	0	0
18	Mar. II wk	15.35	12.14	180.15	175.15	58	49.5	7.15	8.12	0	0
19	Mar. III wk	22.15	14.67	178.33	165.12	69.25	62	12.5	6	0	0
20	Mar. IV wk	12	18.5	166.15	157.12	68.5	58.25	6.5	8.55	0	0
21	April. I wk	78.35	72.25	110.12	105.12	60	78	0	0	0	0
22	April. II wk	75.55	65.75	138.73	132.71	62	48.65	0	0	0	0
23	April. III wk	45.45	55	142.19	138.15	63.75	58	0	0	0	0
24	April. IV wk	85.65	67.5	145.53	142.67	67.55	48.5	0	0	0	0

with Mercury Vapor 125 watt and Ultraviolet light 15 watt (18" tube) was used as light source. Comparison of Ultraviolet blue light lamp and Mercury Vapor lamp against major insect pest of rabi vegetable crops was based on catches obtained on daily basis by operating the light trap throughout the rabi season. As per the objectives of the study experiments were conducted in the field. Light traps were operated every night and collection was being observed next morning. Observations were recorded every day throughout the rabi season and converted into standard weekly averages. Total insects' fauna was

observed and sorted out on the basis of major orders, families and species. In all, two light traps were installed in the experimental area. Spacing between each trap was approximately 400 meters. The insects collected in the collection bag were killed by the exposure of Dichlorvos 76% EC vapors (as fumigating agent) released in a dispenser with scrubber, placed in a collection tray for instant killing of trapped insects. Insects were collected from the collection bag every morning. It includes two treatments to compare the relative efficiency of Ultraviolet lamp over mercury vapor lamp as light source in a light

Table-2(b) : Comparative response of insect species towards light sources, Rabi 2020 21.

S. No.	Observation period (weekly)	Species wise weekly total catches (corrected to seven day) and mean per day/trap									
		<i>Leucinods orbonalis</i>		<i>Plutella xylostella</i>		<i>Aulacophora foveicollis</i>		<i>Dysdercus koenigii</i>		<i>Nezara viridula</i>	
		T1	T2	T1	T2	T1	T2	T1	T2	T1	T2
1.	Nov I wk	0	0	0	0	0	0	0	0	10.55	8
2.	Nov II wk	0	0	0	0	0	0	0	0	10.23	6.75
3.	Nov III wk	18	13.25	20.25	18.25	12.65	12	0	0	3.14	7.14
4.	Nov IV wk	16	18.5	20.8	15.8	11	5.63	0	0	3.33	2.56
5.	Dec. I wk	15.65	23.5	16.15	18.11	3.12	4.13	0	0	8.63	5.25
6.	Dec. II wk	22	30.13	14.5	22.56	4.16	2.83	0	0	4.43	7.43
7.	Dec. III wk	23	27.47	16.16	18.39	2.13	5.87	0	0	3.44	6.67
8.	Dec. IV wk	30.5	35.75	13.25	16.5	4.42	6	0	0	12.5	19.25
9.	Jan. I wk	28.5	26.14	9.75	8.54	5.87	7.37	0	0	12.29	19.86
10.	Jan. II wk	22.35	28.56	11.75	9.88	4.83	7.16	0	0	5.25	11.63
11.	Jan. III wk	32.17	36.67	16.5	8.66	7.5	8	0	0	4.43	7.43
12.	Jan. IV wk	28.88	35.5	11.62	18.37	14.29	14.86	0	0	8	12.25
13.	Feb. I wk	26.83	17.66	31.43	29.2	12.29	12.86	0	0	3.12	9.13
14.	Feb. II wk	35.75	26.12	38.44	45.11	5.25	8.63	0	0	8.46	6.83
15.	Feb. III wk	42.43	33.29	32.58	26.71	4.43	7.75	9.75	7.5	2.13	9.87
16.	Feb. IV wk	38.12	26.25	37.12	28.23	3.67	6.55	11.75	9.88	1.52	4.55
17.	Mar. I wk	29.72	26.15	195.55	178.55	13.25	16.35	16.5	7.66	31.43	29.14
18.	Mar. II wk	27.24	26.75	148.15	140.14	9.75	15.35	9.62	11.37	38.44	35.11
19.	Mar. III wk	151.15	149.36	165.25	158.25	11.75	9.88	38.43	45.9	16.5	18.66
20.	Mar. IV wk	120.55	114.25	175.15	165.17	7.73	15.75	38.44	41.38	11.62	11.35
21.	April. I wk	132.4	126.55	140.25	145.71	16.16	12.39	32.58	45.71	31.43	22
22.	April. II wk	138.14	132.55	110.35	122.35	13.25	14.5	35.46	42.13	37	26.11
23.	April. III wk	152.25	148.25	140	135.15	9.75	11.26	46.12	52.15	16.51	17.66
24.	April. IV wk	145.37	139.35	95	95.37	12.75	10.88	42.35	48.32	10.62	14.37

trap in trapping and collecting insects of various crop pest species. The comparison between both the light sources was conducted during the peak activity period of major phototactic insect pests. The data so obtained were analyzed by using paired t-test. T1-MV (Mercury Vapor) lamp 125-watt T2-UV (Ultra Violet) tube 15 watt.

Results and Discussion

Comparative efficiency of ultraviolet and Mercury vapour light sources based on response of ten insect pest species namely Tomato fruit borer *Helicoverpa armigera* (Hubner), Cabbage semilooper *Plucia orichalsia* (Fabricius), Tobacco caterpillar *Spodoptera litura* (Fabricius), Okra shoot & fruit borer *Earias vitella* (Linnaeus), Green semi looper *Chrysodeixix chalcites* (Esper), Brinjal shoot and fruit borer *Leucinods orbonalis* (Guenee), Diamond back moth *Plutella xlostella*, red pumpkin beetle *Aulacophora foveicollis* (Lucas), Red cotton bug *Dysdercus koenigii* (Fabricius) and Green stink bug *Nezara viridula* (Linnaeus) were identified as important positively phototropic insect pests in the rabi vegetable crops because they occurred regularly and significantly high number in trap catches. Name of major species observed in trap catches and species wise

description is given in Table No.1 and comparative responses of the insect pests towards the light sources is described in Table 2 (a) and 2 (b).

Results of comparative study on Light source—, during 2020-21

Treatments-

T1-MV (Mercury Vapor) lamp 125 watt

T2-UV (Ultraviolet) tube 15 watt (18" length)

Period—1st week of November (2019) to Last week of April (2020)

Species wise respons

1. Tomato fruit borer (*Helicoverpa armigera*)

Details of statistics with light sources MV and UV	T1 MV 125W	T2 UV 15W
Mean	24.07	22.48
Variance	528.06	399.85
No. of observation	24	24
d.f	23	
Tcal	1.159 NS	
Ttab	2.069	

At a level of significance of 5%, the calculated value of t (1.159) is found to be less than the tabulated value of t

at 23 df (2.069). As a result, we accept the null hypothesis and conclude that the mean of MV 125 Watt and UV 15 Watt is not statistically significant. In MV, trap catches were higher than in UV.

2. Cabbage semilooper (*Plucia orichalsia*)

Details of statistics with light sources MV and UV	T1 MV 125W	T2 UV 15W
Mean	73.23	72.09
Variance	4667.78	4180.80
No. of observation	22	22
d.f	21	
Tcal	0.586 NS	
Ttab	2.08	

At a level of significance of 5%, the estimated value of t (0.586) is found to be less than the tabulated value of t at 21 df (2.080). As a result, we accept the null hypothesis and conclude that the mean of MV 125 Watt and UV 15 Watt is not significantly different. In MV, trap catches were higher than in UV.

3. Tobacco caterpillar (*Spodoptera litura*)

Details of statistics with light sources MV and UV	T1 MV 125W	T2 UV 15W
Mean	30.09	28.64
Variance	637.65	499.98
No. of observation	22	22
d.f	21	
Tcal	0.830 NS	
Ttab	2.08	

At a level of significance of 5%, the estimated value of t (0.830) is found to be less than the tabulated value of t at 21 df (2.080). As a result, we accept the null hypothesis and conclude that the mean of MV 125 Watt and UV 15 Watt is not significantly different. In MV, trap catches were higher than in UV.

4. Okra shoot & fruit borer (*Earias vitella*)

Details of statistics with light sources MV and UV	T1 MV 125W	T2 UV 15W
Mean	6.75	5.92
Variance	5.80	8.63
No. of observation	12	12
d.f	11	
Tcal	0.790 NS	
Ttab	2.201	

At a level of significance of 5%, the estimated value of t (0.790) is found to be less than the tabulated value of t at 11 df (2.201). As a result, we accept the null hypothesis and conclude that the mean of MV 125 Watt and UV 15 Watt is not significantly different. In MV, trap catches were higher than in UV.

5. Green semi looper (*Chrysodeixix chalcites*)

Details of statistics with light sources MV and UV	T1 MV 125W	T2 UV 15W
Mean	4.00	4.80
Variance	1.353	1.210
No. of observation	7	7
d.f	6	
Tcal	0.816 NS	
Ttab	2.447	

At a level of significance of 5%, the estimated value of t (0.816) is found to be less than the tabulated value of t at 6 df (2.447). As a result, we accept the null hypothesis and conclude that the mean of MV 125 Watt and UV 15 Watt is not significantly different. In UV, trap catches were higher than MV.

6. Brinjal shoot and fruit borer (*Leucinods orbonalis*)

Details of statistics with light sources MV and UV	T1 MV 125W	T2 UV 15W
Mean	58.05	56.46
Variance	2714.53	2501.48
No. of observation	22	22
d.f	21	
Tcal	1.186 NS	
Ttab	2.080	

At a level of significance of 5%, the calculated value of t (1.186) is found to be less than the tabulated value of t at 21 df (2.080). As a result, we accept the null hypothesis and conclude that the mean of MV 125 Watt and UV 15 Watt is not significantly different. In MV trap captures were higher than UV.

7. Diamond back moth (*Plutella xylostella*)

Details of statistics with light sources MV and UV	T1 MV 125W	T2 UV 15W
Mean	66.36	64.77
Variance	4240.49	3910.25
No. of observation	22	22
d.f	21	
Tcal	1.065 NS	
Ttab	2.080	

At a level of significance of 5%, the estimated value of t (1.065) is found to be less than the tabulated value of t at 21 df (2.080). As a result, we accept the null hypothesis and conclude that the mean of MV 125 Watt and UV 15 Watt is not significantly different. In MV, trap catches were higher than in UV.

8. Red pumpkin beetle (*Aulacophora foveicollis*)

Details of statistics with light sources MV and UV	T1 MV 125W	T2 UV 15W
Mean	8.64	9.82
Variance	18.28	16.25
No. of observation	22	22
d.f	21	
Tcal	1.855 NS	
Ttab	2.080	

At a level of significance of 5%, the calculated value of t (1.855) is found to be less than the tabulated value of t at 21 df (2.080). As a result, we accept the null hypothesis and conclude that the mean of MV 125 Watt and UV 15 Watt is not significantly different. In UV, trap catches were higher than MV.

9. Red cotton bug (*Dysdercus koenigii*)

Details of statistics with light sources MV and UV	T1 MV 125W	T2 UV 15W
Mean	28.10	31.20
Variance	210.64	371.702
No. of observation	10	10
d.f	9	
Tcal	1.579 NS	
Ttab	2.262	

At a level of significance of 5%, the calculated value of t (1.579) is found to be less than the tabulated value of t at 9 df (2.262). As a result, we accept the null hypothesis and conclude that the mean of MV 125 Watt and UV 15 Watt is not significantly different. In UV, trap catches were higher than MV.

10. Green stink bug (*Nezara viridula*)

Details of statistics with light sources MV and UV	T1 MV 125W	T2 UV 15W
Mean	12.29	13.29
Variance	123.40	71.78
No. of observation	24	24
d.f	23	
Tcal	0.989 NS	
Ttab	2.069	

At a level of significance of 5%, the estimated value of t (0.989) is found to be less than the tabulated value of t at 23 df (2.069). As a result, we accept the null hypothesis and conclude that the mean of MV 125 Watt and UV 15 Watt is not significantly different. In UV, trap catches were higher than MV.

Conclusions

Comparative studies of trap catches revealed that Mercury vapour 125 watt has given a higher response

than Ultraviolet 15 watt in the species-*Helicoverpa armigera*, *Plucia orichalsia*, *Spodoptera litura*, *Earias vitella*, *Leucinods orbonalis* and *Plutella xylostella*, while Ultraviolet watt has given higher response than Mercury vapour in the species-*Chrysodeixix chalcites*, *Aulacophora foveicollis*, *Dysdercus koenigii* and *Nezara viridula*. Since, all these six species differences in trap catches were non-significant shows that trapping efficiency of MV was at par with UV light source and another four species differences in trap catches were non-significant shows that trapping efficiency of UV with MV light source. In other words Mercury vapour light source can be successfully used for the operation of light trap as survey and pest control tool against lepidopterous insects but the total wattage of electricity consumption in 125 watt MV v/s 15 watt UV, the Ultraviolet 15 watt seems to a much cheaper & economic light source than MV.

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Formulative Research Study on Satisfaction Level of Farmers Using Information Channels for Banana Cultivation Technologies in Trichy District, Tamil Nadu

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Abstract

Agriculture is the back engine of Nation's developmental agenda. But our farmers still miserably struggling due to non-adoption of modern far technologies. In this context, role of mass media in dissemination of farm information to the farmers is vital. The present study was undertaken to determine the satisfaction level of mass media users (viz., Newspapers, Magazines, Radio, Television, New media) in accessing in Banana production technologies of Trichy district of Tamil Nadu. Based on a five point scale, overall satisfaction on the functions of the media for getting information & technology on banana cultivation was obtained. It was inferred that the maximum overall satisfaction on the activities/ functions of the media for getting information & technology on banana cultivation was found among female respondents. The age group of 26–35 years felt high Level of satisfaction on the activities/ functions of the media for getting information & technology on banana cultivation. The socio economic characteristics such as educational qualification, annual income and ownership of land also had an impact in deciding the satisfaction level of mass media users.

Key words : Farmer's satisfaction, mass media communication, information technology in banana cultivation, agriculture

Introduction

India is the largest producer of banana and plantain in the world with a production of 300 lakh MT on 8.47 lakh hectares of land (Department of Agri. & Cooperation, Horticulture Statistics Division 2020). Tamil Nadu has about 2.12 lakh acres of banana cultivation and Tiruchirappalli district is one of the major area and productions hubs of banana in Tamil Nadu. The Scientific efforts made by National Research Centre for Banana, Tiruchirappalli have overcome those constraints in banana cultivation and enhanced the production and productivity of banana (NRCB at a glance 2010). Tiruchirappalli District located along the Kaveri River in Tamil Nadu, India. The main town in Tiruchirappalli District is the city of Tiruchirappalli, also known as Trichy. As of 2011, the district had a population of 27, 22,290 with a sex-ratio of 1,013 females for every 1,000 males. Ten different types of agricultural programmes (uzhavar ulagam, velan arangam, etc.) were broadcast from All India Radio, Tiruchirappalli, six different types of daily newspapers and two popular magazines (vanoli uzhavar sanga seithi kathir and Kauvery Times) were published on the agricultural information from Tiruchirappalli district.

Agricultural communication and awareness among farming community : Information and Communication Technologies when used adequately can speed up the

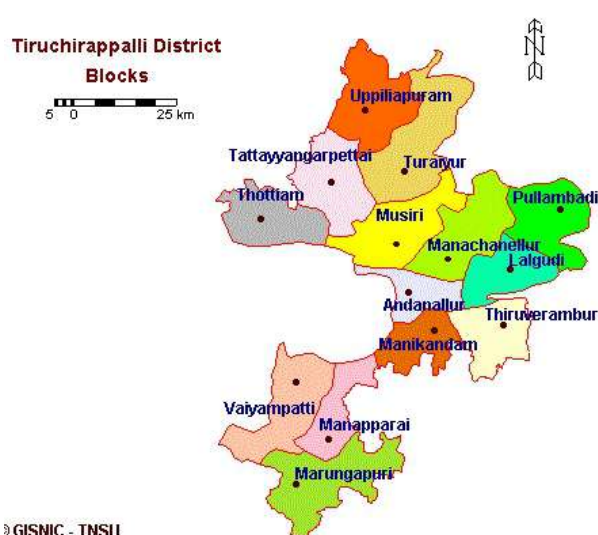
process of transfer of technology. The utilization of mass media, internet and the mobile phones can bring about considerable changes in the life-style of the farmers as it transfers the current and precise technologies. Thus role of mass media in dissemination of farm technologies is vital. Crop production and protection, schemes, market rates and farmers' experience provide adequate information to fulfill the farmers' information needs. When this is reached at the exact time of requirement then it bears fruit. Thus the above said efforts are towards this goal and it hopes to change the livelihood of the farmers (Vadivel *et al*, 2012). ICAR-national research centre for banana (NRCB), Tiruchirappalli and Tamil Nadu Agricultural University (TNAU), Coimbatore initiated a project on 'Mobilizing Mass Media Support for Sharing Agro-Information's in the initiation phase and has been designed and developed with the objective to enhance the agricultural communication and awareness in the country at grass-root level by using effective communication and information tools. The capacity-building will be undertaken to make the communication platform developed under the project sustainable beyond the project period enhancing visibility and adoption of agricultural technologies by farming community and entrepreneurs. Latest ICT tools used to develop a quick and responsive interface with farmers, media and general public. The project will be implemented in the participatory mode with active contribution from consortia partners like ICAR Institutes located at various



places viz. Indian Institute of Horticulture Research, Bangalore (IIHR); Central Institute for Subtropical Horticulture, Lucknow (CISH); Indian Institute of Vegetable Research, Varanasi (IIVR); Indian Institute Spices Research, Calicut (IISR); Central Institute of Fisheries Technology, Cochin (CIFT); Central Institute of Post Harvest Engineering Technology, Bhopal (CIPHET) and link organizations such as IGNOU, IIMC, Prasar Bharati (AIR and Doordarshan) and Media groups located across the country. Directorate of Information and Publications of Agriculture, New Delhi will act as Nodal and Coordinating Agency for the implementation and monitoring of the project. (TNAU, Coimbatore- Associated Review report, 2014) and the nodal office of the Farmer information centre for banana located at Tiruchirappalli, ICAR-National Research Centre for Banana (NRCB at a glance 2013).

Research Methodology

The Quantitative : Survey method was employed to collect the relevant primary data from the sample respondents with the help of a questionnaire. The data was collected from 644 respondents of major banana cultivating blocks of Thottiyam, Lalgudi, Andanallur, Manachanallur and Tiruverambur in Tiruchirappalli district. The data were checked for completeness, classified, tabulated and analyzed with the help of surveys and interpretation. In order to provide a detailed description of independent variables and dependent variables, frequency test, t-test, Chi-square test, ANOVA,



and correlation tests were conducted. A simple statistical parameter like percentage was used for the interpretation of data.

Results and Discussion

Block and overall satisfaction on the activities/ functions of the media for getting information & technology on banana cultivation : To study the effect of block, the distributions of sample respondents according to block the overall satisfaction on the activities/ functions of media for getting information & technology on banana cultivation are shown in the following table-1a. Among five blocks Thottiyam was ranked first and ranged between 96 and 166 with an average of 132.7 (68.05%). Lalgudi was ranged between 85 and 164 with an average of 125.93 (64.58%), Andanallur was ranged between 85 and 164 with an average of 124.51 (63.85%), Manachanallur was ranged between 90 and 160 with an average of 126.41 (64.83%) and Thiruverambur was ranged between 75 and 156 with an average of 125.41 (64.31%). Further to test the significant difference between the mean scores among the demographic variable of block the ANOVA test was used and the result is shown in table 16. Since the p value is less than 0.01 there is significant difference in the mean scores regarding satisfaction found with respect to block.

Thus, it is inferred from the above analysis that the maximum overall satisfaction on the activities/ functions of media for getting information & technology on banana cultivation was found very high among Thottiyam respondents. With a view to finding out the degree of association between block of the respondents and Level of satisfaction on the activities/ functions of the media for getting information & technology on banana cultivation, a two-way table was prepared and the results are shown in the following table-1b.

Table-1a. Block and overall satisfaction on the activities/functions of the media for getting information & technology on banana cultivation.

Block	N	Range		Mean	SD	Mean %	F Statistics	P
		Min	Max					
Thottiyam	172	96	166	132.70	15.89	68.05	6.08	< 0.001**
Lalgudi	155	85	164	125.93	18.97	64.58		
Andanallur	138	89	155	124.51	13.90	63.85		
Manachanallur	121	90	160	126.41	16.57	64.83		
Thiruverumbur	58	75	156	125.41	17.40	64.31		
Total	644	75	166	127.48	16.82	65.37		

*Significant at 5%; **Significant at 1%

Table-1b. Blockwise satisfaction on the activities / functions of the media for getting information & technology on banana cultivation.

Block	Level satisfaction on the activities/ functions of media for getting information & technology on banana cultivation						Total
	Low		Medium		High		
	N	%	N	%	N	%	
Thottiyam	3	1.7	113	65.7	56	32.6	172
Lalgudi	15	9.7	103	66.5	37	23.9	155
Andanallur	9	6.5	114	82.6	15	10.9	138
Manachanallur	9	7.4	85	70.2	27	22.3	121
Thiruverumbur	8	13.8	37	63.8	13	22.4	58
Total	44	6.8	452	70.2	148	23.0	644

Table-1c : Chi square Test.

Factor	Calculated Chi-square value	Degrees of freedom	'p' Value	Remarks
Block	32.48	8	< 0.001**	Highly Significant

It is found from the table (1b.) that the percentage of high level satisfaction on the activities/ functions of media for getting information & technology on banana cultivation was the highest (32.6%) among the Thottiyam respondents and the same was the lowest (10.9%) among the Andanallur respondents. The percentage of medium Level of satisfaction on the activities/ functions of media for getting information & technology on banana cultivation was the highest (82.6%) among the respondents in Andanallur and the same was the lowest (63.8%) among the Thiruverumbur respondents. The percentage of the low Level of satisfaction on the activities/ functions of media for getting information & technology on banana cultivation was the highest (13.8%) among the Thiruverumbur respondents and the same was the lowest (1.7%) among the Thottiyam respondents.

In order to find out the relationship between the block of the respondents and the Level of satisfaction on the activities/ functions of the media for getting information & technology on banana cultivation, a chi-square test was used and result of the test is shown in the following table-1c.

It is noted from the above table-1c that the 'p' value is less than 0.01 and hence the result is significant at 1 %. Hence, the hypothesis 'block of the respondents and the level of satisfaction on the activities/ functions of media for getting information & technology on banana cultivation are not associated' does not hold well. From the analysis

it is concluded that there is a highly significant association found between the block of the respondents and the level of satisfaction on the activities/ functions of the media for getting information & technology on banana cultivation.

Gender wise overall satisfaction on the activities/ functions of the media for getting information & technology on banana cultivation : Thus, it is inferred from the above analysis that the maximum overall satisfaction on the activities/ functions of the media for getting information & technology on banana cultivation was found among female respondents.

With a view to finding out the degree of association between the gender of the respondents and the Level of satisfaction on the activities/ functions of the media for getting information & technology on banana cultivation, a two-way table was prepared and the results are shown in the following table-2b.

It is seen from the table that the percentage of the low level of satisfaction on the activities/ functions of the media for getting information & technology on banana cultivation was the highest (12.5%) among the female respondents whereas the lowest (6.6%) was found among the male respondents.

Age Vs overall satisfaction on the activities/ functions of the media for getting information & technology on banana cultivation : To study the effect of age, the distributions of sample respondents according to age, the

Table-2a : Gender wise overall satisfaction on the activities/ functions of the media for getting information & technology on banana cultivation.

Gender	N	Range		Mean	SD	Mean %	t Statistics	p
		Min	Max					
Male	620	75	166	127.43	16.65	65.35	0.35	0.725
Female	24	89	152	128.67	21.27	65.98		
Total	644	75	166	127.48	16.82	65.37		

*Significant at 5%; **Significant at 1%

Table-2b : Gender and Level of satisfaction on the activities/ functions of the media for getting information & technology on banana cultivation.

Gender	Level satisfaction on the activities/ functions of the media for getting information & technology on banana cultivation						Total
	Low		Medium		High		
	N	%	N	%	N	%	
Male	41	6.6	441	71.1	138	22.3	620
Female	3	12.5	11	45.8	10	41.7	24
Total	44	6.8	452	70.2	148	23.0	644

Table-3 : Age wise overall satisfaction on the activities/ functions of the media for getting information & technology on banana cultivation.

Age	N	Range		Mean	SD	Mean %	F Statistics	p
		Min	Max					
15 - 25	17	103	147	129.47	13.79	66.40	1.88	0.096
26 - 35	74	89	161	131.55	18.42	67.46		
36 - 45	222	75	166	127.62	17.77	65.44		
46 - 55	198	88	165	127.74	16.42	65.51		
56 - 65	96	94	158	124.47	15.66	63.83		
66 - 75	37	97	156	123.97	12.16	63.58		
Total	644	75	166	127.48	16.82	65.37		

overall satisfaction on the activities/ functions of the media for getting information & technology on banana cultivation among the respondents are shown in the following Table No. 3.

It could be noted from the table that the overall satisfaction on the activities/functions of the media for getting information & technology on banana cultivation among the respondents whose age group of 15-25 yrs was ranged between 103 and 147 with an average of 129.47 (66.40%). The overall satisfaction on the activities/ functions of the media for getting information & technology on banana cultivation among 26-35 yrs was ranged between 89 and 161 with an average of 131.55 (67.46%). The overall satisfaction on the activities/ functions of the media for getting information & technology on banana cultivation among 36-45 yrs was ranged between 75 and 166 with an average of 127.62 (65.44%), among the respondents whose age group of 46 – 55 yrs was ranged between 88 and 165 with an average of 127.74 (65.51%), the age group of 56-65yrs was ranged between 94 and 158 with an average of 124.47 (63.83%) and the age group of 66-75 years was ranged between 97 and 156 with an average of 123.97 (63.58%).

Thus, it is inferred from the above analysis that the overall satisfaction on the activities/ functions of the

media for getting information & technology on banana cultivation was found maximum among age group 26-35 years.

Educational qualification Vs overall satisfaction on the activities/functions of the media for getting information and technology on banana cultivation :

To study the effect of educational qualification, the distributions of sample respondents according to educational qualification pertaining to overall satisfaction on the activities/ functions of the media for getting information & technology on banana cultivation among the respondents are shown in the following table-4.

It could be noted from the table that the overall satisfaction on the activities/ functions of the media for getting information & technology on banana cultivation among Primary was ranged between 89 and 147 with an average of 121.52 (62.32%), whereas among up to middle school level was ranged between 75 and 166 with an average of 127.20 (65.23%).

Overall satisfaction on the activities/ functions of the media for getting information & technology on banana cultivation among HSS was ranged between 85 and 164 with an average of 127.36 (65.31%), followed by among the Graduate was ranged between 89 and 166 with an average of 131.97 (67.68%) and Post graduate was

Table-4 : Educational qualification Vs overall satisfaction on the activities/ functions of the media for getting information & technology on banana cultivation.

Educational qualification	N	Range		Mean	SD	Mean %	ANOVA	p
		Min	Max					
Primary	67	89	147	121.52	14.81	62.32	4.12	0.001**
Middle	244	75	166	127.20	17.29	65.23		
HSS	160	85	164	127.36	16.81	65.31		
UG	117	89	166	131.97	16.88	67.68		
PG	41	100	150	129.20	14.87	66.25		
Others	15	95	139	120.13	13.05	61.61		
Total	644	75	166	127.48	16.82	65.37		

*Significant at 5%; **Significant at 1%

Table-5 : Ownership of land Vs level of satisfaction.

Ownership of land	N	Range		Mean	SD	Mean %	ANOVA	p
		Min	Max					
Own land	339	91	165	128.49	16.17	65.89	1.52	0.220
Contract land	127	75	166	127.13	17.29	65.19		
Both	178	85	166	125.81	17.65	64.52		
Total	644	75	166	127.48	16.82	65.37		

ranged between 100 and 150 with an average of 129.20 (66.25%) whereas among others was ranged between 95 and 139 with an average of 120.13 (61.61%).

Ownership of land and Level of satisfaction : To study the effect of ownership of land, the distributions of sample respondents according to ownership of land pertaining to overall satisfaction on the activities/ functions of the media for getting information & technology on banana cultivation are shown in the following table-5.

It could be noted from the table that the level of satisfaction among the own land was ranged between 91 and 165 with an average of 128.49 (65.89%) and the level of satisfaction among the contract land was ranged between 75 and 166 with an average of 127.13(65.19%) and the level of satisfaction among the own & contract land was ranged between 85 and 166 with an average of 125.81 (64.52%).

Thus, it is inferred from the above analysis that the maximum level of satisfaction was found among the respondents on own land.

Annual income Vs level of satisfaction : To study the effect of annual income, the distributions of sample respondents according to annual income pertaining to the level of satisfaction are shown in the following table 6.1. It could be noted from the table that the level of satisfaction among the 50 thousand was ranged between 75 and 166 with an average of 124.47. The level of satisfaction among 51 thousand – 1 lakh was ranged between 89 and 164 (63.83%) with an average of 127.78 (65.53%). Among 1-3 lakh was ranged between 90 and 164 with an average of 128.53(65.91%). The level of satisfaction among 3-5 lakh was ranged between 85 and 161 with an average of 126.64 (64.94%), the level of satisfaction among 5-10 lakh was ranged between 95 and 166 with an average of 127.73 (65.50%) and the level of satisfaction among

10-25 lakh was ranged between 102 and 148 with an average of 130.78 (67.07%).

Thus, it is inferred from the above analysis that the maximum level of satisfaction was found among 10-25 lakh respondents.

Further to test the significant difference between the mean scores among the demographic variable of annual income the ANOVA test was used and the result is also shown in table-6a. Since the p value is greater than 0.05 there is no significant difference in the mean scores regarding satisfaction found with respect to annual income.

With a view to finding out the degree of association between the annual income of the respondents and the level of satisfaction, a two-way table was prepared and the results are shown in the following table-6b.

It is found from the table that the percentage of high level of satisfaction of respondents was the highest (29.5) among 1-3 lakh respondents, whereas the lowest (12.7) was found among the 50 thousand respondents. The percentage of medium level of satisfaction over the availability was the highest (82.9) among the respondents in 5-10 lakhs, whereas the lowest (62.6) was found among the 51 thousand – 1 lakh respondents. The percentage of low level of satisfaction over the availability was the highest (11.1) among the 50 thousand - 1lakh respondents, whereas the lowest (2.4) was found among the 5-10lakh respondents.

In order to find out the relationship between the annual income of the respondents and the level of satisfaction, a Chi-square test was used and result of the test is shown in the following table 6.1b.

It is noted from the above table that the 'p' value is less than 0.01 and hence the result is significant at 1 %.

Table-6a : Annual income Vs level of satisfaction

Annual income	N	Range		Mean	SD	Mean %	ANOVA	p
		Min	Max					
50 thousand	118	75	166	124.47	16.77	63.83	1.22	0.297
51 thousand - 1 lakh	171	89	164	127.78	17.43	65.53		
1 - 3 lakh	224	90	164	128.53	17.27	65.91		
3 - 5 lakh	58	85	161	126.64	17.05	64.94		
5 - 10 lakh	41	95	166	127.73	15.28	65.50		
10 - 25 lakh	32	102	148	130.78	10.36	67.07		
Total	644	75	166	127.48	16.82	65.37		

* Significant at 5 %; ** Significant at 1 %

Table-6b : Annual income Vs level of satisfaction

Annual income	Level of satisfaction						Total
	Low		Medium		High		
	N	%	N	%	N	%	
50 thousand	9	7.6	94	79.7	15	12.7	118
51 thousand - 1 lakh	19	11.1	107	62.6	45	26.3	171
1 - 3 lakh	12	5.4	146	65.2	66	29.5	224
3 - 5 lakh	3	5.2	45	77.6	10	17.2	58
5 - 10 lakh	1	2.4	34	82.9	6	14.6	41
10 - 25 lakh			26	81.3	6	18.8	32
Total	44	6.8	452	70.2	148	23.0	644

Table-6.1b. : Chi square Test

Factor	Calculated Chi-square value	Degrees of freedom	'p' Value	Remarks
Annual income	27.33	10	0.002	Highly Significant

Hence the hypothesis 'annual income of the respondents and the level of satisfaction are not associated' does not hold well. From the analysis it is concluded that there is a highly significant relationship found between the annual income of the respondents and the level of satisfaction.

Conclusion

The findings of the research study suggested that delivery of and access to timely and relevant agricultural information and knowledge is the need of the hour to increase the crop production. It is inferred from the present study that the socio economic status of the respondents such as age, gender, land holding pattern and income have an impact on satisfaction level of the respondents. Though smallholder farmers mainly depend on informal channels, mass media channels delivers agricultural information and knowledge in quicker span of time to larger audience. Since the mass media channels have their own merits and demerits, the choice of the media also plays an important role in farm technology transfer. Interactive communication methods are needed, in order to increase the satisfactory level of mass media users across the rural community. The contents and technical terminologies should be presented in an easily understandable language, with local dialect of the farmers. Media should provide a platform to the farmers' centric specific programmes to strengthen the banana cultivation. The new media communication viz., WHATSAPP messages, FB posts, SMS and Voice messages could be well utilized.

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Constraints Faced by the Farmers in Adoption of Improved Cultivation Practices of Kalonji (*Kalonji sativa*)

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Abstract

Neemuch district has good scope for agricultural development due to various agro-ecological regions. This study was undertaken in Krishi Vigyan Kendra, Neemuch (M.P) during the period 2020-21. Various trainings, FLDs and lectures are conducted by scientists of KVK to improve the cultivation practices of kalonji in Neemuch district. This study emphasis on constraints faced by farmers to adopt an improved cultivation practices in kalonji. Ex-post-facto research design was used in the present investigation. Total 120 respondents selected for the study. Final results revealed that major constraints perceived by respondents were Non availability of improved seed, No information about seed treatment and Unavailability of vermicompost as per recommendation. Major suggestions given by respondents were timely availability of improved seed, Providing e-marketing facility and grading, packing machine and Availability of all input through co- operatives should be provided.

Key words : *Kalonji, KVK, Expost-facto*

Introduction

Farmers are becoming more interested in cultivating medicinal crops due to the high demand in the market, which provides a solid income. However, many farmers are still unaware of it. Indeed, many farmers are active in the cultivation of medicinal crops, but many are also unaware of the proper techniques. Kalonji sativa is a high-yielding crop and can generate tremendous profits. Many farmers are aware of it, but not aware of the improved varieties of it that are in demand these days. Kalonji sativa is used as a dried seed in food. It is also used by pharmaceutical industries for medicinal use and is also used by cosmetic industries. Its high medicinal properties are mentioned in various religious and old literature dated more than 2000 years back.

But many hurdles for successfully adoption of improved cultivation practices of kalonji in Neemuch district are faced. Kalonji crop is suffering from various insect, pest, disease, weed and nutrient deficiency among them the pest attack create more losses throughout their production and farmers uses various pesticide for production of Kalonji.

Keeping this fact in view, it is necessary to study constraints in adoption of improved cultivation practices of kalonji in Neemuch district, with following specific objectives.

Objectives

To study constraints faced by respondents in adoption of improved cultivation practices of kalonji.

To study the suggestions given by respondents to overcome the constraints.

Materials and Methods

Present study was conducted in Neemuch district of Madhya Pradesh region. Three blocks named Jawad, Neemuch and Manasa where maximum number of FLDs given in previous years, purposively selected and from each block two villages selected randomly. Total six villages from selected blocks constitute the total sample size 120 means each village 20 farmers selected for study (Table 1).

Ex-post-facto research design was used in the present investigation. The interview schedule was developed keeping in view the specific objectives of the study and the data was collected by survey method during year 2020-21.

Constraints refer as the difficulties as perceived by the respondents to adopt improved practice of Kalonji. Percentage was worked out for each of the constraints and overall ranks were assigned on the basis of percentage. Based on the constraints perceived by the respondents to adopt improved practice of Kalonji, possible suggestions were seeked from them. Percentage was work out for each suggestion and overall ranks were assigned on the basis of percentage.

Results and Discussion

Constraints faced by the farmer's adoption of improved cultivation practices of Kalonji : Constraints in adoption of new technology never end. However they

Table-1 : List of villages selected for the study.

Sr. No.	Name of Taluka	Name of Village	No. of respondents
1.	Neemuch	Amlikheda	20
		Hanumantiya Pawar	20
2.	Jawad	Ramnagar	20
		Lalpura	20
3.	Manasa	Majiria	20
		Bhatkhedi	20
Total			120

Table-2 : Constraints faced by the respondents' adoption of improved cultivation practices of Kalonji. n=120

Sr. No.	Constraints	F	Percentage	Rank
1.	Lack of knowledge about bio fertilizer	69	57.50	VII
2.	Non availability of improved seed	96	80.00	I
3.	Lack of knowledge about Plant based botanical Insecticides and Pesticides	78	65.00	V
4.	Non availability of fertilizers in time	60	50.00	VIII
5.	Unavailability of vermicom post as per recommendation	88	73.33	III
6.	Unavailability of farm yard manure	49	40.83	X
7.	No information about seed treatment	91	75.83	II
8.	Lack of guidance about recommended technology	85	70.83	IV
9.	Lack of Knowledge about post harvest management	56	46.66	IX
10.	Lack of Knowledge about irrigation schedule	71	59.16	VI

Table-3 : Suggestions from the respondents to overcome the constraints. n=120

Sr. No.	Suggestions	F	Percentage	Rank
1.	Timely availability of improved seed	105	87.50	I
2.	Availability of all input through co-operatives	88	73.33	III
3.	Assured availability of bio fertilizer and bio pesticide	64	53.33	VI
4.	Provision of training in regards about Plant based botanical Insecticides and Pesticides	76	63.33	V
5.	Knowledge about seed treatment methods should provided	60	50.00	VII
6.	Providing seeds, pesticides and fertilizers at reasonable rate	80	66.66	IV
7.	Providing e-marketing facility and grading, packing machine	92	76.66	II

can be minimized. The respondents were requested to express the constraints faced by them in adoption of improved cultivation practices of kalonji.

The data presented in table-2 found that major constraints perceived by respondents were Non availability of improved seed; 80.00 per cent and ranked at first position followed by No information about seed treatment; 75.83 per cent, Unavailability of vermicompost as per recommendation; 73.33 per cent, Lack of guidance about recommended technology; 70.83 per cent, lack of knowledge about Plant based botanical Insecticides and Pesticides; 65.00 per cent, Lack of Knowledge about irrigation schedule; 59.16 per cent, lack of knowledge about bio fertilizer; 57.50 per cent, Non availability of fertilizers in time; 50.00 per cent, lack of Knowledge about post harvest management; 46.66 per cent and Unavailability of farm yard manure; 40.83 percent which ranked at II, III, IV, V, VI, VII, VIII, IX and X respectively.

Suggestions from the farmers to overcome the constraints : An attempt was also made to ascertain suggestions from farmers to overcome various constraints faced by them in adoption of improved cultivation practices of kalonji. The respondents were requested to

offer their valuable suggestion against difficulties faced by them in the adoption of improved cultivation practices of kalonji. The data were collected and summarized in table-3. The data presented in table-3 revealed that major suggestions given by respondents were timely availability of improved seed; 87.50 per cent, Providing e-marketing facility and grading , packing machine; 76.66 per cent, Availability of all input through co- operatives; 73.33 per cent, Providing seeds, pesticides and fertilizers at reasonable rate; 66.66 percent, Provision of training in regards about Plant based botanical Insecticides and Pesticides; 63.33 per cent, Assured availability of bio fertilizer and bio pesticide; 53.33 per cent and Knowledge about seed treatment methods should provided; 50.00 per cent which ranked at II, III, IV, V, VI and VII respectively.

It can be concluded from the above study that, major constraints perceived by respondents were Non availability of improved seed, No information about seed treatment and Unavailability of vermicompost as per recommendation. Major suggestions given by respondents were timely availability of improved seed, Providing e-marketing facility and grading, packing machine and Availability of all input through co-operatives should be provided.

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Production Management of Inland Fisheries in East Godavari District, Andhra Pradesh : Economic Analysis

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Abstract

The present study was undertaken to analyze the production management of inland fisheries in East-Godavari district, Andhra Pradesh. This study is purely based on primary data, which was collected through personal interview method from aqua-farmers by using pretested and well-structured schedules. In the district, 30 sample respondents each from Indian major carps and shrimp were selected randomly for the study. The study identifies the production management aspects, labour management, input management, cost and returns of inland fisheries per acre was analyzed with the help of descriptive statistics. The results of the study revealed that, total cost of production was highest in the case of vannamei (shrimp) compared to carps farming. The total cost of production in carp farming was 3,43,365.99 and in vannamei (shrimp) was 5,17,317.88 per acre, respectively. Variable costs accounted for 77.64 per cent (carps) and 81.93 per cent (shrimp) of total costs. Whereas, the fixed costs shares were 22.36 and 18.07 percent, respectively. The average yield under carps was 3.73 tonnes and 2.45 tonnes in vannamei (shrimp). The average selling price was 106.10/kg (carps) and 248.60/kg (shrimp) respectively. The gross returns and net returns obtained per acre were highest in shrimp compared to carps, respectively. The gross returns obtained per acre were 3,96,562.54 (carps) and 6,09,815.80 (shrimp) with secured net returns of 53,196.55 and 92,497.92 respectively. Cultivation and production of carp and shrimps were found to be profitable by the magnitude of returns per rupee of investment (B:C) of 1.15 and 1.18 respectively.

Key words : *Production aspects, labour management, input management, cost of cultivation and returns.*

Introduction

India is blessed with an abundance of fisheries resources, both inland and marine. The country has a long coastline of around 8,118 km and equally large areas under estuaries, backwaters, lagoons, etc., conducive for developing capture as well as culture fisheries. The inland fishery resources include 1.96 lakh km stretch of rivers and canals, 3.15 million hectares reservoirs, 2.44 million hectares ponds and tanks, 0.798 million hectares of beels, derelict water bodies, 1.24 million hectare brackish water areas, and 0.29 million hectares of estuaries (Datta, 2011). India also has a vast floodplain wetland resource of 0.5 million hectares that has massive potential for culture-based fisheries. Hence, there is a huge scope for fisheries and aquaculture in India. India ranks second in aquaculture production and third in fisheries, globally. Total fish production in India during 2019-20 was around 141.64 lakh tonnes with a share of 73.68 per cent of inland (104.37 lakh tonnes) and 26.32 per cent from marine (37.27 lakh tonnes). Andhra Pradesh was the leading producer state with respect to inland fish production, which accounts for around 34.58 per cent (36.10 lakh tonnes) followed by West Bengal (16.19 lakh tonnes), Uttar Pradesh (6.99 lakh tonnes), Odisha (6.60 lakh tonnes), Bihar (6.41 lakh tonnes), Chattisgarh (5.72 lakh tonnes), Assam (3.73 lakh tonnes) and Karnataka (2.29

lakh tonnes) (Anon., 2020). The major cultivating inland species were major carps (catla, rohu & marigal), minor carps, exotic carps, murrels (*ophiocephalus* spp.), cat fishes and other fresh water fishes. Fisheries contribute to about 0.91 per cent of the Gross Domestic Product (GDP) and 5.23 per cent to the Agriculture Gross Value Added (GVA) of the country. The major exporting destinations are United States of America (USA), South-East Asia, European Union, Japan, China and Middle East Countries. The marine products are exported mainly in the form frozen shrimp contributing around 45 to 50 per cent followed by frozen fish nearly 25 per cent, frozen squid (7 %), dried items (7 %) and frozen cuttle fish (4 %) etc.

Andhra Pradesh scenario : Andhra Pradesh has been contributing significantly to the fish basket of the country in the recent years through an effective strategy in both coastal as well as freshwater aquaculture and marketing. Fisheries sector in Andhra Pradesh shown as one of the growth engines for the achievement of double digit growth, because the state is blessed with potential and diversified water resources with 974 km of coastline, 33,227 km of continental shelf area, 555 marine fishermen villages, 2 fishing harbours, 350 fish landing centres, 31,147 fishing crafts, 65 cold storages, 64 processing plants, 235 ice plants, 28 feed mills, 357 hatcheries and 234 aqua labs. In addition to this, there is potential of 1.74 lakh hectares of brackish water area and about 8 lakh

Table-1 : Production management aspects of Inland fish (Carp and Shrimp) growers in East-Godavari.

Sl. No.	Particulars	East-Godavari			
		Carps		Vannamei	
		Number	%	Number	%
1.	Seed rate/ac				
a.	Below recommendation	0	0.00	0	0.00
b.	As per recommendation	12	40.00	13	43.33
c.	Above recommendation	18	60.00	17	56.67
2.	Type of soil texture				
a.	Sandy Clay soils	10	33.33	22	73.33
b.	Clay Loamy soils	18	60.00	2	6.67
c.	Sandy Silt soils	2	6.67	6	20.00
3.	Source of irrigation				
a.	Canal Back Water	28	93.33	0	0.00
b.	Bore well/Pump set	0	0.00	0	0.00
c.	Both	2	6.67	30	100.00
4.	Nutrition Management				
A.	Type of fertilizer used				
a.	Organic	0	0.00	0	0.00
b.	Chemical	0	0.00	0	0.00
c.	Organic and chemical	30	100.00	30	100.00
B.	Fertilizer dose				
a.	Below recommendation	0	0.00	4	13.33
b.	As per recommendation	22	73.33	24	80.00
c.	Above recommendation	8	26.67	2	6.67
C.	Method of fertilizer application				
a.	Single dose application (Basal)	9	13.33	4	13.33
b.	Split dose application	26	86.67	26	86.67
5.	Feed Management				
A.	Method of feeding				
a.	Bag feeding	26	86.67	0	0.00
b.	Floating feed	4	13.33	30	100.00
B.	Frequency of feeding/day	Once	-	Four	-
6.	Growth promoters				
a.	Not used and Below recommendation	0	0.00	0	0.00
b.	As per recommendation	18	60.00	24	80.00
c.	Above recommendation	12	40.00	6	20.00
7.	Period of pond drying				
a.	< 1 month	8	26.67	10	33.33
b.	1-2 months	16	53.33	18	60.00
c.	>2 month	6	20.00	2	6.67
8.	Pest and Disease management				
a.	Preventive measures	8	26.67	0	0.00
b.	Curative measures	22	73.33	30	100.00
c.	IPM	0	0.00	0	0.00
9.	Criteria for harvesting				
a.	Based on size and weight	22	73.33	26	86.67
b.	Based on marketing demand and price	8	26.67	4	13.33
10.	Experience in cultivation				
a.	< 4 years	6	20.00	8	26.67
b.	5-10 years	20	66.67	18	60.00
c.	>10 years	4	13.33	4	13.33
11.	pH test				
A.	Soil				
a.	Yes	28	93.33	28	93.33
b.	No	2	6.67	2	6.67
B.	Water				
a.	Once in a week	0	0.00	18	60.00
b.	Fortnightly	22	73.33	12	40.00
c.	Once in a month	8	26.67	0	0.00

Table-2 : Labour management in inland fisheries [Carp and Shrimp] cultivation in East-Godavari. [Per Acre]

Sl. No.	Particulars	Carps				Vannamei (Shrimp)			
		HL	%	ML	%	HL	%	ML	%
1.	Ploughing	1.00	0.77	1.90	10.78	1.07	0.77	1.88	10.43
2.	Harrowing	1.00	0.77	2.63	14.92	1.00	0.72	2.60	14.42
3.	Pond Preparation (Embankment)	2.37	1.83	6.37	36.13	2.43	1.75	6.72	37.27
4.	Desilting/ Demudding	2.40	1.86	1.43	8.11	2.47	1.78	1.28	7.10
5.	Repairing of Dykes	2.23	1.73	5.30	30.06	2.33	1.68	5.55	30.78
6.	Seeds Releasing	2.20	1.70	-	-	2.13	1.53	-	-
7.	Lime Application	4.33	3.35	-	-	4.33	3.12	-	-
8.	Compost Application	5.30	4.10	-	-	5.33	3.84	-	-
9.	Fertilizer/Chemicals Application	10.67	8.26	-	-	10.33	7.44	-	-
10.	Feeding	71.83	55.61	-	-	78.03	56.21	-	-
11.	Watch and Ward	12.87	9.96	-	-	16.97	12.22	-	-
12.	Control of aquatic weeds, predatory and weed fish	2.23	1.73	-	-	2.40	1.73	-	-
13.	Harvesting	10.73	8.31	-	-	10.00	7.20	-	-
	Total	129.17	100.00	17.63	100.00	138.83	100.00	18.03	100.00

Note : HL: Human Labour ML: Machine Labour

Table-3 : Input management in inland fisheries [Carp and Shrimp] cultivation in East-Godavari. [Per Acre]

Sl. No.	Particulars	Units	Carps	Vannamei (Shrimp)
1.	Seeds/Fingerlings	Number	2533	125833
	Vermicompost	Tonnes	1.16	1.12
2.	Manures	Farm Yard Manure	0.74	0.61
	Neem Cake	kg	107.17	86.50
3.	Bleaching Powder	kg	94.00	108.33
4.	Lime + Agricultural Lime	Tonnes	0.72	0.59
	Urea	kg	54.00	45.50
5.	Fertilizers	Potash	52.33	48.67
	Super Phosphate	kg	102.00	81.17
6.	Minerals	kg	9.87	12.17
7.	Feed	Tonnes	4.46	2.96
8.	Growth Promoters	lt	2.50	3.60
9.	Medicines	lt	10.27	9.03
10.	Human Labour	Man-days	129.17	138.83
11.	Machine Labour	Hours	17.63	18.03

hectares of freshwater resources. Fisheries and aquaculture sector provides employment to nearly 14.5 lakh people directly and indirectly in the state. Andhra Pradesh contributes around 30 per cent of total fish production and 70 per cent of shrimp production in India, and also one of the major exporters of shrimp in India. Per capita consumption of fish in Andhra Pradesh was 8.07 kg per year. The major exporting destinations are West Bengal, Odisha, Bihar, Assam and Tamil Nadu etc.

Andhra Pradesh ranks first in inland fish production as well as third in marine fish production in the country. In 2019-20, total fish production in Andhra Pradesh was 41.74 lakh metric tonnes with a share of 36.10 lakh tonnes of inland and 5.64 lakh tonnes of marine fisheries. The well-marked cultivating districts of inland fisheries are East Godavari, West Godavari, Krishna and Nellore. These four districts contribute around 85 per cent of the total inland fish production in the state. West Godavari

stands first in inland production, with a production of 11.26 lakh tonnes followed by Krishna (9.50 lakh tonnes), Nellore (2.41 lakh tonnes) and East Godavari (2.08 lakh tonnes) (Anon., 2019).

Objectives of the study : To analyze production management of inland fisheries in East-Godavari district

Materials and Methods

The study was purely based on primary data, and the data were collected through personal interview method from fish/aqua-farmers (Indian major carps & shrimp) and market functionaries with the help of well-structured and pre-tested questionnaire exclusively designed for the study. For the present study, multi-stage random sampling procedure was adopted. The first stage was comprised of selection of district in the state. East-Godavari district was selected purposively for the study. East-Godavari was one of the major inland fish

Table-4 : Cost and returns of inland fisheries cultivation per acre in East-Godavari.

Sl. No	Particulars	Carps	%	Vannamei	%	
Variable Cost						
1.	Seeds/Fingerlings (number)	31937.39	9.30	65039.67	12.57	
	Vermicompost (Tonnes)	6071.33	1.77	5595.75	1.08	
2.	Organic Manures	Farm Yard Manure (Tonnes)	949.17	0.28	758.25	0.15
	Neem cake (kg)	4335.00	1.26	3627.00	0.70	
3.	Bleaching Powder (kg)	4683.33	1.36	5196.83	1.00	
4.	Agricultural Lime (Tonnes)	922.70	0.27	771.82	0.15	
	Urea (kg)	356.40	0.10	302.94	0.06	
5.	Inorganic Manures	Potash (kg)	968.17	0.28	917.37	0.18
	Super Phosphate (kg)	739.50	0.22	555.99	0.11	
6.	Minerals (kg)	2119.33	0.62	2756.33	0.53	
7.	Feed (Tonnes)	117965.78	34.36	201002.89	38.85	
8.	Growth Promoters (lt)	3487.67	1.02	3559.50	0.69	
9.	Medicines (lt)	9874.33	2.88	9606.33	1.86	
10.	Human Labour (Man-Days)	38049.83	11.08	41113.83	7.95	
11.	Machine Labour (Hours)	15727.83	4.58	15716.00	3.04	
12.	Electricity	5601.67	1.63	30870.00	5.97	
13.	Miscellaneous Expenditures	3058.33	0.89	5055.00	0.98	
14.	Interest on variable cost @8%	19747.82	5.75	31395.64	6.07	
	Total Variable Cost	266595.59	77.64	423841.15	81.93	
Fixed Costs						
15.	Construction of Pond, Water supply channel, Installation of Tube well.	126500.00		280666.67		
16.	Rental Value of Land	51756.67	15.07	34088.33	6.59	
17.	Land Revenue	500.00	0.15	500.00	0.10	
18.	Depreciation on tools and machineries	3638.33	1.06	20806.37	4.02	
19.	Depreciation on capital investment @10%	12650.00	3.68	28066.67	5.43	
20.	Interest on FC @12%	8225.40	2.40	10015.36	1.94	
	Total Fixed Cost	76770.40	22.36	93476.73	18.07	
Total cost of production		343365.99	100.00	517317.88	100.00	
21.	Yield (Tonnes)	3737.63		2453.00		
22.	Selling Price (₹/kg)	106.10		248.60		
23.	Gross Returns (₹)	396562.54		609815.80		
24.	Net Returns (₹)	53196.55		92497.92		
25.	Returns per rupee of investment (B:C)	1.15		1.18		

producing districts across the districts of Andhra Pradesh. The second stage comprised of selection of mandals/taluks. In this stage, three mandals were selected from the district for the study. The third stage comprised of selection of Indian major carps and shrimp cultivators from the selected mandals of the district. In the district, 30 sample respondents each from Indian major carps and shrimp were selected randomly for the study.

Results and Discussion

Production management aspects of Inland fish (Carp and Shrimp) growers : Management aspects associated with production of Indian major carps and vannamei (shrimp) growers in the study area are presented in Table-1.

Seed rate (stocking density) : It was observed from the table that, in Indian major carps maximum number of respondents 18 farmers (60.00 %) followed seed rate (stocking density) above the recommendation, whereas

the number of farmers following the stocking density as per recommendation (2250 number/ac) was 12 (40.00 %). Whereas in case of vannamei (shrimp) cultivation, the number of farmers followed seed rate as per recommendation (1,20,000 to 1,50,000 number/ac) was 13 members (43.33 %) and above recommendation 17 members (56.67 %). According to seed rate concerned, in both the species farmers, used above the recommendation followed by as per and below recommendations respectively. Over stocking of fish/shrimp in aquaculture had an effect on growth, such as improper and stunted (retarded) growth, disease incidence and constraint in management of feed. A good quality and specific pathogen free seed as per recommendation resulted in healthy in appearance, uniform in size, potential for high survival, better growth and less or no disease usually in the pond. To reduce the culture period in carps, it was usually advisable to stock young fish of 250 to 300 grams size (Zero size) having one year age.

Type of soil texture : According to Table 1, the majority of Indian major carp farmers produced on clay loamy soils 18 members (60.00 %), 10 farmers (33.33 %) on sandy clay soils and 2 farmers (6.67 %) on sandy silt soils. Whereas in case of vannamei (shrimp) cultivation, maximum number of respondents had cultivation/production under sandy clay soils *i.e.* 22 farmers (73.33 %) followed by sandy silt soils (20.00 %) and clay loamy soils (6.67 %). In carps, maximum number of farmers were cultivating in clay loamy soils followed by sandy clay and sandy silt soils. Whereas in case of shrimps, farmers were practicing cultivation in sandy clay soils followed sandy silt and clay loamy soils. Clay loamy soils and sandy clay soils retained more water than any other soils. Water holding capacity was one prime and important factor in water management in aquaculture.

Sources of irrigation : In carp culture, 28 farmers (93.33 %) used canal creek/ back water as major source of irrigation for the culture and 6.67 per cent farmers used both canal creek water and tube-well for irrigation purposes. While in case of vannamei (shrimp) culture, cent per cent of the respondents (farmers) used both canal creek water and tube-well for irrigation purpose. Because aquaculture fields required continuous supply of water and also maintained a static water level in the fields, this impacted on growth and factors responsible for yield component. In tube well water, they maintained pH of 7.5 to 8.5 indicated the condition of alkaline water. The pH of the water in an alkaline condition helped in moulting of shrimp and resulted in attainment of growth and yield.

Nutrition management : With respect to nutrition management, cent per cent of the respondents in both carps and vannamei (shrimp) were using both manures and fertilizers. In carps, the number of respondents who followed fertilizer dose as per recommendation (22 farmers) and the number of respondents followed above recommendation were 8 farmers. Whereas, in vannamei (shrimp) cultivation, the number of farmers with below, as per and above recommendation were 4, 24 and 2 respectively. In both carps and vannamei (shrimp), 86.67 per cent (26 farmers) of them applied fertilizers in split dose form and rest 13.33 per cent (4 farmers) were followed basal dose (single dose). Proper application of fertilizers such as organic (manures) and non-organic (chemical fertilizers) were necessary for the production of phytoplankton and zooplankton in the pond, these also in turn increased the availability of food for fish and shrimp. In split dose, farmers were mix the fertilizers with water and spread it all over the pond.

Feed management : With respect to feed management, in carps, 26 farmers followed the bag feeding method and rest of them followed floating feed (4 farmers). The

frequency of feeding was one time in a day usually early hours. Whereas in the case of vannamei (shrimp) cultivation, cent percent farmers followed floating feed and the frequency of feeding was four times per day. Feed was the major expenditure for fish and shrimp farmers in the study. In order to reduce the wastage of feed and overall cost in production, in carps farmers were followed bag feeding. Where as in case of shrimp, the feeding type was floating feed for cent per cent of the respondents in the study area due to shrimps were usually laid at the lower levels of water so the wastage of feed was reduced by using slow shrinkage floating feed helped in better feed conversion ratio. In shrimp culture, feed monitoring should be done with check tray evaluation method for optimum feed management.

Growth promoters : All the sample farmers in both carp and vannamei (shrimp) cultivation used growth promoters either as per or above the recommendation but not below it. The percentage of sample farmers who used growth promoters as per the recommendation was 60.00 and 80.00 and above recommendation were 40.00 and 20.00 respectively. Aquaculture in general and shrimp farming in particular need high quality feeds, which should contain not only necessary nutrients but also complementary feed additives which favoured growth and to keep the organism (fish and shrimp) healthy. The most commonly used growth promoting additives were hormones, antibiotics, salts, ionospheres and probiotics.

Pond drying : In carps, 8 farmers (26.67 %) went for pond drying for a period of less than a month. In case of pond drying for 1-2 months and greater than two months, the percentages were 53.33 and 20.00, respectively. Whereas in case of vannamei (shrimp) cultivation, the farmers usually went for pond drying for less than a month, 1-2 months and greater than two months were 10 (33.33 %), 18 (60.00 %) and 2 (6.67 %), respectively. Unwanted larger aquatic organisms that could survive in puddles of water can be eliminated and controlled with the help of pond drying. It was an environmental friendly operation in aquaculture due to drying oxidizes and harmful chemical substances especially sulfides and also facilitated mineralization of organic matter.

Pest and disease management : Of all the surveyed respondents, 22 farmers (73.33 %) followed curative measures and 8 farmers (26.67 %) followed preventive measures in carp culture for pest and disease control in the culture. Whereas in case of vannamei (shrimp) culture, cent percent farmers followed curative measures for pest and disease control. Diseases in aquaculture were typically of viral, fungal or bacterial origin or they might be caused by ectoparasites and endoparasites. These were controlled with the help of curative measures

as when disease incidence was noticed or occurred in the culture. Therefore, curative measures were more preferable and more profitable than preventive measures. These in turn reduced the cost of cultivation also. The curative measures usually followed in culture were treating the affected ponds with KMnO_4 , followed by lime, malachite green bath for 30 min, formalin, 2-3 per cent NaCl bath for 10 minutes, reducing the density of fishes/shrimps in pond and draining and drying the ponds.

Criteria for harvesting : In fish and shrimp culture, the proper stage of harvesting was very important and critical. The carp/shrimp growers decided harvesting based on two categories, such as based on size and weight and based on market demand and price. As observed from the table, it was noticed that in carps 73.33 per cent (22 farmers) decided to harvest based on size and weight and rest of them (8 farmers) were decided to harvest based on market demand and price. Whereas in case of vannamei (shrimp), 26 farmers (86.67 %) and 4 farmers (13.33 %) decided harvesting based on size and weight and based on market demand and price, respectively. The respondents decided harvesting criteria based on market demand and price, because they usually concentrated on exports and higher returns, but for farmers it was difficult due to retention of crop (culture) creating additional expenditure on it and also operating in smaller area. Partial harvesting was done to remove the bigger/larger fish/shrimp and also allowed the smaller ones space to grow before final harvest.

Experience in cultivation : In terms of experience concerned, the majority of carp and shrimp farmers had extensive production and cultivation experience. In carps, the number of farmers having experience of less than four years was 6 (20.00 %), around 67 per cent of farmers had experience of 5-10 years and 4 farmers (13.33 %) had more than 10 years of experience. While in case of vannamei (shrimp), the percentages are 26.67, 60.00 and 13.33 respectively. Experience also helped in reducing mistakes and errors in cultivation, it in turn led to better management practices in culture.

pH test : In both carp and shrimp cultivation, 93.33 per cent of farmers conducted a soil pH test before beginning the culture. With respect to water pH, in carps 22 farmers (73.33 %) did pH tests in the culture fortnightly and rest (26.67 %) went for pH test once a month. Whereas in case of shrimp, the number of farmers went for water pH test once in a week (60 %) is equal to 1.5 times of the respondents in fortnightly (40 %). The usual pH of water was 7.5 to 8.5, exceeding pH (>9) is dangerous as ammonia toxicity increases rapidly. Control of pH is essential for minimizing ammonia and H_2S toxicity.

Labour management in inland fisheries [Carp and Shrimp] cultivation in East-Godavari : An operation-wise labour requirement in carp and shrimp cultivation was calculated per acre and the results were depicted in Table 2. The results indicated that, the average human labour employed in carps was 129.17 man-days and 17.63 machine hours, similarly in vannamei (shrimp) the average human labour employed were 138.83 man-days and 18.03 machine hours, respectively. In both the species, maximum number of human labour man-days was employed for feeding (55.61 % and 56.21 %) followed by watch and ward (9.96 % and 12.22 %), harvesting (8.31 % and 7.20 %), fertilizers/chemicals application (8.26 % and 7.44 %), compost application (4.10 % and 3.84 %), lime and agricultural lime application (3.35 % and 3.12 %), desilting (1.86 % and 1.78 %), pond preparation (1.83 % and 1.75 %), repairing of dykes (1.73 % and 1.68 %), control of aquatic weeds, predatory and weed fish (1.73 % each), fish/shrimp seeds releasing (1.70 % and 1.54 %), harrowing (0.77 % and 0.72 %) and ploughing (0.77 % each).

As per machine labour concerned, in both the species, maximum machine labour hours were engaged for pond preparation 6.37 hours (carps) and 6.72 hours (shrimp) respectively, followed by repairing of dykes (5.30 and 5.55 hours), harrowing (2.63 and 2.60 hours), ploughing (1.90 and 1.88 hours) and desilting 1.43 and 1.28 hours, respectively. The findings were in line with the findings of the study on economic analysis of production management of watermelon in Haveri (Karnataka) and Ananthapur Districts (Andhra Pradesh) by Kumar and Kulkarni (2018).

Input management in inland fisheries [Carp and Shrimp] cultivation in East-Godavari : Input management plays a vital and critical importance in aquaculture cultivation. Input use patterns in carp and shrimp production per acre for farmers in East-Godavari district were tabulated in Table 3. The results showed that in carps, the average number of seeds/fingerlings used was 2533 number per acre. The quantity of vermicompost applied was 1.16 tonnes. Similarly, 0.74 tonnes of farm yard manure (FYM) and 107.17 kilogram of neem cake were applied respectively. Wherein, 94.00 kilogram of bleaching powder was used, quantity of lime and agricultural lime (0.72 tonnes), fertilizers viz., urea (54.00 kg), potash (52.33 kg) and super phosphate (102.00 kg), minerals (9.87 kg), feed (4.46 tonnes), growth promoters (2.50 lt) and medicine (10.27 lt), respectively were applied to pond culture in the management of carp cultivation. The average amount of human and machine labour employed by farmers were 129.17 man days and 17.63 machine hours, respectively.

As far as vannamei (shrimp) cultivation was concerned, the number of seeds/fingerlings used was 1,25,833 per acre in the district. With respect to manures, the average quantity of vermicompost applied by farmers was 1.12 tonnes. Similarly, FYM (0.61 tonnes) and neem cake (86.50 kg) were applied to the ponds respectively. The average amount of bleaching powder applied to the ponds was 108.33 kilogram, wherein the quantity of 0.59 tonnes of lime and agricultural lime, fertilizers viz., urea (45.50 kg), potash (48.67 kg) and super phosphate (81.17 kg), minerals (12.17 kg), feed (2.96 tonnes), growth promoters (3.60 lt) and medicine (9.03 lt) respectively were applied to pond culture in the management of vannamei (shrimp) cultivation. Whereas, human labour employed were 138.83 man days and machine labour 18.03 machine hours respectively. Almost in both the species, used similar quantity of inputs in the culture; there were minor variations in between them in usage of inputs.

Cost and returns of inland fisheries cultivation per acre in East-Godavari : The cost of cultivation and returns indicate the investment in the variable inputs used in the cultivation and also the services rendered by the fixed assets. The cost incurred on various inputs viz., seeds/fingerlings, manures, bleaching powder, agricultural lime, fertilizers, minerals, feed, growth promoters, medicines, human labour, machine labour and electricity and also fixed costs from Indian major carps and vannamei (shrimp) were calculated and are presented in Table-4.

The total cost of production was highest in the case of vannamei (shrimp) when compared to carps farming. The total cost of production in carp farming was 3,43,365.99 and in vannamei (shrimp) was 5,17,317.88 per acre, respectively. Variable costs accounted for 77.64 per cent (carps) and 81.93 per cent (shrimp) of total costs. Whereas, the fixed costs shares were 22.36 and 18.07 percent, respectively.

The distribution pattern of operational cost or working capital under various inputs indicated that the feed accounted highest share in both the species i.e. 34.36 per cent in carps and 38.85 per cent in vannamei (shrimp), followed by human labour (11.08 and 7.95 %), seeds/fingerlings (9.30 and 12.57 %), machine labour (4.58 and 3.04 %), manures (3.31 and 1.93 %), medicines (2.88 and 1.86 %), electricity (1.63 and 5.97 %), bleaching powder (1.36 and 1.00 %), miscellaneous expenditures (0.89 and 0.98 %), growth promoters (1.02 and 0.69 %), fertilizers (0.60 and 0.35 %), minerals (0.62 and 0.53 %) and lime and agricultural lime (0.27 and 0.15 %) respectively. Interest on variable cost was accounted a share of 5.75 per cent (carps) and 6.07 per cent

(vannamei) in farming. Interest on variable cost was calculated for interest rate of eight per cent, because in financial institutions and non-financial institutions the interest on short term loans was 7-8 per cent per annum.

Similarly, the distribution pattern of fixed cost under various particulars revealed that the rental value of land accounted for the majority (15.07 and 6.59 %) followed by depreciation on capital investment @ 10 per cent (3.68 and 5.43 %), depreciation on tools and machineries (1.06 and 4.02 %) and land revenue (0.15 and 0.10 %). Interest on fixed cost was calculated for interest rate of 12 per cent, because in financial institutions and non-financial institutions the interest on long term loans was 10-12 per cent per annum. While in farming, the interest on fixed costs accounted for 2.40 per cent (carps) and 1.94 per cent (vannamei).

The results presented in Table 4 on yield and returns realized by Indian major carps and shrimp indicated that the average yield under carps was 3.73 tonnes and 2.45 tonnes in vannamei (shrimp). The average selling price was 106.10/kg (carps) and 248.60/kg (shrimp) respectively. The gross returns and net returns obtained per acre were highest in shrimp compared to carps, respectively. The gross returns obtained per acre were 3,96,562.54 (carps) and 6,09,815.80 (shrimp) with secured net returns of 53,196.55 and 92,497.92 respectively. Cultivation and production of carp and shrimps were found to be profitable by the magnitude of returns per rupee of investment (B:C) of 1.15 and 1.18 respectively.

Conclusions

According to seed rate concerned, in both the species farmers, used above the recommendation, over stocking of fish/shrimp in aquaculture had an effect on growth, such as improper and stunted (retarded) growth, disease incidence and constraint in management of feed. Water holding capacity was one prime and important factor in water management in aquaculture. Clay loamy soils and sandy clay soils retained more water than any other soils. Proper application of fertilizers such as organic (manures) and non-organic (chemical fertilizers) were necessary for the production of phytoplankton and zooplankton in the pond, these also in turn increased the availability of food for fish and shrimp. In split dose, farmers were mix the fertilizers with water and spread it all over the pond. Farmers decided harvesting criteria based on market demand and price, because they usually concentrated on returns, to achieved this they followed partial harvesting was done to remove the bigger/larger fish/shrimp and also allowed the smaller ones space to grow before final harvest. The usual pH of water was 7.5 to 8.5, exceeding pH (>9) is dangerous as ammonia toxicity increases

rapidly. Control of pH is essential for minimizing ammonia and H₂S toxicity.

The total cost of production was highest in the case of vannamei (shrimp) when compared to carps farming. The total cost of production in carp farming was 3,43,365.99 and in vannamei (shrimp) was 5,17,317.88 per acre, respectively. Variable costs accounted for 77.64 per cent (carps) and 81.93 per cent (shrimp) of total costs. Whereas, the fixed costs shares were 22.36 and 18.07 percent, respectively. The average yield under carps was 3.73 tonnes and 2.45 tonnes in vannamei (shrimp). The average selling price was 106.10/kg (carps) and 248.60/kg (shrimp) respectively. The gross returns and net returns obtained per acre were highest in shrimp compared to carps, respectively. The gross returns obtained per acre were 3,96,562.54 (carps) and 6,09,815.80 (shrimp) with secured net returns of 53,196.55 and 92,497.92 respectively. Cultivation and production of carp and shrimps were found to be profitable by the magnitude of returns per rupee of investment (B:C) of 1.15 and 1.18 respectively.

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Aquaculture Status in Andhra Pradesh : Growth and Instability Analysis

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Abstract

The present study was undertaken to analyze the production trends (growth) of fisheries in Andhra Pradesh, because the state contributing significantly to the fish basket of the country in the recent years through an effective strategy in both inland and marine aquaculture. Based on production of fisheries in the state, four districts were selected purposively viz., East-Godavari, West-Godavari, Krishna and Nellore for the present study. These four districts contributed around 85 to 90 per cent of total fish production in the state. This study is mainly based on time series data and the secondary data on production of inland, marine of Andhra Pradesh were collected from various sources viz., Agricultural Statistics at a Glance, District at a Glance, Annual reports, Department of Fisheries – Government of Andhra Pradesh. The status of fisheries in Andhra Pradesh was examined by using statistical tools like Compound Annual Growth Rate (CAGR) and Instability Indices such as Cuddy-Della Instability Index (CD II) and Coppock's Instability Index (CII). The results revealed that, in inland fish production highest compound annual growth rates was observed in East-Godavari (12.57) followed by Krishna (12.30), West-Godavari (11.95) and Nellore (10.62) per cent per annum in Andhra Pradesh. In case of marine fish production, East-Godavari (8.33) recorded highest CAGR followed by Krishna (7.60), Nellore (6.25) and West-Godavari (5.01) per cent per annum respectively. The results of Cuddy Della Valle and Coppock's Instability Index showed that, both inland and marine fish production fluctuated the most in the state. According to Cuddy Della Valle instability index, East-Godavari and West-Godavari districts showed more fluctuations in inland and marine fish production than compared with other districts. While in case of Coppock's instability index, West-Godavari district showed more fluctuations in inland and marine fish production than compared with other districts.

Key words : Compound annual growth rate, coefficient of variation, cuddy-della instability index, coppock's instability index.

Introduction

The importance of fisheries in a country cannot only be measured by the contribution to the GDP; it must also be considered that fisheries resources and products are essential components of human nutrition and employment. Fisheries play an important role in a country with a coastline of over 8,000 kilometers, an Exclusive Economic Zone (EEZ) of over 2 million square kilometers, and abundant freshwater resources. Currently, fisheries and aquaculture contribute 1.07 percent to the national GDP, whereas agriculture and related sectors provide 5.30 percent, with an average annual value of output of ₹ 43720.98 crore with quantity of 11,49,510 tonnes for the year 2020-21 (MPEDA).

India is the world's third-largest fish producer and the world's second-largest aquaculture fish producer. India accounts for nearly seven per cent of global fish production. The country is also home to more than 10 per cent of the world's fish biodiversity and is one of the 17 countries with the most biodiversity. (Anon., 2020a) Fisheries and related activities employ around 14 million people. The Government of India introduced the scheme Pradhan Mantri Matsya Sampada Yojana (PMMMSY) which primarily focuses on doubling income of fisherman and to address challenges faced in fisheries sector. For

the past five decades fisheries recorded a highest growth rate than that of agricultural sector. There is a gradual shift in fish production from marine fisheries to inland fisheries due to rapid growth of inland aquaculture. The state of Andhra Pradesh produces the maximum fish in the country, followed by West Bengal and Gujarat. The total fish production in India during 2019-20 is estimated to be 14.16 million metric tonnes, of which nearly 73.69 per cent (10.43 million metric tonnes) is from inland sector and the rest around 26.31 per cent (3.72 million metric tonnes) is from marine sector.

Fisheries sector in India has shown impressive growth over the years, production has registered an average annual growth of 7.53 per cent from 2014-15 to 2019-20 and stood at an all-time high of 141.64 lakh metric tons during 2019-20 (Anon., 2020a). The total fish production during 2019-20 is estimated to be 14.16 million metric tonnes, of which nearly 73.65 per cent (10.43 million metric tonnes) is from inland sector and the rest around 26.27 per cent (3.72 million metric tonnes) is from marine sector.

Andhra Pradesh was the leading producer state with respect to inland fish production, which accounts around 34.58 per cent (36.10 lakh tonnes) and Gujarat was the leading producer state in marine fish production i.e. around 18.80 per cent (7.02 lakh tonnes) (Anon., 2020b).

Table-1 : Growth trend in inland fish production in Andhra Pradesh (2000-01 to 2018-19).

Sl. No.	Year	East-Godavari	West-Godavari	Krishna	Nellore
1.	2000-01	14901	93923	94667	30523
2.	2001-02	20029	107052	108080	33592
3.	2002-03	15835	217043	174363	39760
4.	2003-04	18312	262458	216035	36100
5.	2004-05	22466	277464	181150	32957
6.	2005-06	18528	271086	219155	38541
7.	2006-07	15252	222155	239273	43317
8.	2007-08	18403	270726	255200	45805
9.	2008-09	29522	320182	311668	54486
10.	2009-10	27042	307015	380211	49013
11.	2010-11	33219	606264	370359	37398
12.	2011-12	41021	380836	415955	75612
13.	2012-13	48052	465452	462264	78744
14.	2013-14	38825	489312	512684	83418
15.	2014-15	46299	569261	560127	86340
16.	2015-16	55655	668005	611270	112173
17.	2016-17	80434	783349	712844	128969
18.	2017-18	114367	1004957	914427	182456
19.	2018-19	208577	1126182	950522	241403
MEAN		45617.84	444353.79	404750.21	75295.11
CAGR		12.57**	11.95**	12.30**	10.62**
CD-II		41.83	20.94	10.62	27.96
C-II		25.82	28.47	13.24	22.17
R Square		0.8344	0.8951	0.9711	0.8616

CAGR: Compound Annual Growth Rate, CD II: Cuddy and Della Instability Index.

CII: Coppock's Instability Index, **Significant at one per cent probability level.

In 2018-19, total fish production in Andhra Pradesh was 39.92 lakh metric tonnes with a share of 28.63 lakh tonnes of inland and 6.00 lakh tonnes of marine fisheries. The well-marked cultivating districts of inland fisheries are East Godavari, West Godavari, Krishna and Nellore. These four districts contribute around 85 per cent of the total inland fish production in the state. West Godavari stands first in inland production, with a production of 11.26 lakh tonnes followed by Krishna (9.50 lakh tonnes), Nellore (2.41 lakh tonnes) and East Godavari (2.08 lakh tonnes). Similarly, Visakhapatnam is the leading producer in marine fish production, with a production of 1.33 lakh tonnes followed by East Godavari (1.17 lakh tonnes), Nellore (1.14 lakh tonnes) and Prakasham (0.66 lakh tonnes). The major cultivating inland fish species are carps (catla, rohu, marigal), barbus, cat fishes, common carps, murrel, mullets, prawns and hilsa etc.,

Materials and Methods

The study is based on secondary data for the last 19 years, i.e. from 2000-01 to 2018-19 from Andhra Pradesh. The fish production data are largely drawn from Handbook on Fisheries Statistics – 2020 (Government of India), whereas Andhra Pradesh production data were collected from various secondary sources such as Agricultural Statistics at a Glance, District at a Glance, Annual reports, Department of Fisheries–Government of Andhra Pradesh, India Agri Stat, Commissioner of Fisheries, Vijayawada, Government of Andhra Pradesh etc.

Analytical tools

Growth rate analysis : For computing compound annual growth rate of production of inland and marine fisheries in Andhra Pradesh, the exponential function of the following form was used.

$$Y = a b^t e^U \quad \dots(1)$$

Where, Y = Dependent variable (Production)

a = Intercept term

b = Regression coefficient

('a' and 'b' are the parameters to be estimated)

t = time period

e^U = Error term

The equation (1) was transformed into log linear form and written as;

$$\log Y = \log a + t \log b + Ut \quad \dots(2)$$

Equation (2) was estimated by using Ordinary Least Squares (OLS) technique.

Compound growth rate (g) was then computed

$$g = (b - 1) \times 100 \quad \dots(3)$$

Where, g = Compound growth rate in per cent per annum

b = Antilog of log b

The standard error of the growth rate was estimated and tested for its significance with 't' test statistic.

Table-2 : Growth trend in marine fish production in Andhra Pradesh (2000-01 to 2018-19).

Sl. No	Year	East-Godavari	West-Godavari	Krishna	Nellore
1.	2000-01	27541	3165	11971	43134
2.	2001-02	36504	7451	18420	35567
3.	2002-03	42753	8302	22593	53951
4.	2003-04	54790	11061	20232	48586
5.	2004-05	47320	7552	16500	32474
6.	2005-06	31249	8835	15802	39556
7.	2006-07	53059	5215	19564	49724
8.	2007-08	56599	2603	20597	48763
9.	2008-09	63824	2060	24627	52241
10.	2009-10	60358	1999	24720	58261
11.	2010-11	67254	2000	26488	38457
12.	2011-12	81128	8190	31207	71334
13.	2012-13	96710	8874	33096	74276
14.	2013-14	94445	10998	36619	82484
15.	2014-15	101729	11805	39943	82611
16.	2015-16	111724	12475	41229	91332
17.	2016-17	124932	12676	48689	95417
18.	2017-18	126880	14744	55939	105153
19.	2018-19	117494	11670	50476	114837
MEAN		73489.11	7982.89	29405.89	64113.58
CAGR		8.33**	5.01@	7.60**	6.25**
CD-II		13.61	22.62	13.93	18.44
C-II		20.41	56.80	14.74	26.29
R Square		0.9051	0.8065	0.8984	0.7772

CAGR: Compound Annual Growth Rate, CD II: Cuddy and Della Instability Index

CII: Coppock's Instability Index

** Significant at one per cent probability level, @ Significant at ten per cent probability level

Instability Index : The coefficient of variation was used to measure the variability in production. The coefficient of variation or index of instability was computed by using the following formula :

$$CV = \frac{\text{Standard deviation ()}}{\text{Mean } (\bar{X})} \times 100$$

Linear trends were fitted to the original data of production for the period of 19 years from 2000-01 to 2018-19. The trend coefficients were tested for their significance. Whenever the trend of series found to be significant; the variation around the trend rather than the variation around mean was used as an index of instability.

Cuddy and Della Instability Index (CD II) : The formula suggested by Cuddy and Della (1978) was used to compute the degree of variation around the trend. That is coefficient of variation was multiplied by the square root of the difference between the unity and coefficient of multiple determinations (R^2), in the cases where R^2 was significant to obtain the Instability Index.

$$\text{Instability Index} = \frac{\text{Standard deviation ()}}{\text{Mean } (\bar{X})} \times 100 \times \sqrt{1 - R^2}$$

Coppock's Instability Index (CII) : Trend free measure of variability which is a close approximation of the average year to year percentage variation adjusted by trend (Kaur and Singhal, 1988) (Coppock J. D., 1962)

$$\text{Instability index} = \frac{[\log((X_{t+1}(X_t)) - m)]^2}{n}$$

Coppock's instability index (CII) = Antilog (vVlog-1)
100

Where, X_t = Area/ Production/ Yield

T = Number of years

m = Mean of the difference between logs of X_{t+1} , X_t

log V = Logarithmic variance of the series

Results and Discussion

The Tables showed that, both inland and marine fish production in Andhra Pradesh especially in the selected districts such as East-Godavari, West-Godavari, Krishna and Nellore districts showed significant and positive (increased) growth rates during the period (2000-01 to 2018-19). According to Table-1, average inland fish production was recorded highest in West-Godavari district (444353.79 tonnes) followed by Krishna (404750.21 tonnes), Nellore (75295.11 tonnes) and East-Godavari (45617.84 tonnes) respectively. Similarly, in Table 2 the average marine fish production in Andhra Pradesh was highest in East-Godavari (73489.11 tonnes) followed by Nellore (64113.58 tonnes), Krishna (29405.89 tonnes) and West-Godavari (7982.89 tonnes).

As seen from Table 1 and 2, it was noticed that in

Andhra Pradesh inland fish production were expanding/increasing at a substantial rate of 12.57, 12.30, 11.95 and 10.62 per cent per year in East-Godavari, Krishna, West-Godavari and Nellore districts respectively. The similar growths in marine fish production in the state were 8.33, 7.60, 5.01 and 6.25 per cent per annum respectively.

The findings of an analysis of the instability indices for inland and marine fish production in Andhra Pradesh revealed that, the state showed more fluctuations in inland production than compare to marine fish production. According to Cuddy Della Valle instability index, East-Godavari and West-Godavari districts showed more fluctuations in inland and marine fish production than compared with other districts. While in case of Coppock's instability index, West-Godavari district showed more fluctuations in inland and marine fish production than compared with other districts.

The findings revealed a positive productivity growth accounted for a significant increase in both inland and marine production. In the last two decades, enhanced production and farming technology, production through integrated multitrophic aquaculture systems, introduction of genetically modified species like *Penaeus vannamei*, induced fish breeding, and composite carp culture have all contributed to substantial production. According to the estimates, production has increased seven times in Andhra Pradesh. The three Indian main carps (IMCs), catla (*Catla catla*), rohu (*Labeo rohita*), and mrigala (*Cirrhinus mrigala*), account for the majority of carp production in the state. Carps, catfishes, murrels, and other finfishes are farmed for the domestic market, whereas giant freshwater prawn (*Macrobrachium rosenbergii*) is the sole species from the freshwater industry that is exported. In the recent years, after the introduction *Penaeus vannamei* (white legged shrimp), the production of giant freshwater prawn has increased.

Conclusions

Andhra Pradesh was the leading producer state with respect to inland fish production, which accounts around 34.58 per cent (36.10 lakh tonnes) and Gujarat was the leading producer state in marine fish production i.e. around 18.80 per cent. The well-marked cultivating districts of inland fisheries are East Godavari, West Godavari, Krishna and Nellore. These four districts contribute around 85 per cent of the total inland fish production in the state. West Godavari stands first in inland production, with a production of 11.26 lakh tonnes and Visakhapatnam is the leading producer in marine fish production, with a production of 1.33 lakh tonnes followed by East Godavari (1.17 lakh tonnes). In Andhra Pradesh

inland fish production were expanding/increasing at a substantial rate of 12.57, 12.30, 11.95 and 10.62 per cent per year in East-Godavari, Krishna, West-Godavari and Nellore districts respectively. The similar growths in marine fish production in the state were 8.33, 7.60, 5.01 and 6.25 per cent per annum respectively. The instability indices for inland and marine fish production in Andhra Pradesh revealed that, the state showed more fluctuations in inland production than compare to marine fish production.

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Problems and Suggestions Given by Tendu Leaves Pluckers During Collection of Tendu Leaves in Chhattisgarh

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Abstract

The purpose of this research was to look into the status and economic contribution through tendu leaves collection among tribal families in Chhattisgarh. The study was conducted in Gaurella-Pendra-Marwahi district of Chhattisgarh in the years 2019-20. The result reveals that the majority of the tribal families pointed out that they were facing the problem of more competition among the tendu leaves pluckers, followed by bonus has not been provided to the pluckers for promotion of tendu leaves collection. Also revealed that less availability of tendu leaves, tendu leaves not being collected by pluckers due to Pandemic (COVID-19), fear of wild animals during tendu leaves collection and lack of information about period of time for collection of tendu leaves. Regarding suggestion given by tendu leaves pluckers, the result revealed that the majority of the tendu leaves pluckers suggested that period of time for tendu leaves collection should be increased, followed by increases wages of tendu leaves collection, information should be provided in a proper time, suggested that bonus were provided to the pluckers for promotion of tendu leaves collection, suggested that there wages should be made available in proper time, essential requirement viz-footwear, water bottles etc were provided to the Tendu leaves pluckers, and deforestation should be checked.

Introduction

Tendu leaves (*Diospyros melanoxylon*) is a blooming tree in the *Ebenaceae* family with a hard, dry bark that is endemic to India and Sri Lanka. It gets its name from the Coromandel region in south eastern India. Temburini, or Tendu in Hindi, is the name given to it locally. Tendu leaves are extensively harvested and sold for cash since they are an economic resource and a source of subsistence for the impoverished, especially tribals. Tendu leaves provides employment opportunities for millions of tribals and other landless people during summer when there is no agricultural work or opportunities of wage earnings.

The Chhattisgarh Govt. took a major policy decision in 2004 to sell the leaves in advance to the purchasers that instead of selling go-downed leaves. The primary co-operative organisation, on the other hand, will be in charge of collecting leaves and paying the pluckers' collection wages. Green leaves will be given over to the purchaser who has been pre-arranged at the collection centre. The purchaser will treat the leaves at collection centre, transport and store in his godowns or the godowns of Forest Department/Federation. The purchaser will make the payment of the purchase price in four equal installments. In nut shell, the change in the trade of Tendu leaf policy has brought good results.

The above literatures enlighten that very major efforts have been made to study the contribution of tendu leaves in the sustainable livelihood pattern of the tribes in the country in general and in the Chhattisgarh state in

particular. The state is divided into 31 districts unions and districts union is divided into 916 primary co-operatives societies which is divided into collection centers. In this district Gaurella, Pendra and Marwahi blocks are tribal blocks. The total population Gaurella block are known for the home to many indigenous tribal groups of the region.

Materials and Methods

Location of the study area : The study was conducted in Gaurella – Pendra - Marwahi district of Chhattisgarh state during the year 2019-2020. Gaurella – Pendra – Marwahi district was selected purposively because the maximum area tribal population is residing in Chhattisgarh plains, comes under this district. All the 3 blocks in this district i.e Pendra, Gaurela and Marwahi were selected purposively because maximum numbers of tribes and maximum area comes under the forest in these blocks. Three villages were selected randomly from each selected block. In this way total 9 villages were selected. Ten tendu leaves collecting tribal were selected randomly from each selected village. Thus, the total 90 tribes ($9 \times 10 = 90$) were considered as tendu leaves pluckers for this study. The data were collected personally in cooperation with forest officers and other officials of the district by using pre-tested interview schedule.

Results and Discussion

Problems faced by the tribes in collection of Tendu leaves : Simple ranking technique was applied to measure the problems faced by the tendu leaves pluckers during collection of tendu leaves. Each tendu leaves

Table-1 : Problems faced by the tribal families in the collection of Tendu leaves.

S. No.	Problems	Frequency	Per centage	Rank
1.	Tendu leaves not being collected by pluckers due to Pandemic (COVID-19)	40	44.44	IV
2.	Less availability of tendu leaves	50	55.55	III
3.	More competition among the tendu leaves pluckers.	80	88.89	I
4.	Fear of wild animals during tendu leaves collection.	21	23.33	V
5.	Lack of information about the period of tendu leaves collection	20	22.22	VI
6.	Bonus has not been provided to the pluckers for promotion of tendu leaves collection.	70	77.78	II

*Data are based on multiple responsesa

Table-2 : Suggestions from the tribal families to overcome the problems.

S. No.	Suggestions	Frequency	Per centage	Rank
1.	Wages should be made available in proper time	50	55.56	V
2.	Information should be provided in a proper time.	68	75.56	III
3.	Deforestation should be checked.	29	32.22	VII
4.	Period of tendu leaves collection should be increased.	80	88.89	I
5.	Bonus should be provided to the pluckers for promotion of tendu leaves collection.	55	61.11	IV
6.	Wages of tendu leaves collection should be increased.	79	87.77	II
7.	Essential requirement viz-footwear, water bottles etc should be provided to the tendu leaves pluckers.	40	44.44	VI

*Data are based on multiple responses

pluckers was asked to mention his problems in collection of tendu leaves in order of degree of difficulties. The response was calculated and presented on the basis of frequency and percentage.

Suggestions from the tribal families to overcome the problems : Tendu leaves pluckers were asked to give their valuable suggestions to overcome the problems faced by them during collection of tendu leaves. The suggestions offered were summarized on the basis of number and per cent of plucks who reported for the respective suggestions.

Problems faced by the tribal families during the collection of Tendu leaves : The result show in table-1 regrading problums faced by them the majority of the tribal families (88.89%) pointed out that they were facing the problem of more competition among the tendu leaves pluckers, followed by 77.78 per cent bonus has not been provided to the pluckers for promotion of tendu leaves collection. Also 5.55 per cent revealed less availabilities of Tendu leaves,44.44 per cent were reported tendu leaves not being collected by pluckers due to Pandemic (COVID-19), fear of wild animals during Tendu leaves collection (23.33%) and lack of information about period of time for collection of tendu leaves (22.22%).

Suggestions given by from the tribal families to overcome the problems : Table-2 shows that regarding suggestions the result revealed that the majority of the tendu leaves pluckers (88.89%) suggested that period of time for tendu leaves collection should be increased, followed by 87.77 per cent tribal families who suggested that wages of tendu leaves collection should be increased,

75.56 per cent information should be provided in a proper time, 61.11 per cent suggested that bonus should be provided to the pluckers for promotion of tendu leaves collection, 55.56 per cent suggested that there wages should be made available in proper time, 44.44 per cent suggested that essential requirement viz-footwear, water bottles etc should be provided to the Tendu leaves pluckers, and 32.22 per cent suggested that deforestation should be checked.

Conclusions

The result reveals that problems faced by tendu leaves pluckers the majority of the tribal families (88.89%) pointed out that they were facing the problem of more competition among the tendu leaves pluckers, followed by 77.78 per cent bonus has not been provided to the pluckers for promotion of tendu leaves collection. Also 5.55 per cent revealed less availabilities of tendu leaves,44.44 per cent were reported tendu leaves not being collected by pluckers due to Pandemic (COVID-19), fear of wild animals during Tendu leaves collection (23.33%) and lack of information about period of time for collection of tendu leaves (22.22%).

The result revealed that the majority of the tendu leaves pluckers (88.89%) suggested that period of time for tendu leaves collection should be increased, followed by 87.77 per cent tribal families who suggested that wages of tendu leaves collection should be increased, 75.56 per cent information should be provided in a proper time, 61.11 per cent suggested that bonus should be provided to the pluckers for promotion of tendu leaves collection, 55.56 per cent suggested that there wages

should be made available in proper time, 44.44 per cent suggested that essential requirement viz-footwear, water bottles etc should be provided to the Tendu leaves pluckers, and 32.22 per cent suggested that deforestation should be checked.

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Quality Evaluation of Bitter Gourd (*Momordica charantia*) Treated with Hot Water Treatment with Hot Water Treatment

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Abstract

Bitter gourd (*Momordica charantia*) is one of the promising commodities for exports to European Union due to its health benefits. As a *kharif* crop, infestation of thrips (*Thysanoptera*) *Thrips tabaci* is prominent on fruits. The ridged arrangement on surface provides space to tiny thrips for hiding against predators, hence export hurdles. Hot water treatment is considered as one of the important quarantine treatment against surface and subsurface pest of climbers. Continuous type hot water treatment unit was tested with various time temperature combinations followed by storage at 8°C temperature of treated bitter gourd for shelf life and quality evaluation. It will eliminate the thrips infection on bitter gourd and maintain the quality of bitter gourd up to 8days at 8°C and 95%Rh on the basis of PLW, firmness and colour values.

Introduction

India is at number one position in production of vegetables. Okra, snake gourd, bitter gourd, pointed gourd, ridged gourd, plain gourd etc. are export oriented vegetables from India. Out of that, bitter gourd (*Momordica charantia*) is one of the promising commodities for exports to European Union (www.apeda.co.org). The immature bitter gourd is used in variety of culinary preparations, due to its nutritive value and health benefits. Temperate climate condition restricts the European farmers to cultivate this climber (bitter gourd). Insect infestation is major problem in bitter gourd as it cultivated in open field during and after *kharif* (monsoon) period. Stringent pesticide residue load restrict the farmers to use agrochemicals for control on pest infestation. Thrips (*Thysanoptera*) are minute, slender insects with fringed wings and unique asymmetrical mouthparts. Different thrips species feed mostly on plants by puncturing and sucking up the contents, although a few are predators. Entomologists have described approximately 6,000 species. The species found on bitter gourd and other climbers is *Thrips tabaci*. It is a surface pest. The European Union recommend hot water treatment to importing vegetables as quarantine measures for vegetable surface as well as sub-surfaces pests and diseases spores. The hot water treatment includes the submergence of vegetables in hot water at specific temperature for certain period of time to get desired heat energy to kill the laid egg of pests or small insects without damage to commodities. It can be done by either static method or dynamic method. In dynamic method, the submerged vegetables are conveyed into hot water for specific time. The temperature and time

combination significantly affects on quality of vegetables, pest infection and export unit production efficiency, etc. The hot water treatment system was developed to solve the problem in bitter gourd export targeting pest infestation of thrips. The shelf life evaluation of bitter gourd, treated with continuous type hot water treatment system was carried out by considering the above facts and measuring quality parameters.

Materials and Methods

The freshly harvested bitter gourd from associated farm of M/s. Kay Bee Exports Pack House, at Bedchit, Tapi, Gujarat, India was purchased. The sorting was done looking to physical characteristics as per standard operating procedure. The sorted bitter gourd fruits were washed with turbulent water and spray jet mechanism to confirm no any other surface insect infestation. The bitter gourd was separated and tagged for ten treatments and three replications. The quality and insect infestation observations were carried out before hot water treatment. The equal quantity of (20kg) bitter gourd were filled in crates and labeled as per treatment-replication combinations. Onion thrips (*Thrips tabaci*) were collected from onion farm and taken out from onion leaves. The collected thrips were used for infestation in each treatment-replication lot and kept ready for hot water treatment by closing them with perforated heavy metal mesh. The blue sticky card was kept around the hot water tank as precautionary measure. The continuous type of hot water system was tested with bitter gourd as per the treatment viz.; T1 = 48°C and 3min, T2 = 48°C and 5min, T3 = 50°C and 3min, T4 = 50°C and 5min, T5 = 52°C and 3min, T6 = 52°C and 5min, T7 = 54°C and 3min, T8 = 54°C and 5min, T9 = without heating for 3min, and T10 =

Table-1 : PLW(%) in bitter gourd during storage under the effect of hot water treatments.

Treatments	Storage Days									
	PLW (%)									
	0	1	2	3	4	5	6	7	8	9
T ₁	0	0.9	1.6	3.5	4.9	8.7	11.9	12.7	13.5	14.5
T ₂	0	0.3	1.5	3.5	4.8	8.3	9.9	11.4	12.5	14.0
T ₃	0	0.7	1.3	3.1	4.1	7.6	9.6	11.5	13.9	14.4
T ₄	0	0.3	1.4	3.1	4.1	7.4	9.0	11.1	13.3	14.0
T ₅	0	0.6	1.5	2.5	3.6	6.7	8.6	11.1	13.6	13.9
T ₆	0	0.3	1.1	2.5	3.4	6.2	8.4	10.1	12.2	13.4
T ₇	0	0.6	1.1	2.3	3.0	5.5	8.2	11.2	12.5	13.4
T ₈	0	0.1	0.9	1.6	2.2	4.2	8.0	10.2	12.1	13.2
T ₉	0	1.5	2.0	4.5	6.9	9.0	9.9	12.9	15.5	16.8
T ₁₀	0	0.4	1.9	4.4	6.7	8.8	9.7	12.4	14.8	16.1
Mean	0	0.57	1.43	3.1	4.37	7.24	9.32	11.46	13.39	14.37
SEm±	—	0.13	0.12	0.31	0.50	0.53	0.39	0.32	0.38	0.40
CD @ 5%	—	0.39	0.34	0.89	1.46	1.53	1.12	0.93	1.09	1.15
CV %	—	0.71	0.24	0.30	0.35	0.22	0.12	0.08	0.08	0.08

Table-2 : Sugar (%) in bitter gourd during storage under the effect of hot water treatments.

Treatments	Storage Days									
	Sugar (%)									
	0	1	2	3	4	5	6	7	8	9
T ₁	0.7	0.8	0.8	0.8	0.9	0.9	0.9	0.9	1.0	1.0
T ₂	0.7	0.8	0.8	0.9	0.9	0.9	1.0	1.0	1.0	1.1
T ₃	0.7	0.9	0.8	1.1	1.0	0.9	1.2	1.1	1.1	1.2
T ₄	0.8	0.9	0.8	1.0	0.9	0.9	1.1	1.1	1.0	1.1
T ₅	0.7	0.9	0.8	1.1	1.1	1.0	1.2	1.2	1.2	1.3
T ₆	0.8	0.9	0.9	1.0	1.0	0.9	1.0	1.0	1.0	1.0
T ₇	0.7	0.9	0.8	1.0	0.9	0.9	1.0	1.0	1.0	1.1
T ₈	0.7	0.8	0.7	0.9	0.8	0.8	1.0	1.0	1.0	1.1
T ₉	0.7	0.9	0.8	1.2	1.0	1.0	1.3	1.3	1.3	1.4
T ₁₀	0.7	0.8	0.8	1.1	1.0	0.9	1.2	1.2	1.2	1.3
Mean	0.72	0.86	0.80	1.01	0.95	0.91	1.09	1.08	1.08	1.16
SEm±	0.25	0.02	0.02	0.04	0.03	0.02	0.04	0.04	0.04	0.04
CD @ 5%	0.73	0.05	0.05	0.12	0.08	0.05	0.12	0.12	0.11	0.13
CV %	1.06	0.06	0.06	0.12	0.09	0.06	0.12	0.11	0.11	0.12

without heating for 5min. The treated bitter gourd crates were taken out of hot water tank from unloading end of quarantine zone. The water was drained from crates. The bitter gourd was pre-cooled in pre-cooler to bring down the fruit core temperature just below 8°C. The pre-cooled fruits were observed for survival of thrips particularly as well as pests and diseases under magnifying glass followed by packing in box. The packed bitter gourd was conveyed in refrigerated van at 8°C to the Center of Excellence on Post Harvest Technology. Navsari and stored in cold storage at same temperature. The bitter gourd boxes were kept in close condition up to five days storage and then kept open on perforated crates up to ten days. Every day samples were drawn from each treatment-replication combination for physiochemical quality analysis.

Construction of Hot Water Treatment System : The hot water treatment was fabricated in such a way so part of tank laid in non-quarantine area while rest in quarantine

area. In the non-quarantine area raw and untreated fruits were loaded for treatment, where as at other side treated commodity unloaded. Hot water tank was fabricated using stainless steel angles, square pipes and 16gauge SS sheet. Both the section was partially separated by divider wall. This wall was submerged in hot water of tank. The 50mm of water level was maintained from the submerged lower end of water divider wall. This ensured that the non-quarantine and quarantine area was connected only through the water in the tank. If bitter gourd is submerged in the non-quarantine area and taken into the quarantine area through the hot water tank, there is no possibility of thrips flying from non-quarantine area to quarantine area as it has to compulsorily pass through hot water tank. Hot water tank consist water submerged teflon endless conveyor powered by electrical motor through gear box and chain-sprocket drive. Seven electrical heaters were placed just below the conveyor to heat the water. The speed of conveyor, water inlet-outlet flow and water temperature were controlled by PLC based control panel.

Table-3 : Carbohydrate (%) of bitter gourd during storage under the effect of hot water treatments.

Treatments	Storage Days									
	Carbohydrate (%)									
	0	1	2	3	4	5	6	7	8	9
T ₁	4.3	4.3	4.1	4.1	4.1	3.8	3.7	3.6	3.4	3.1
T ₂	4.7	4.4	4.4	4.2	4.1	4.0	3.8	3.7	3.4	3.4
T ₃	5.4	5.4	4.9	4.9	4.6	4.1	4.1	4.0	4.0	3.7
T ₄	4.9	4.6	4.6	4.3	4.2	4.1	4.0	3.7	3.7	3.3
T ₅	5.5	5.4	5.3	5.1	4.9	4.9	4.7	4.7	4.4	4.1
T ₆	4.5	4.4	4.3	4.3	4.2	4.1	4.1	4.0	3.8	3.6
T ₇	5.9	5.7	5.6	5.5	5.3	5.2	5.0	4.8	4.3	4.1
T ₈	5.8	5.7	5.7	5.5	5.4	5.2	4.9	4.9	4.1	4.1
T ₉	4.7	4.5	4.4	4.3	4.1	4.1	4.0	3.8	3.5	3.0
T ₁₀	4.8	4.4	4.3	4.3	4.1	4.0	3.9	3.8	3.7	3.7
Mean	5.05	4.88	4.76	4.65	4.50	4.35	4.22	4.10	3.83	3.61
SEm±	1.78	0.20	0.19	0.18	0.17	0.18	0.16	0.17	0.12	0.14
CD @ 5%	5.17	0.57	0.56	0.53	0.50	0.51	0.45	0.48	0.35	0.40
CV %	1.06	0.12	0.12	0.12	0.12	0.12	0.11	0.12	0.09	0.11

Table-4: Volume (cc) of bitter gourd fruit during storage under the effect of hot water treatments.

Treatments	Storage Days									
	Volume (cc)									
	0	1	2	3	4	5	6	7	8	9
T ₁	53.0	52.846	52.726	52.383	52.126	51.469	50.892	50.755	50.618	50.441
T ₂	53.0	52.942	52.738	52.388	52.160	51.542	51.251	50.988	50.784	50.534
T ₃	53.0	52.879	52.798	52.447	52.274	51.657	51.306	50.960	50.545	50.459
T ₄	53.0	52.947	52.807	52.456	52.280	51.700	51.402	51.033	50.647	50.524
T ₅	53.0	52.893	52.739	52.555	52.371	51.819	51.482	51.037	50.592	50.546
T ₆	53.0	52.940	52.761	52.552	52.403	51.896	51.523	51.018	50.836	50.628
T ₇	53.0	52.900	52.774	52.598	52.473	52.021	51.557	51.224	50.792	50.641
T ₈	53.0	52.981	52.837	52.712	52.616	52.261	51.590	51.206	50.871	50.660
T ₉	53.0	52.733	52.655	52.212	51.783	51.403	51.246	50.723	50.265	50.029
T ₁₀	53.0	52.862	52.760	52.479	52.278	51.785	51.309	50.955	50.594	50.521
Mean	53.0	52.892	52.760	52.478	52.276	51.755	51.356	50.990	50.654	50.498
SEm±	-	0.023	0.017	0.046	0.075	0.087	0.069	0.054	0.060	0.060
CD @ 5%	-	0.068	0.049	0.133	0.218	0.253	0.200	0.156	0.173	0.174
CV %	-	0.001	0.001	0.003	0.004	0.005	0.004	0.003	0.004	0.004

Working of Hot Water Treatment System : The water was filled into the tank. When the water level achieved, the water supply valves was closed. The circulation valve was open. The water circulating pump, heaters, conveyor drive were switch ON. The water temperature and conveyor speed were set as per treatment at PLC based control panel. Two more portable temperature sensors were installed in hot water tank along with fixed temperature sensors to get diagonal profile of water temperature. When the actual value of water temperature and conveyor speed reached at set value, the crates were submerged into hot water and placed on conveyor at loading end of non-quarantine zone. The submerged fruits were conveyed from Non-quarantine end to quarantine end of machine.

Parameter Evaluation : During hot water treatment to bitter gourd, the fruit core temperature was measured by insertion temperature sensor at loading point and unloading points. The four PT-100 sensors were placed

diagonally for temperature measurement of hot water. The temperature of water and fruits was recorded at every 30 s interval using two temperature sensors (Make: Model:) and a stop watch (Make: Model:). For the phytosanitary parameters, immediately after unloading, the post-treatment *thrips* count was recorded as live, dead or no *thrips* by observing individual fruits under high resolution glass. The fruit were then observed for any disease infections. If any infected fruit found, that was separated and discarded. As far as insect is concern, the random samples were cut diagonally and observed for live or dead insect.

During the storage, the fruit quality parameters like; Total Soluble Solids (TSS), firmness, Physiological Loss in Weight (PLW), Acidity in terms of citric acid, pH, Carbohydrate, Sugar and change in fruit skin color etc. were measured as per the standard methods described by Ranganna, S. (2009) using hand refractometer (Make: Hamh Optics & Tools; Range: 0-32°Brix), firmness tester (Make: Vaisesikha; Range: 0-10kgf $\pm$ 0.2kgf), weighing

Table-5 : Density (g/cc) of bitter gourd fruit during storage under the effect of hot water treatments.

Treatments	Storage Days									
	Density (g/cc)									
	0	1	2	3	4	5	6	7	8	9
T ₁	0.366	0.366	0.363	0.358	0.355	0.346	0.344	0.339	0.336	0.331
T ₂	0.374	0.371	0.370	0.365	0.361	0.351	0.341	0.339	0.338	0.336
T ₃	0.365	0.365	0.362	0.358	0.355	0.347	0.343	0.337	0.332	0.330
T ₄	0.371	0.369	0.368	0.363	0.36	0.351	0.346	0.341	0.334	0.333
T ₅	0.409	0.409	0.405	0.402	0.399	0.392	0.386	0.376	0.373	0.370
T ₆	0.418	0.407	0.414	0.411	0.408	0.398	0.393	0.384	0.376	0.377
T ₇	0.430	0.429	0.407	0.405	0.404	0.399	0.387	0.382	0.375	0.371
T ₈	0.409	0.416	0.426	0.422	0.420	0.412	0.405	0.401	0.395	0.390
T ₉	0.408	0.404	0.403	0.396	0.389	0.383	0.380	0.372	0.364	0.360
T ₁₀	0.410	0.408	0.407	0.406	0.404	0.378	0.371	0.365	0.360	0.358
Mean	0.396	0.394	0.393	0.389	0.386	0.376	0.370	0.364	0.358	0.356
SEm±	0.139	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.007	0.007
CD @ 5%	0.404	0.023	0.023	0.024	0.024	0.024	0.023	0.022	0.021	0.021
CV %	1.056	0.061	0.061	0.064	0.065	0.066	0.065	0.064	0.062	0.061

Table-6 : Specific gravity of bitter gourd during storage under the effect of hot water treatments.

Treatments	Storage Days									
	Specific Gravity									
	0	1	2	3	4	5	6	7	8	9
T ₁	0.900	0.834	0.749	0.784	0.830	0.700	0.800	0.860	0.836	0.894
T ₂	0.900	0.862	0.610	0.755	0.840	0.706	0.740	0.797	0.778	0.779
T ₃	0.900	0.697	0.764	0.699	1.050	0.629	0.742	0.865	0.793	0.689
T ₄	0.900	0.778	0.764	0.647	0.700	0.813	0.825	0.885	0.790	0.650
T ₅	0.900	0.773	0.617	0.808	0.700	0.700	0.800	0.742	0.865	0.793
T ₆	0.900	0.790	0.634	0.882	0.735	0.751	0.800	0.825	0.885	0.650
T ₇	0.900	0.805	0.969	0.949	0.800	0.891	0.629	1.069	0.769	0.689
T ₈	0.900	0.937	0.716	0.782	1.082	0.840	0.830	0.745	1.083	1.083
T ₉	0.900	1.031	0.830	0.874	0.736	0.757	0.750	0.742	0.865	0.793
T ₁₀	0.900	0.836	0.735	0.878	0.738	0.760	0.752	0.747	0.860	0.782
Mean	0.900	0.834	0.739	0.806	0.821	0.755	0.767	0.828	0.852	0.780
SEm±	-	0.031	0.036	0.031	0.046	0.026	0.020	0.034	0.030	0.044
CD @ 5%	-	0.090	0.105	0.089	0.134	0.074	0.057	0.098	0.088	0.127
CV %	-	0.112	0.147	0.114	0.168	0.102	0.077	0.123	0.107	0.168

balance (200g $\pm$ 0.05g), Pipette (10ml fixed volume) and Burette (50.0ml $\pm$ 0.1ml), pH meter (Make: AVI Banchtop; Range:0-14), visible spectrum spectrophotometer (Make: METTLER TOLEDO; Model: UV-7), color reader instrument (Make: HunterLab; Model: ColorFlex-EZ). The change in volume was measured by gravimetric method described by Mohsenin, N. (1986).

Results and Discussion

The parameters like; water and fruit temperature during treatments as well as fruit quality parameters during storage were recorded and presented in the form of graphs and tables.

Water and Fruit Temperature : In general fruit temperature increased with respect to time (Figure-1). The rate of increase in temperature was also increased with rise in set temperature of water. The fruit temperature did not increased above 46°C irrespective of treatment. The water temperature generally remains within the range of set temperature.

The results indicated that, even at full load condition (50kg/batch), the drop of temperature of water was not observed significant in negative direction but maintained due to precise temperature control system between 48°C to 54°C set temperature.

Fruit Quality Parameters : The fruit quality parameters like; TSS, Acid, pH, carbohydrate, sugar, chlorophyll, firmness, specific gravity, change in color, change in volume, etc. were recorded and discussed hereunder.

The table-1 indicated the results of physiological loss in weight (PLW). The PLW of bitter gourd was increased with storage time (Figure-2). PLW was observed highest in controlled T₉ and T₁₀ treatments compared to other treatments. The significantly lowest loss in weight was observed with 54°C hot water treatment irrespective of the treatment time (T₇ and T₈). The rate of increase of PLW was observed to be 1.9%/day for T₉ and T₁₀ against 1.66%/day for average of T₁ to T₈ (Figure-2).

Table-7 : Chlorophyll (mg/100g) of bitter gourd during storage under the effect of hot water treatments.

Treatments	Storage Days									
	Chlorophyll (mg/100g)									
	0	1	2	3	4	5	6	7	8	9
T ₁	13.84	13.83	13.21	13.14	13.05	12.31	11.73	11.56	10.88	10.03
T ₂	15.06	14.45	14.00	13.76	13.26	13.21	12.80	12.05	11.30	9.71
T ₃	17.29	17.12	15.79	15.74	14.67	13.25	13.21	12.94	12.85	11.84
T ₄	15.71	14.72	14.69	13.63	13.35	13.21	12.84	11.95	11.75	10.67
T ₅	17.63	17.17	16.83	16.32	15.81	15.81	14.98	14.94	14.07	12.21
T ₆	14.42	14.21	13.85	13.60	13.48	13.28	13.21	12.65	12.03	11.37
T ₇	19.07	18.70	18.13	17.55	17.16	16.58	15.61	15.56	13.21	13.11
T ₈	18.80	18.24	18.08	17.73	16.99	16.80	16.52	16.24	15.56	14.21
T ₉	14.92	14.23	14.11	13.37	13.21	12.77	12.30	11.89	11.02	11.00
T ₁₀	14.87	14.20	14.00	13.15	13.10	12.41	12.11	11.70	10.81	10.96
Mean	16.161	15.687	15.269	14.799	14.408	13.963	13.531	13.148	12.348	11.511
SEm±	5.713	0.631	0.608	0.616	0.551	0.577	0.537	0.585	0.523	0.460
CD @ 5%	16.568	1.831	1.763	1.787	1.597	1.674	1.557	1.697	1.515	1.335
CV %	1.061	0.121	0.119	0.125	0.115	0.124	0.119	0.133	0.127	0.120

Table-8 : Number of fruits skin colour changed during storage as an effect of HWTs.

Storage Days*	6		7		8		9		10	
	T ₉	T ₁₀	T ₉	T ₁₀	T ₁	T ₂	T ₉	T ₁₀	T ₁	T ₂
Treatment in which colour changed	T ₉	T ₁₀	T ₉	T ₁₀	T ₁	T ₂	T ₉	T ₁₀	T ₁	T ₂
Total Fruit	64	60	64	60	56	66	64	60	56	66
25% Red	1	1	1	1	1	1	3	4	1	1
50% Red			1	1			1	1	1	1
75% Red									2	1
100% Red										1
Green	63	59	62	58	55	65	60	55	54	65

*up to five days of storage change in colour was not observed in bitter gourd skin.

Table-9 : Thrips, pest and disease on bitter gourd after and before hot water treatments.

Treatment	No of Thrips			Larva			Disease	
	After Treatment	Live	Dead	After Treatment	Live	Dead	After Treatment	
T ₁	8	2	6	3	1	2	0	
T ₂	12	1	11	2	1	1	0	
T ₃	11	0	11	3	1	2	0	
T ₄	14	0	14	1	0	1	0	
T ₅	12	0	12	1	0	1	0	
T ₆	16	0	16	1	0	1	0	
T ₇	15	0	15	2	0	2	0	
T ₈	19	0	19	2	0	2	0	
T ₉	13	13	0	4	4	0	0	
T ₁₀	9	9	0	5	5	0	0	

The firmness of bitter gourd fruits reduced from 8.8kgf to nearby 4.0kgf (Figure-3). The highest reduction in firmness was observed in controlled treatments T₉ and T₁₀. The lowest reduction in firmness was observed with 54°C hot water treatment (T₇ and T₈). On individual day the firmness was found non-significant. The rate of decrease in fruit firmness was observed (– 0.52) kgf/day for T₉ and T₁₀ against (– 0.49) kgf/day for average of T₁ to T₈ (Figure-3).

The acidity of bitter gourd was increased with storage time (Figure-4). Acidity was observed

non-significant among all treatments. The rate of increase of acidity was observed almost equal for T₉ and T₁₀ and average of T₁ to T₈ with value of 0.0111%/day and 0.0096%/day, respectively.

The pH of bitter gourd fruits reduced from 6.6 to 5.5±0.1 (Figure-4). pH of fruit was observed non-significant among all treatments. The rate of decrease in fruit pH were observed to be similar for T₉ and T₁₀ and average of T₁ to T₈ with values (– 0.117 per day) and (– 0.1258 per day), respectively.

Table-7 : Chlorophyll (mg/100g) of bitter gourd during storage under the effect of hot water treatments.

Treatments	Storage Days									
	Chlorophyll (mg/100g)									
	0	1	2	3	4	5	6	7	8	9
T ₁	13.84	13.83	13.21	13.14	13.05	12.31	11.73	11.56	10.88	10.03
T ₂	15.06	14.45	14.00	13.76	13.26	13.21	12.80	12.05	11.30	9.71
T ₃	17.29	17.12	15.79	15.74	14.67	13.25	13.21	12.94	12.85	11.84
T ₄	15.71	14.72	14.69	13.63	13.35	13.21	12.84	11.95	11.75	10.67
T ₅	17.63	17.17	16.83	16.32	15.81	15.81	14.98	14.94	14.07	12.21
T ₆	14.42	14.21	13.85	13.60	13.48	13.28	13.21	12.65	12.03	11.37
T ₇	19.07	18.70	18.13	17.55	17.16	16.58	15.61	15.56	13.21	13.11
T ₈	18.80	18.24	18.08	17.73	16.99	16.80	16.52	16.24	15.56	14.21
T ₉	14.92	14.23	14.11	13.37	13.21	12.77	12.30	11.89	11.02	11.00
T ₁₀	14.87	14.20	14.00	13.15	13.10	12.41	12.11	11.70	10.81	10.96
Mean	16.161	15.687	15.269	14.799	14.408	13.963	13.531	13.148	12.348	11.511
SEm±	5.713	0.631	0.608	0.616	0.551	0.577	0.537	0.585	0.523	0.460
CD @ 5%	16.568	1.831	1.763	1.787	1.597	1.674	1.557	1.697	1.515	1.335
CV %	1.061	0.121	0.119	0.125	0.115	0.124	0.119	0.133	0.127	0.120

Table-8 : Number of fruits skin colour changed during storage as an effect of HWTs.

Storage Days*	6		7		8		9		10	
	T ₉	T ₁₀	T ₉	T ₁₀	T ₁	T ₂	T ₉	T ₁₀	T ₁	T ₂
Treatment in which colour changed	T ₉	T ₁₀	T ₉	T ₁₀	T ₁	T ₂	T ₉	T ₁₀	T ₁	T ₂
Total Fruit	64	60	64	60	56	66	64	60	56	66
25% Red	1	1	1	1	1	1	3	4	1	1
50% Red			1	1			1	1	1	1
75% Red									2	1
100% Red										1
Green	63	59	62	58	55	65	60	55	54	65

*up to five days of storage change in colour was not observed in bitter gourd skin.

Table-9 : Thrips, pest and disease on bitter gourd after and before hot water treatments.

Treatment	No of Thrips			Larva			Disease	
	After Treatment	Live	Dead	After Treatment	Live	Dead	After Treatment	
T ₁	8	2	6	3	1	2	0	
T ₂	12	1	11	2	1	1	0	
T ₃	11	0	11	3	1	2	0	
T ₄	14	0	14	1	0	1	0	
T ₅	12	0	12	1	0	1	0	
T ₆	16	0	16	1	0	1	0	
T ₇	15	0	15	2	0	2	0	
T ₈	19	0	19	2	0	2	0	
T ₉	13	13	0	4	4	0	0	
T ₁₀	9	9	0	5	5	0	0	

The figure-5 indicated the values of Total Soluble Solid (TSS) in °Brix and sugar percentage for bitter gourd fruits, respectively. The TSS of fruit in general increased from 2.9°Brix to 4.4±0.3°Brix. The TSS was no- significant among treatments. Similarly, the sugar percent of the fruit was increased from 0.7% to around average value of 1.2±0.2%. The highest increase in sugar was observed in control treatments T₉ and T₁₀. Significantly highest sugar was developed in treatments T₉ and T₁₀ (Table-2).

The table-3 and table-4 indicated the results of carbohydrate and volume of fruit, respectively. The

carbohydrate of bitter gourd was decreased with storage time (Figure-6). The significantly highest carbohydrate was observed in treatment T₇ and T₈. The highest reduction in carbohydrate was observed in controlled T₉ and T₁₀ treatment compared to other treatments. The volume of fruits decreased from 53.000 cc to average value of 50.605cc. The significantly highest volume was observed in treatment T₈. The trend of reduction in carbohydrates was same among all treatments (Figure-6).

The table-5 and table-6 indicated the results of

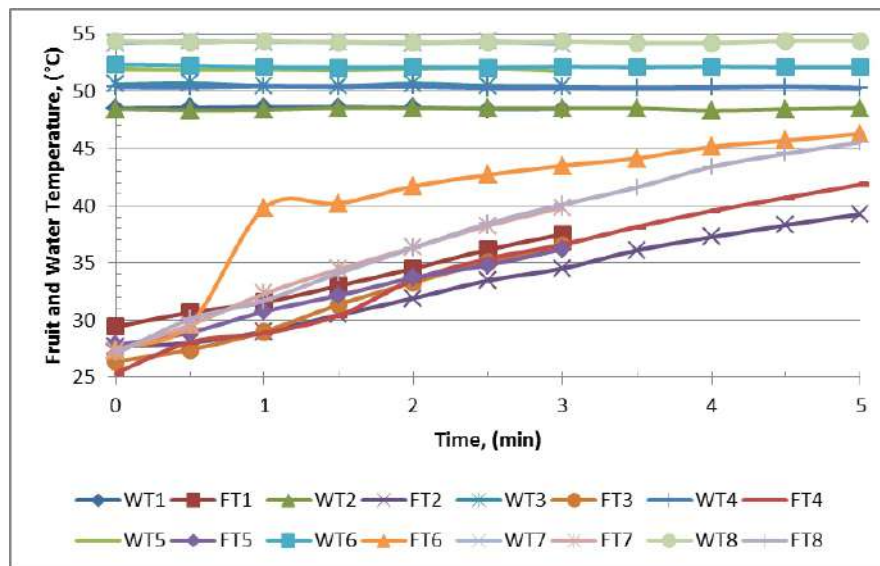


Figure-1: Change in water and fruit temperature (°C) during various treatments.

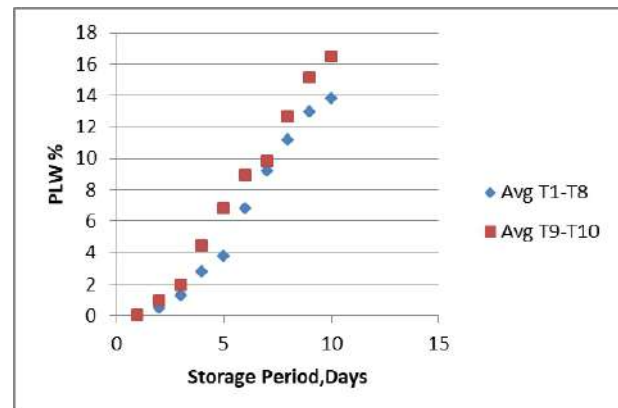
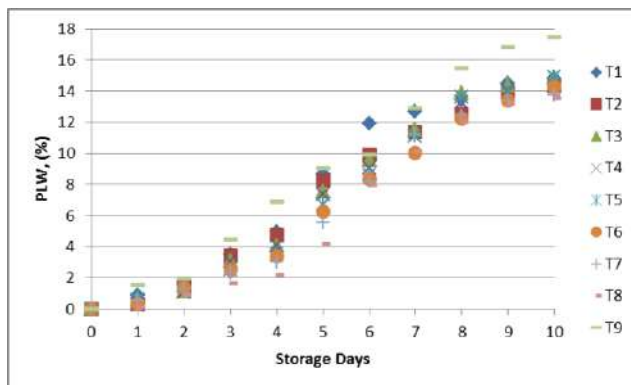


Figure-2: Change in PLW (%) of bitter gourd with storage period.

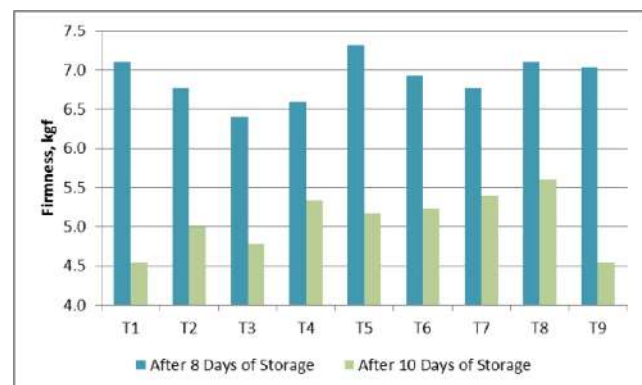
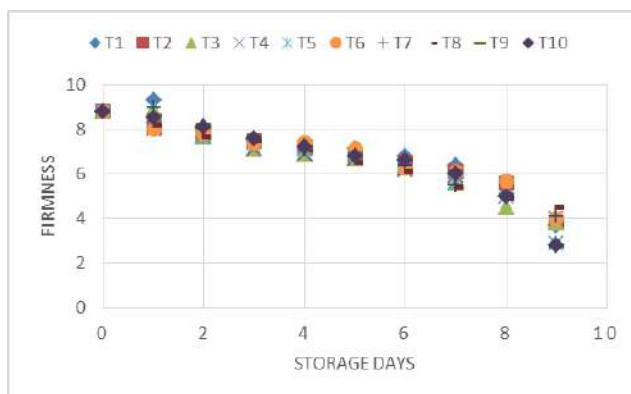


Figure-3: Change in firmness (kgf) of bitter gourd during storage.

density and specific gravity of bitter gourd fruits, respectively. The density of bitter gourd was decreased with storage time (Figure-7). The reduction in density

value was observed highest in controlled T₉ and T₁₀ treatments compared to other treatments. The similar trend was observed in reduction of density among rest of

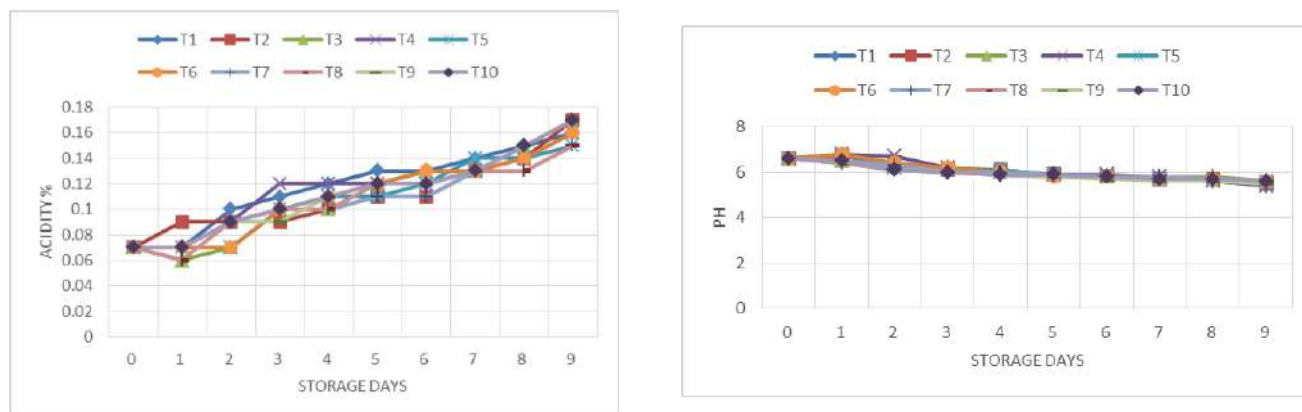


Figure-4: Change in Acidity and pH of bitter gourd during storage.

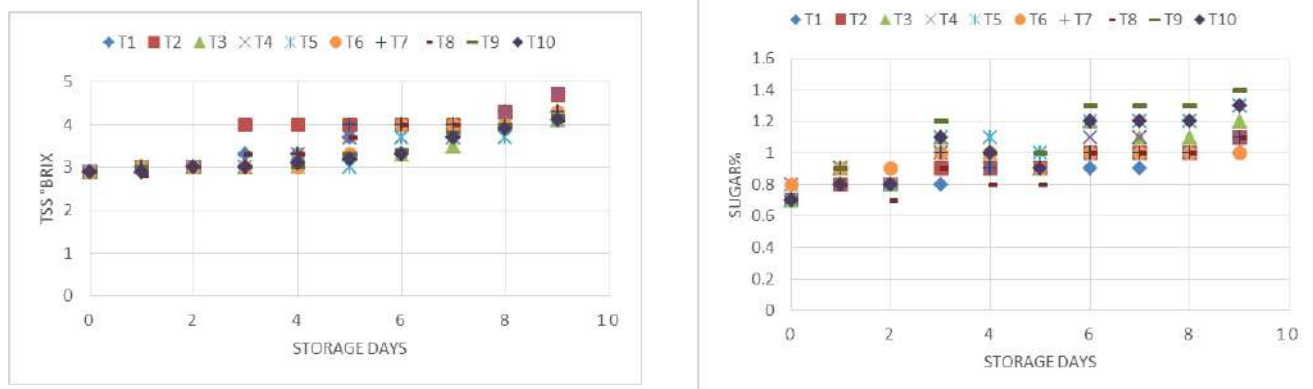


Figure-5: Change in TSS(°Brix) and sugar(%) of bitter gourd during storage.

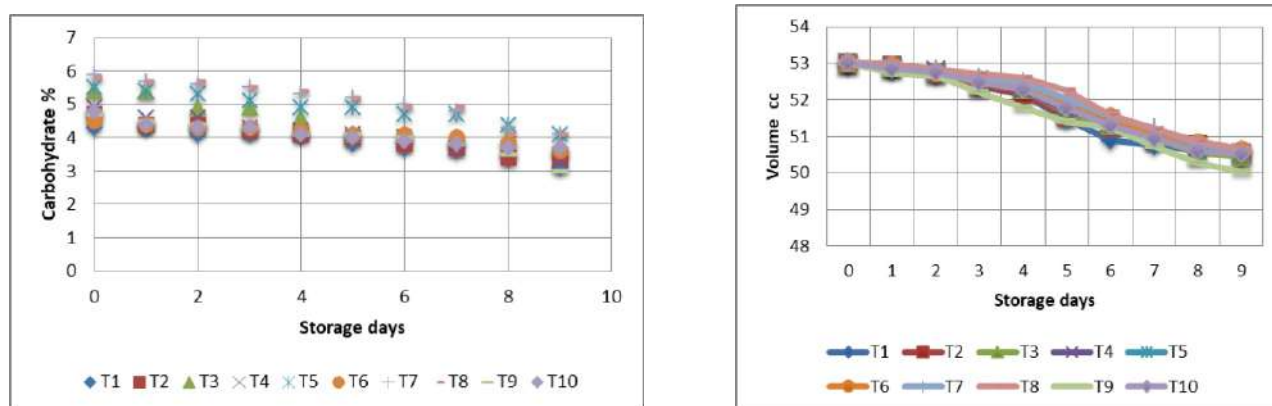


Figure-6: Change in carbohydrate (%) and volume (cc) of bitter gourd during storage.

treatments. The significantly highest density was observed in treatment T₈. The specific gravity of fruits did not show any specific trend (Figure-7). Variation in data was observed to be higher due to change in fruit every

day analysis. Significantly highest specific gravity was observed in treatment T₈.

The table-7 indicated that results of chlorophyll content of bitter gourd fruits. The chlorophyll content of bitter gourd was decreased with storage time (Figure-8).

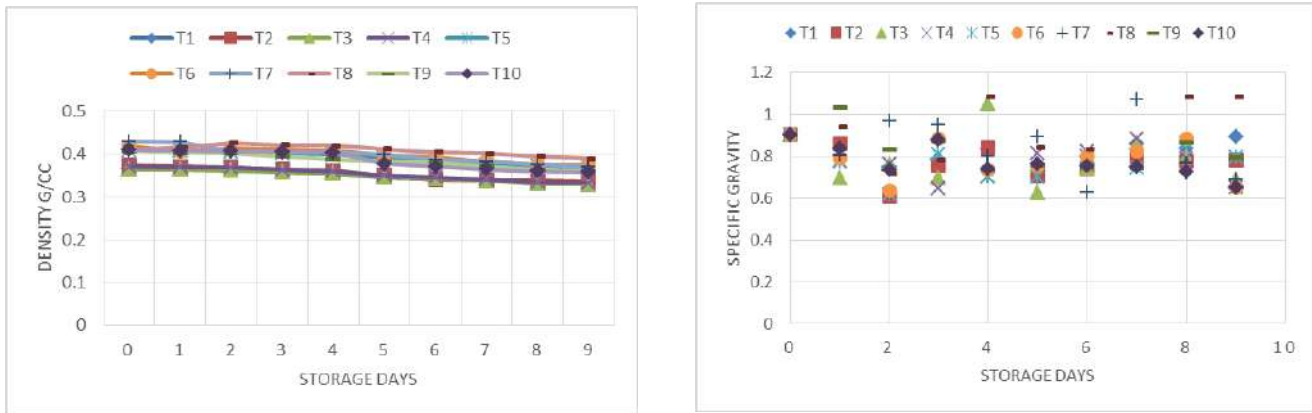


Figure-7: Change in density (g/cc) and specific gravity of bitter gourd during storage.

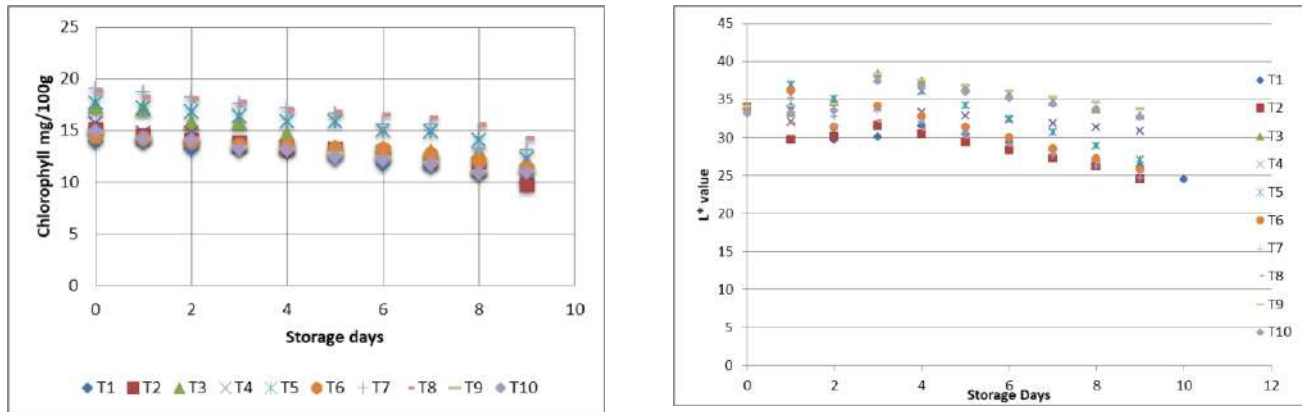


Figure-8: Change in chlorophyll (mg/100g) content and colour scale in L* of bitter gourd skin during storage.

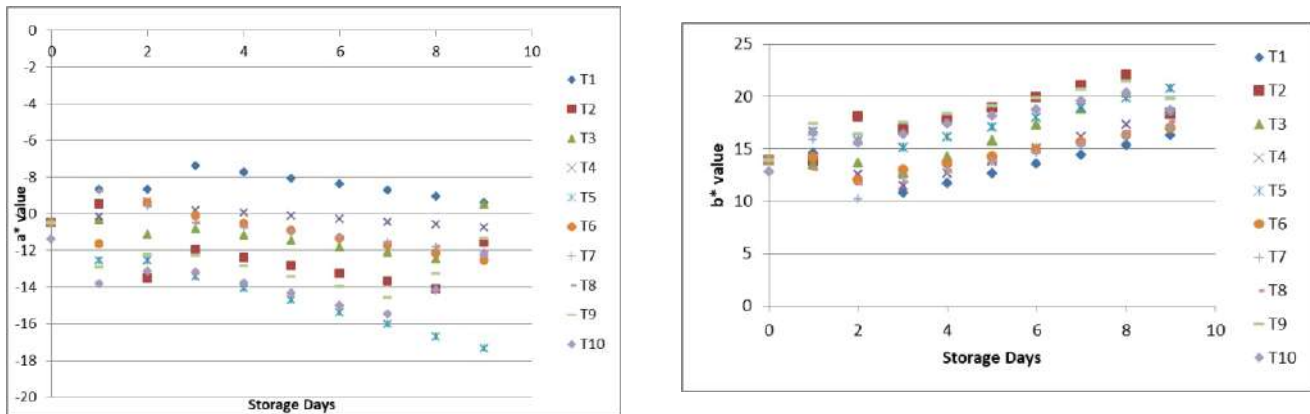


Figure-9: Change in colour scale in a* and b* of bitter gourd skin during storage.

Initial reading indicated that, hot water treatment reduce the concentration of chlorophyll compared to control treatment T₉ and T₁₀, where as the reduction in chlorophyll value was observed highest in controlled T₉ and T₁₀ treatment compared to other treatments at the

end of 10 days storage. Significantly highest chlorophyll was observed in treatment T₈. No much change in chlorophyll was observed in treatments T₆, T₇ and T₈. The similar trend was observed with electronic color sensor reading in relation to brightness (L*) and hue (a*)

(Figure-8 and Figure-9). Whereas the chrome (b^*) value increased with storage period (Figure-9). The change in skin colour of bitter gourd was first observed after 5 days of storage. Numbers of fruits, in which skin colour change observed, was recorded in table-8. The colour change in fruit skin found higher in control treatment T_9 and T_{10} . The colour change was started after 5 days of storage.

The results of PLW, firmness, skin colour machine value, chlorophyll, etc. indicated that, the quality of fruit could be maintained up to 8 days in cold room at 8°C and 95%Rh.

Phytosanitary Parameters : The table-9 indicated the observations and results related thrips, pest and diseases on bitter gourd fruits before and after hot water treatments. In treatment T_1 and T_2 two and one live thrips were observed, respectively. In other treatments from T_3 to T_8 , no live thrips was observed. In the control treatment (T_9 and T_{10}) thirteen and nine live thrips were reported, respectively as those did not treat with hot water. In all the treatments, dead thrips were observed, except in treatment T_9 and T_{10} . The data indicated that, the thrips could not survive in hot water treatment and so, 100% mortality was observed above 48°C temperature of hot water. Due to small body and soft structure of thrips, it could not resist the heat. Thus the hot water treatment temperature 50°C, 52°C and 54°C with either 3min or 5min treatment time was observed to be effective for thrips treatment to achieve 100% mortality.

The larva was also observed in fruit during storage (Table-9). In control treatment T_9 and T_{10} four live larvae were observed, while in T_1 , T_2 and T_3 each one live larva observed. The dead larvae were also observed in treatments T_1 to T_8 . The data indicated that, the larva could not survive in hot water treatment and 100% mortality was observed above 50°C temperature of hot water. Thus the hot water treatment temperature 52°C and 54°C with either 3min or 5min treatment time were observed to be effective for larva to achieve 100% mortality.

The bitter gourd fruit pulp colour and texture was observed immediate after treatment by cutting it in cross sections. The pulp colour and texture were not affected due to hot water treatment. During storage, the soft and dark tissue was observed in the bitter gourd fruits pulp, particularly where, the larva infection found. In general, no disease infection was found during storage of bitter gourd in any treatments.

The data of results indicated that, the hot water treatment temperature 52°C and 54°C with either 3min or 5min treatment time were observed to be effective for thrips, larva to achieve 100% mortality with no quality change in skin color of bitter gourd.

Conclusion

The combined effects of temperature and time indicated that, the hot water treatment temperature 52°C and 54°C with either 3min or 5min treatment time were observed to be effective for thrips, larva to achieve 100 % mortality with no quality change in skin color of bitter gourd. Looking to overall quality parameters with respect to PLW, firmness, skin colour machine values (L , a^* , b^*) and chlorophyll content, the hot water treated bitter gourd could be stored up to 8 days when pre-cooling and stored at 8°C and 95 % Rh after treatment.

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A Test to Measure Knowledge of the Farmers About Interventions under Farmer FIRST Programme of NDRI, Karnal

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Abstract

A test was constructed to measure the extent of knowledge of the farmers about selected interventions under farmer FIRST Programme of NDRI, Karnal. Split half method was followed for testing reliability of the scale and reliability co-efficient of the scale was 0.84. Hence, the scale is reliable and can produce consistent results. The validity of the scale was examined for Content validity by determining how well the contents of the scale were selected by discussing it with specialists of extensions, professors, scientists of different fields. After Pre-testing and Item analysis a total of 85 items from a total 125 items were retained finally, for the final knowledge test.

Key words : *Test, knowledge, intervention, reliability, validity.*

Introduction

The Farmer FIRST Programme (FFP) is an ICAR initiative to move beyond the production and productivity, to privilege the smallholder agriculture and complex, diverse and risk prone realities of majority of the farmers through enhancing farmers-scientists interface. The Farmer FIRST as a concept of ICAR is developed as farmer in a centric role for research problem identification, prioritization and conduct of experiments and its management in farmers' conditions. The focus is on farmer's Farm, Innovations, Resources, Science and Technology (FIRST). Knowledge test was developed and the difference between pre and posttest was considered as gain in knowledge. English and English (1961) defined 'knowledge' as the body of understood information as possessed by a person. The knowledge of the beneficiaries regarding the interventions made under the programme is very essential for effective implementation and outcome of an intervention or technology. Keeping this in view, an attempt has been made to develop a test to measure the extent of knowledge of the farmers about the interventions under farmer FIRST programme of NDRI, Karnal.

Research Methodology

In the present study, a test was constructed which can measure the extent of knowledge of the farmers about the interventions under farmer FIRST programme of NDRI, Karnal. A test usually contains problems or tasks graded in difficulty from very easy to very hard by known steps or intervals (Garrett, 1966). The content of the 'knowledge test' is composed of items. A comprehensive list of test items regarding different technologies/ interventions

under farmer FIRST programme were prepared, by going through relevant literature as obtained from books, manuals, internet sources, and in consultations with the experts. In item selection stage of scale development 125 statements were selected for content validity. A total of 85 items from a total 125 items were retained finally, for the final knowledge test and these 85 knowledge items were administered to the selected 30 non-sample farmers and their responses were taken into count for calculating the difficulty index and discrimination index of each item.

Collection of Items : A test usually contains problems or tasks graded in difficulty from very easy to very hard by known steps or intervals (Garrett, 1966). These problems or tasks are referred to as 'items'. The content of the 'knowledge test' is composed of items. A comprehensive list of test items regarding different technologies/ interventions under farmer FIRST programme were prepared, by going through relevant literature as obtained from books, manuals, internet sources, and in consultations with the experts.

Results and Discussion

Pre-testing and Item Analysis : The preliminary knowledge test battery was administered to the respondents of non-sampling area. The scores were assigned 1 and 0 for correct and incorrect answers, respectively; and then, the total score for each respondent was calculated by summing up his/her scores for all the items. Later on the "Difficulty Index" and "Discrimination Index" for each of the item were calculated, separately.

Difficulty Index : Difficulty of an item refers to the relative difficulty for the respondents to answer, correctly, to the

Table-1 : Difficulty and Discrimination Indices of the Selected Knowledge Items.

Sl. No.	Item	Difficulty Index	Discrimination Index
A. Crop based Interventions			
1. Integrated Pest Management in Paddy			
1.	Among the following which is the most common pest of paddy in your area? a. Leaf hopper b. Whitefly c. Pod borer d. shoot borer (Ans: a)	73.33	0.27
2.	Among the following which chemical is applied to control leaf hopper? a. Cartap Hydrochloride b. Chlorophriphos c. Tricyclozole (Beam) d. Propiconazole (Ans : a)	76.67	0.33
3.	At what rate Cartap hydrochloride is applied? a. 400g / acre b. 600g / acre c. 500g/acre d. 300g/acre (Ans : a)	74.33	0.27
4.	Any infestation of Neck blast of rice in your field? a. Yes b. No (Ans : a)	79.86	0.60
5.	How can Neck blast be identified? a. Neck region of panicle develops a black colour b. Panicle breakup at the neck c. Both a & b d. Not Known (Ans : c)	73.00	0.40
6.	Which chemical is applied to control neck blast? a. Tricyclozole (Beam) b. Propiconazole c. Catap Hydrochloride d. Chlorophriphos (Ans : a)	74.00	0.27
7.	What is the application rate of Tricyclozole? a. 120-160 ml/acre b. 180-200 ml/acre c. 100-120 ml/acre d. 80 – 100 ml/acre (Ans : a)	70.00	0.33
8.	What is the time of application of Tricyclozole? a. Booting or just before appearance of panicle b. After panicle emergence stage c. During panicle initiation d. Before panicle initiation (Ans : a)	73.33	0.40
9.	Any infestation of Brown plant hopper in your field? a. Yes b. No (Ans : a)	70.00	0.33
10.	Among the following Which chemical is used to control BPH? a. Buprofezin b. Quinolphos c. Tricyclozole (Beam) d. Propiconazole (Ans : a)	74.33	0.27
11.	Application rate of buprofezin? a. 320 ml/ acre b. 400 ml/ acre c. 100 ml/acre d. 200ml/acre (Ans : a)	80.00	0.40
12.	Do you know about pheromone traps being used in pest control? a. Yes b. No (Ans : a)	80.00	0.40
13.	Do you know what crop rotation is? a. Yes b. No (Ans : a)	76.67	0.26
14.	Khaira disease is due to the deficiency of..... a. Zn b. Mg c. Mn d. Ca (Ans : a)	73.33	0.33
15.	Chemical used to control Khaira disease is a. Zinc Sulphate b. Calcium Sulphate c. Calcium Carbonate d. Ammonium Sulphate (Ans : a)	70.00	0.26
16.	What is the rate of application of the above chemical used to control Khaira disease? a. 5 kg Zinc Sulphate /ha b. 3 kg Zinc Sulphate / ha c. 6 kg Zinc Sulphate/ha d. 2 kg zinc Sulphate/ ha (Ans : a)	76.67	0.66
2. Effective weed control in Wheat			
17.	Among the following which is the most common weed in the Wheat? a. Phalaris minor b. Parthenium Spp. c. Amaranthus Spp. d. Not known (Ans : a)	70.00	0.40
18.	Which is the post -emergence herbicide used to control Phalaris minor and other weeds? a. Pendimethalin b. 2, 4 -D c. Sulfosulfuran (Leader) d. Not known (Ans : a)	70.00	0.23
19.	What is the time of application of Sulfosulfuran (Leader)? a. 10-15 DAS b. 30-35 DAS c. 35- 50 DAS d. Not known (Ans : a)	73.00	0.67
20.	Does crop rotation help in weed control? a. Yes b. No (Ans : a)	80.00	0.35
21.	Is it a good practice to use higher or lower doses of herbicide than recommended to control weeds? a. Yes b. No c. Use the recommended quantity d. Not known. (Ans : c)	76.00	0.40

Table-1 : Contd...

Sl. No.	Item	Difficulty Index	Discrimination Index
A. Crop based Interventions			
3. Round the year fodder production			
22.	What is the sowing time of fodder maize in your area? a. April to July b. December c. February d. October (Ans : a)	70.00	0.33
23.	Which is the most popular variety of fodder maize? a. African Tall/ J-1006 b. Pratap c. Vijay d. Not known (Ans : a)	65.00	0.40
24.	What is the appropriate harvesting time for fodder maize? a. 60-65 DAS b. 100-120 DAS c. 150 DAS d. Not known (Ans : a)	70.00	0.27
25.	What is the sowing time of Oats? a. October b. January c. February d. Not known (Ans : a)	76.00	0.33
26.	What is the sowing time for Berseem? a. Last week of September to first week of October b. June- July c. April d. May (Ans : a)	73.00	0.40
27.	What is the seed rate for Berseem? a. 8-10 kg/acre b. 15 kg/acre c. 5-8 kg/ acre d. 20 kg/acre (Ans : a)	80.00	0.33
28.	Which is the common weed found in Berseem? a. Chicorium intybus (kasani) b. Commelina benghalensis c. Cyperus rotundus d. Cynodon dactylon (Ans : a)	76.00	0.27
29.	Which is the most popular variety of Berseem popularized under FFP of NDRI? a. Mescavi/BL-2,10,42 etc. b. African tall c. Pratap d. Vijay (Ans : a)	70.00	0.40
30.	What is the appropriate time for first cutting in berseem (BL-42)? a. 60 DAS b. 75 DAS c. both d. Not known (Ans : a)	73.00	0.66
31.	How many cuttings can be taken from one Berseem crop (BL-42)? a. 5-7 b. 15-20 c. 5-10 d. 20-25 (Ans : a)	75.00	0.45
4. Integrated Nutrient Management in Wheat			
32.	What is the rate of application of ZnSO ₄ chemical? a. 25 kg Zinc Sulphate /ha b. 53 kg Zinc Sulphate / ha c. 15 kg Zinc Sulphate / ha d. Not known (Ans : a)	70.00	0.33
33.	How many number of splits of urea is recommended for top dressing? a. 1 b. 2-3 c. 4 d. Not known (Ans : b)	73.00	0.44
34.	What is the recommended dose of fertilizers in Wheat? a. 120 : 60 : 60 (N: P: K kg/ha) b. 150 : 25 : 50 (N: P: K kg/ha) c. Both d. Not known (Ans : a)	71.00	0.23
5. Dhaincha crop cultivation			
35.	Dhaincha is grown in Season (April – May)	80.00	0.33
36.	Can Dhaincha be used fodder purpose? a. Yes b. No (Ans : a)	77.00	0.67
37.	Why do we incorporate Dhaincha in soil? a. To improve soil texture b. For reclamation of problematic soil c. Both a & b d. None of the above (Ans : a)	73.00	0.23
38.	Whether Dhaincha can enhance organic matter in soil? a. Yes b. No (Ans : a)	71.00	0.44
39.	At which stage Dhaincha is incorporated in soil for green manuring? a. 8-10 weeks after sowing b. After flowering c. When the crop has attained 1 meter height d. Both a and c (Ans : a)	70.00	0.66
B. Dairy Based Interventions			
1. Endo-parasite control			
40.	Do you know what is deworming? a. Yes b. No (Ans : a)	74.00	0.40
41.	How many times animal has to be dewormed every year? a. 1 time b. 2 times c. 4 times d. 5 times (Ans : b)	70.00	0.33
42.	Among the following, for which animals deworming can be done? a. only for calf b. only for lactating and adult animals c. whole herd d. Not known (Ans : b)	77.00	0.27

Table-1 : Contd...

Sl. No.	Item	Difficulty Index	Discrimination Index
43.	How does de-worming affects animals? a. On growth b. On disease control c. On both d. Not known (Ans : b)	70.00	0.40
	2. Ecto-parasite control		
44.	Do you have knowledge regarding Ecto-parasite control? a. Yes b. No (Ans : a)	73.00	0.27
45.	In what season Ecto - parasite should be preferably controlled? In summer season b. In winters c. In monsoon d. None of the above (Ans : a)	70.00	0.33
46.	At what interval ecto-parasites should be controlled? Once in a year b. On half yearly basis c. Every month d. Once in five years (Ans : a)	69.00	0.40
47.	Among the following, for which animal's ecto- parasite control is necessary? a. Cross bred animals only b. Indigenous cows & buffalo only c. Whole herd d. Not known (Ans : c)	71.00	0.66
48.	What type of method is used for ecto-parasite control? a. Spraying on animal body b. Spraying on shed & floor c. Injectable medicines d. a & b (Ans : d)	74.00	0.27
	3. Theileriosis vaccine		
49.	Among the following, against which disease vaccination is done? a. Theileriosis b. Babesiosis c. Both d. Not known (Ans : a)	70.00	0.33
50.	In which breed vaccination of Theileriosis is particularly required? a. Crossbred cows b. Indigenous cows c. Buffaloes d. For all (Ans : a)	71.00	0.26
51.	Up to how many months animals should be protected after vaccination? a. 6 months b. One year c. Two years d. Whole life (Ans: d)	73.00	0.33
	4. Mineral Mixture		
52.	Does mineral mixture help in growth of animal & increases milk yield? a. Yes b. No (Ans : a)	69.00	0.60
52.	Does mineral mixture help in growth of animal & increases milk yield? a. Yes b. No (Ans : a)	69.00	0.60
53.	Is mineral mixture useful against infectious diseases? a. Yes b. No (Ans : a)	73.00	0.40
54.	Is mineral mixture useful against metabolic diseases? a. Yes b. No (Ans : a)	79.00	0.23
55.	What should be the dose of mineral mixture in lactating cows/ buffaloes? a. 5-10 gm b. 30-50 gm c. 100-200 gm d. Not known (Ans : c)	80.00	0.40
56.	What is the effect of mineral mixture on reproductive efficiency of dairy cows/ buffaloes? a. Increases b. Decreases c. Does not affect d. Not known (Ans : a)	73.00	0.33
	5. Bypass fat		
57.	What does By-pass fat supplements? a. Energy b. Protein c. Both d. Not known (Ans : c)	71.00	0.40
58.	By-pass fat is recommended in which physiological stage? a. Early lactation b. Dry period c. Both d. Not known (Ans : a)	77.00	0.66
59.	What shall be the minimum dose of by-pass fat in lactating cows/buffalos a. 300 gm b. 100 -200 gm c. Both d. Not known (Ans : b)	73.00	0.26
60.	What are the benefits of feeding bypass fat to the animals? a. Increase in milk production b. Increase of fat in milk c. Improve the body condition score of animal d. a & c (Ans : d)	71.00	0.40
	6. Balanced feeding		
61.	What are the examples of energy supplement in concentrate mixture? a. Cereal grains b. Oilseed cake c. Both d. Not known (Ans : a)	73.00	0.66
62.	What are the examples of protein supplement in concentrate mixture? a. Cereal grains b. Oilseed cake c. Both d. Not known (Ans : b)	70.00	0.26
63.	What are the benefits of balanced feeding? a. Increase in milk production b. Help to improve reproduction c. Improve the body condition score of animal d. All of the above (Ans : d)	80.00	0.40

Table-1 : Contd...

Sl. No.	Item	Difficulty Index	Discrimination Index
64.	By supplementing 1 kg concentrate, how much milk production is achieved per day? a. 1kg b. 2.5kg c. 5kg d. Not known (Ans : b)	71.00	0.33
7. Mastitis control			
65.	What is mastitis? a. Swelling of teats& udder b. Infected milk c. Both d. Not known (Ans : c)	76.00	0.66
66.	Do you have knowledge about control of mastitis? a. Yes b. No (Ans : a)	70.00	0.27
67.	Among the following, in which animals mastitis is more common? a. High yielding cows b. Low yielding cows c. Both d. Not known (Ans : a)	73.00	0.33
68.	Are you aware about the steps of control of mastitis? a. Cleanliness of teats, udder, milker, floor/ shed b. Isolation of affected animals c. Dipping of teats in antiseptic solution after milking d. All of the above (Ans : d)	71.00	0.40
C. Horticultural based Interventions			
1. Vegetable based Cropping System			
69.	What is the sowing season of peas? a. November b. December c. Both d. Not known (Ans : a)	77.00	0.66
70.	What is the seed rate for garden pea? a. 32-40 Kg/ acre b. 40-50 Kg/acre c. 50-60 kg/ acre d. Not known (Ans : a)	74.00	0.40
71.	What is the average pod yield? a. 40-50qtl/acre b. 20-30qtl/acre c. 10 qtl/ acre d. Not known (Ans : a)	70.00	0.33
72.	Which is the most serious pest of pea? a. Pod Borer b. Thrips c. Wilt d. leaf spot (Ans : a)	73.00	0.26
73.	Which chemical is used to control pod borer? A Chlorantraniliprole (Coragen) b. Dimethoate c. Carbendazim d. Not known (Ans : a)	79.00	0.40
74.	Which is the sowing season of cucumber? a. February – March b. Sept – Oct c. Both d. Not known (Ans : a)	74.00	0.66
75.	What is the seed rate for cucumber? a. 1Kg/ acre b. 2Kg/acre c. 5 kg/ acre d. Not known (Ans : a)	71.00	0.26
76.	Which is the serious pest of Cucumber? a. Fruit fly b. Thrips c. Wilt d. Leaf spot (Ans : a)	80.00	0.33
77.	What is the average crop yield of Pusa Barkha? a. 78qtl/acre b. 50qtl/acre c. 30 qtl/ acre d. Not known (Ans : a)	76.00	0.40
78.	What is the sowing time for Bhindi in spring season? a. February-March b. June- July c. Both d. Not known (Ans : a)	70.00	0.33
79.	What is the seed rate for spring season crop of Bhindi? a. 4-15 Kg/acre b. 20 Kg/acre c. 30 kg/ acre d. Not known (Ans : a)	73.00	0.27
80.	What is the average crop yield for spring season crop of Bhindi? a. 40-50qtl/acre b. 20-30qtl/acre c. Both d. Not known (Ans : a)	76.00	0.40
81.	Which pest is observed in vegetative growth stage in Bhindi? a. Shoot and fruit borer b. Thrips c. Fruit fly d. Not known (Ans : a)	70.00	0.33
82.	Which chemical is used to control fruit and shoot borer in Bhindi? a. Coragen b. Carbaryl c. Chlorpyrifos d. Not known (Ans : b)	74.00	0.40
D. Advisory based Intervention			
83.	What is the frequency of receiving messages through SMS service? a. Daily b. Weekly c. Fortnightly d. monthly (Ans : b)	69.00	0.33
84.	Are you getting Weather forecasting messages through FFP Farmers 'portal'? a. Yes b. No (Ans : a)	71.00	0.27
85.	Are you getting useful messages through FFP Farmers' portal? a. Yes b. No (Ans : a)	73.00	0.40

item or question. The index was calculated by using the following formula :

$$DI = \frac{nc}{N}$$

Where, DI = Difficulty index nc = Number of respondents who answered the question correctly

N = Total number of respondents

Discrimination Index : It expresses the extent to which an item discriminates among the subjects who differ sharply in their knowledge measured by the test as whole. An item has a greater power to discriminate more knowledgeable from less one, if it is answered correctly by only a few of the respondents, instead of everyone. On the other hand, a statement which is either answered correctly by everyone or none in the sample, is supposed to have no power of discrimination. In order to compute discrimination indices for all the items, the total scores of all the respondents were arranged in the descending order. Out of this, the top 27 per cent and the bottom 27 per cent of the respondents were treated as high and low groups. Then, the discrimination index was calculated as follows :

$$DI = \frac{n1H - n2L}{n}$$

Where, DI = Discrimination index

n1H = Number of non-sample respondents in 27 per cent high group who answered correctly

n2L = Number of non-sample respondents in 27 per cent low group who answered correctly and

n = (n1+n2) = Total number of non-sample respondents in 27 per cent high group and 27 per cent low group.

Final selection of items : Those items, which met all the following conditions, were finally selected for the knowledge test: Difficulty index (DI) between 0.20 and 0.80. Discrimination index value above 0.20 as followed by Begum (2017). Thus, a total of 85 items from a total 125 items were retained finally, for the final knowledge test.

Reliability statistics of the Knowledge test developed : A test is reliable when it produces consistently the same

results when applied to the matched sample. The final set of the 85 statements which represent Knowledge test of participants was administered on a two point continuum to a fresh group of 30 farmers of non-sample area.

Validity of the knowledge test : The validity of the test was established on account of "content validity". According to Anastasi (1968), "content validity" involves essentially the systematic examination of the test content to determine whether it covers a representative sample of the behavior domain to be measured. Accordingly all possible statements, covering wide aspects of topic were collected; and the same were subjected to measure the difficulty as well as discrimination indices in order to select the final statements.

Conclusion

As seen in Table-1. The list of items selected for final knowledge test under different modules we had different interventions. As mentioned in methodology based on the difficulty index and discrimination index value the above mentioned items were selected to know the knowledge level of the respondents about the different interventions. The validity and reliability of the developed scale indicated the accuracy and consistency of the scale.

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Management of Sclerotinia rot of Cauliflower Caused by *Sclerotinia sclerotiorum* (Lib.) De Bary through Botanicals

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Abstract

The present investigation was undertaken Management of sclerotinia rot of cauliflower caused by *Sclerotinia sclerotiorum* (Lib.) de Bary through botanicals *in vitro* and *in vivo*. The present investigation entitled "Management of Sclerotinia rot of cauliflower caused by *S. sclerotiorum* (Lib.) de Barry through botanicals" was carried out at College of Horticulture, Veer Chandra Singh Garhwali, Uttarakhand University of Horticulture and Forestry, Bharsar, Pauri Garhwal during year 2020 – 21. The result obtained in the present research study minimum radial growth of pathogen was observed in Garlic (12.32 mm) at 30 per cent concentration. Seed treatment with Garlic @ 30 per cent was highly effective which gave minimum disease incidence 11.11 per cent and highest yield (17.3 kg/plot). From this investigation it is concluded that seed treatment with Garlic bulb extract @ 30 per cent is the most effective treatment to reduce the disease incidence in field condition.

Key words : Garlic, cauliflower, *Sclerotinia sclerotiorum*, seed treatment, botanicals.

Introduction

Cauliflower (*Brassica oleracea* var. *botrytis*) belonging to the family Brassicaceae. This is one of the most important cole crop of Europe, Australia and India. It attains an important place in vegetable crop because of its delicious taste, flavor and nutritive value. The popularity of the crop has been constantly increasing and now it occupies more area than other vegetable crop in certain part of the world. (Mitra *et al.*, 1990).

Cauliflower is one of the most important winter vegetables grown in India. India is the second largest vegetable producer in the world, next only to China with the area of 472 thousand hectares and production of 9370 thousand metric tones. In India major cauliflower growing states are West Bengal, Bihar, Madhya Pradesh, Haryana, Odisha, Assam, Chattisgarh, Uttar Pradesh, Punjab, Jharkhand etc. In Uttarakhand cauliflower is grown in an area of 3367.06 hectares with the production of 43292.95 Metric Tons (State Horticulture mission, 2020). Cauliflower crop suffers from various disease caused by fungi and other microorganisms. Important diseases are white rust, downy mildew, powdery mildew damping off (Iyar, 1929), Black rot, *Rizoctonia solani* (Dohroo *et al.*, 1990), Alternaria blight (Ellis, 1968) and Sclerotinia rot is caused by *Sclerotinia sclerotiorum* (Sharma *et al.*, 1983; Purdy, 1979).

Among the major pathogens *Sclerotinia sclerotiorum* (Lib.) de Bary. The causal organism of Sclerotinia rot is the most ubiquitous, omnivorous, soil – borne and destructive

plant pathogen, inciting disease more than 500 plant species. Sclerotinia rot is more common and severe in temperate and sub – tropical regions of cool and wet seasons (Saharan and Metha, 2008 and Sharma, 2014). The fungus belongs to the class- *Ascomycetes*, in the order *Helotiales* and family *Sclerotiniaceae*, characterized by the formation of hard blackish sclerotia, which on germination produce cup shaped brown colored apothecia.

The first symptoms that often develop on leaves or young stems are water soaked spots that may enlarge and become a watery soft rot in most hosts. In other hosts, relatively "dry" lesions are produced on stems, stalks, branches or twigs with a sharp demarcation between healthy and diseased tissues. (Purdy, 1997).

The fungus survive on weeds or as resting bodies (sclerotia) in soil and crop debris. If moist conditions persists for several weeks *S. sclerotiorum* produces sexual stages (apothecia). The ascospores are forcibly ejected from apothecia and cause infection of the leaves and stems (Steadman, 1983). It can survive for 5 or more years in the soil to keep the pathogen viable and affected the host when it is available.

Chemical control measures alone are not economical and eco-friendly, because of their residual toxic effect, wide spectrum activity. The continuous use of these potentially hazardous chemical is posing an increasing threat to environment. Moreover, pesticide contamination of the environment is harmful to human and wild life and to other non-target beneficial microorganism. Thus in recent years,

Table-1 : Effects of different botanicals on radial growth (mm) of the pathogen.

T. No.	Treatments	10% ± S.E. (m)	20% ± S.E. (m)	30% ± S.E. (m)
T ₁	Control	88.00±00.00	88.00±00.00	88.00±00.00
T ₂	Pines	51.27*±0.97	41.86*±0.60	36.14*±0.45
T ₃	Kapoor	41.42*±0.95	35.46*±1.02	32.50*±0.89
T ₄	Artemisia	62.92*±1.15	59.40*±1.22	50.74*±0.09
T ₅	Thuja	54.10*±0.41	52.30*±0.79	47.46*±0.62
T ₆	Vach	35.70*±0.98	30.48*±0.54	25.52*±1.25
T ₇	Lemongrass	38.93*±1.03	34.64*±0.22	29.04*±0.53
T ₈	Stinging Nettle grass	51.83*±1.16	47.29*±0.91	43.66*±1.20
T ₉	Rosemary	25.52*±0.94	20.40*±0.26	17.74*±0.21
T ₁₀	Garlic	19.06*±1.02	16.28*±0.26	12.32*±0.34
SE(d)		1.31	1.02	0.98
C.D.(0.05)		2.77	2.14	2.07

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

Table-2 : Effect of botanicals on mycelium inhibition of the pathogen at different concentrations at 10, 20 and 30 %.

T. No.	Treatments	10 %± S.E. (m)	20%± S.E. (m)	30%± S.E. (m)
T ₁	Control	00.00±00.00 (00.00)	00.00±00.00 (00.00)	00.00±00.00 (00.00)
T ₂	Pine	41.73±1.65 (40.22)	52.43±1.23 (46.37)	58.93±1.53 (50.13)
T ₃	Kapoor	53.13±1.82 (46.78)	59.70±0.17 (50.57)	63.06±1.21 (52.55)
T ₄	Artemisia	28.50±1.32 (32.24)	32.50±0.76 (34.74)	42.33±1.16 (40.57)
T ₅	Thuja	38.52±0.27 (38.34)	40.56±1.67 (39.54)	46.07±0.56 (42.72)
T ₆	Vach	59.43±1.10 (50.42)	65.37±0.14 (53.93)	71.00±1.52 (57.40)
T ₇	Lemongrass	55.76±0.96 (48.29)	60.63±0.67 (51.12)	67.00±0.57 (54.91)
T ₈	Stinging Nettle grass	41.10±1.41 (39.85)	45.06±0.59 (42.15)	50.39±0.79 (45.20)
T ₉	Rosemary	71.00±1.62 (57.41)	76.81±0.48 (61.19)	79.83±0.72 (63.29)
T ₁₀	Garlic	78.33±1.45 (62.25)	81.50±0.86 (64.51)	86.00±0.57 (68.00)
S.E. (d)		1.83 (1.11)	1.16 (0.70)	1.39 (0.85)
C.D. (0.05)		3.85 (2.34)	2.43 (1.47)	2.92 (1.78)

() Value in parenthesis are angular transformed

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

an increasing consciousness about environmental pollution due to pesticide and development of fungicide strains in plant pathogens has challenged plant pathologist to search for ecofriendly tools for disease management.

Considering the importance of Sclerotinia rot of cauliflower we have planned our research work on *in vitro* and *in vivo* evaluation of Botanicals against *Sclerotinia Sclerotiorum* (Lib) de Bary.

Materials and Methods

Collection, Isolation, Identification of the pathogen :

Infected curd of cauliflower with sclerotinia rot were collected from Vegetable research and Demonstration Block, College of Horticulture, VCSG UUHF, Bharsar and used for isolation of the pathogen. The infected portions were cut into small pieces and surface sterilized using 0.1% sodium hypo chloride solution for 30 seconds. The pieces were thoroughly washed in sterile distilled water to remove the residue of sodium hypo chloride and then aseptically transfer to sterile potato dextrose agar slant and incubated at 25±1° C temperature and observed periodically for mycelia growth of fungus. Colonies, which developed from the pieces, were

identified by microscope observation by taking mycelia character as mean for identifying the pathogen. The morphological characters of the fungus observed to confirm the identity of the isolated pathogen. Fungal growth was then examined through the compound microscope, after making slide in water and cotton blue stain. Microscopic observation was taken in 40x magnification. The morphological characters such as colony, color of the colony, mycelia growth, sclerotia, length and width of sclerotia were studied and compared with characters of *Sclerotinia sclerotiorum*. (Bharti, 2015).

Poisoned food technique : The poisoned food technique (Nene and Thapliyal., 1993) was adopted for *in vitro* evaluation of different botanicals- Pine, Kapoor, Artemisia, Thuja, Vach, Lemongrass, Stinging nettle grass, Garlic, Rosemary against the test fungus. For bioassay, concentrations of botanicals were prepared by dissolving 10, 20 and 30 ml of stock solution of plant extract in 90, 80, and 70 ml of sterilized PDA respectively to get the final concentration of 10, 20 and 30% each botanical separately. After that, the flasks were shaken gently to ensure proper mixing of botanicals in PDA. Then, 20 ml of molten PDA was

Table-3 : Effects of botanicals on per cent disease incidence and plant yield (Kg/plot).

T. No.	Treatment Name	Dose (%)	Disease Incidence	Yield (Kg/plot)
T ₁	Control	30	66.67±1.34 (54.72)	5.95±0.56
T ₂	Pine	30	29.62*±1.75 (32.94)	12.61*±0.30
T ₃	Kapoor	30	25.92*±1.73 (30.57)	12.95*±0.58
T ₄	Artemisia	30	51.84*±2.37 (46.04)	08.87*±0.44
T ₅	Thuja	30	48.14*±2.05 (43.91)	09.61*±1.41
T ₆	Vach	30	18.51*±1.80 (25.42)	14.06*±0.58
T ₇	Lemongrass	30	22.22*±1.56 (28.08)	13.35*±1.24
T ₈	Stinging nettle grass	30	33.33*±2.60 (35.21)	11.72*±0.97
T ₉	Rosemary	30	14.81*±0.14 (22.62)	16.16*±1.42
T ₁₀	Garlic	30	11.11*±0.57 (19.45)	17.30*±0.85
S.E. (d)			1.27 (0.76)	0.89
C.D. (0.05)			2.69 (1.62)	1.89

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

() Value in parenthesis are angular transformed

poured in each Petri plate. After solidification of media, mycelial disc of 5 mm diameter were cut from 5 day old culture and inoculated with the help of sterilized cork borer. Incubation of Petri plates was done at 25±1°. Suitable control were kept in which the culture disc were grown under same condition on PDA without botanicals. The radial colony growth of the fungi was measured after 2, 4, 6 and 8 days of incubation.

Percent inhibition of growth was calculated in relation to growth in control using the following formula of Bliss (1934).

$$PGI = \frac{C - T}{C} \times 100$$

Where; PGI = Per cent mycelial growth inhibition

C = Radial growth of fungus in control (mm)

T = Radial growth of fungus in treatment (mm)

Seed treatment : The botanicals were prepared by crushing (plant part) mixing in distilled water (1:1 w/v). The mixture was passed through muslin cloth. Desire concentration was made by mixing calculated volume of plant extract into calculated volume of water. (Upadhyay, 2019)

The seeds of cauliflower were soaked in the plant extracts @ 30% for one hour. Then the excess extract was drained off and treated seed were kept in blotting paper to remove excess moisture from seed surface and dry in the open air. After complete drying the seeds were sown in the nursery. (ISTA, 1996)

Field preparation and transplanting : Nursery preparation was done by sowing cauliflower variety Pusa Snowball-1, in the first week of July 2021. Field was prepared in the first week of August thoroughly by two ploughing with power tiller followed by two cross tilling and it was leveled with help of pata then divided into plots having irrigation channels, path and distance to mark different replication as well as plot as shown in layout. Plots 0.90 m × 1.20 m size was prepared

by mixing of well rotten FYM in the soil. Nine plants were transplanted at 30 cm × 45 cm apart per bed in the soil and there after watered with the help of rose can. Regular watering was done of the plots to maintain proper moisture for the growing seedlings. Plots were kept weed free by with the help of hand weeding as and whenever required.

Observation recorded

Per cent disease incidence : Disease incidence was estimated by using following formula.

$$\text{Disease incidence} = \frac{\text{Number of infected plants}}{\text{Total number of plant observed}} \times 100$$

Total yield (Kg / plot) : The curds were harvested at mature stage to record yield per plot. The total plant was multiply by with total number of plants / plot to obtain yield / plot in kilograms. The operation was done for each treatment separately.

Results and Discussion

Typical symptoms appear initially on the collar region and above the ground level. The infected plant die completely and white mycelium grows on the plant parts which come in contact to the soil surface. The pith region of attacked stem is filled with large, hard and black sclerotial bodies.

Radial growth (mm) of the pathogen at different concentrations : Minimum radial growth was recorded in T₁₀, Garlic (12.32 mm) at 30 % concentration. Next effective botanicals was T₉, Rosemary (17.74 mm) followed by T₆, Vach (25.52 mm), T₇, Lemongrass (29.04 mm), T₃, Kapoor (32.50 mm), T₂, Pine (36.14 mm), T₈, Nettle grass (43.00 mm), T₅, Thuja (47.46 mm), T₄, Artemisia (50.74 mm) at 30 % concentration while maximum radial growth was observed in T₁, Control (88.00 mm). This information was confirmed by Ghasolia *et al.*, (2016).

Per cent mycelium inhibition of *S. sclerotiorum* : Among botanical tested on this experiment T₁₀, Garlic (86.00 %)

inhibited maximum growth of fungus followed by T₉, Rosemary (79.83 %), T₆, Vach (71.00 %), T₇, lemongrass (67.00 %), T₃, Kapoor (63.06 %), T₂, Pine (58.93 %), T₈, Stinging nettle grass (51.13 %), T₅, Thuja (46.06 mm), T₄, Artemisia (42.33 %) at 30 % concentration.

Effect of botanicals on per cent disease incidence and yield : The data revealed significant variation from disease incidence between control and all the treatments. The performance of the treatments ranged from 11.11% to 51.84%. Minimum per cent disease incidence was observed in T₁₀, Garlic (11.11%) whereas, maximum per cent disease incidence was found in Artemisia (51.84%). All the treatments were found significant as compared to control. Upadhyay and Tewari (2019) found similar results.

Maximum yield was recorded in T₁₀, Garlic (17.30 kg/plot) followed by T₉, Rosemary (16.16 kg/plot) while minimum yield was obtained in T₄, Artemisia (8.87 kg/plot).

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Role of Jute Agro Textiles in Conservation of Crops from Climate Change

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Abstract

Agriculture is the backbone of Indian economy. We earn a major portion of our GDP from agriculture and its subsidiary activities. The changes in climate and rise in temperature at global level produce adverse impact on agricultural activities. The growth and development of plants, their fruit bearing capacity, crop yield are hindered by climate change. Thus, there is a requirement of mitigating strategies. Recently jute agrotexiles have been highlighted by agricultural scientist as a solution to crop damage by climate change. The experiments employing jute agro textiles have given positive results thus, suggesting it as an emerging field.

Keywords: Climate, jute, agriculture, temperature, agrotexiles.

Introduction

Agriculture is the most ancient occupation of human kind and still now it is one of the major global industries (Chowdhury *et al.* 2017). Indian economy is decidedly reliant on agriculture. It plays a very pivotal role in our nation. Agriculture can clearly be witnessed that it has to support almost 17 percent of the global population from 2.3 percent of world's geographical area and 4.2 percent of world's water resources. About 60 to 70 percent population directly or indirectly depends upon agriculture for their livelihood (Arjun 2013). The soil, temperature and water resources act as huge ancillary dynamics for agriculture in our nation.

In spite of having a number of supporting pillars, it has been widely evident that Indian agriculture and crop management is suffering a lot. The farmers are not able to make minimal profits and thus the younger generation is finding it difficult to stick to the profession and trying to migrate to other sectors for earning a livelihood. The major obstacles faced by the country in achieving food security are lack of technical application, awareness and its poor exploitation. Several factors are responsible for poor crop production in India. Climate change is one amongst the crucial factors which require urgent attention of agriculture scientist. As our first Prime Minister Pt. J. L. Nehru stated "Most things, except agriculture, can wait."

Climate change and agriculture are interrelated processes, both of which take place on a global scale. Global warming affects agriculture in a number of ways, including through changes in average temperatures, rainfall and climate extremes, changes in pests and diseases, change in atmospheric carbon dioxide and ground level ozone concentrations, change in nutritional quality of some foods and changes in sea level (Wikipedia

2020). Global warming is steadily increasing and impacting on highly vulnerable developing countries. Agriculture which is an essential sector for most of developing countries contributing to climate change with greenhouse gas emissions (GHG) and suffering from the effects of climate change. The challenge of feeding the population and reducing agricultural greenhouse gas emissions requires the successful transfer of climate-friendly agricultural and land use practices to farmers serving adaptation and mitigation needs (Singh 2017). Crops are very sensitive to climate change and sudden rise in temperature as well as irregular precipitation at any phase of crop production can affect the normal growth, flowering, pollination, fruit development and subsequent decrease in the crop yield. With the increase in concern towards agriculture, scientists are coming up with innovative approaches and strategies of mitigating the effects of climate change on crop production. One such approach is usage of agro textiles in crop production and management.

Textile fibers, since their discovery, were mainly used for clothing applications but with the technological development, these materials became more used in a wide variety of technical applications namely automotive and aeronautics, medical and hygiene applications, protection and defense, civil and agricultural engineering and their use keeps growing continuously (Pritchard *et al.* 2000). In the agricultural field, the use of technical textiles showed a promising development which led to the birth of new textile-based materials called agrotexiles (Palamutcu and Devrent 2017).

What is agrotexiles?

In detailed definition agriculture textiles are one of the widening technical textile groups that are used for crop

protection, fertilization, aquaculture, horticulture and forestry. They are termed as “Farm to Folk” products (Bhavani *et al.* 2017). With increasing environmental awareness and specified knowledge of various inter-disciplinary technologies, considerable attention has been given on non-conventional technical applications like using textile structures in agriculture and horticulture sectors to enhance quality and yield of the agro-products (Paul and Sanyal 2012). Textile materials in the form of woven, nonwoven, knitted, knotted, twine, braided, etc. are used for various applications of agrotexiles. Agro textile products can be classified as; landscape fabric that is used for weed control; wind protection fabric that is used for protection of crops from the wind; frost cover fabric that is used for adjustment of weather conditions from the sudden changing of temperature and seasonal changes; shade cloth that is used for protection of crops and livestock from the harmful effects of sun shine; poultry curtain that is used for light control, thermal protection and ventilation control; drainage textiles that are used to solve the problems of surface water and drained soil; sealing sheet that is used as tanks for fluid products or liquid manure; agricultural belting; tarpaulins; anti-insect fabrics; flower and vegetable support mesh and livestock ground fabric. Ultimately sensor equipped agro textiles are also started to be used in the detection of agricultural human activities of digging, harvesting and bed making (Fisher 2013, Kumar 2017).

The employability of textiles in agriculture can be guessed easily by the fact that in total agro textile items contributed 8% share in the technical textiles market volume with consumption accounting for around 8.2% by volume and 6.4% by value of the global technical textiles market in 2010. However, the sector is among those with the strongest growth predictions based on the projected increase in global population and the demand for higher

quality food. In developing countries the market is estimated to be growing by around 8-10% a year and around 3-9% a year in developed countries.

Major constituent fibres used in composition of agrotexiles : Among synthetic fibres, polyolefin fibres are extensively used apart from small quantities of nylon, polyester fibres, whereas, jute, wool, coir, sisal, flax and hemp fibres are the representative of natural fibres. Due to their high strength, durability and other suitable properties of agricultural applications, synthetic fibres are widely used in agrotech sector. On the other hand natural fibre based agrotexiles not only serve the specific purpose but also after some year degrade and act as natural fertilizers.

Utilization of jute in agrotexiles : Jute is cultivated in the alluvial plains in the tropical and subtropical zones in South Asia region. India alone, accounts for about 50% of the world production of jute and allied fibre. It is a natural fibre popularly known as the golden fibre. It is one of the cheapest and the strongest of all natural fibres and considered as fibre of the future. Jute is second only to cotton in world's production of textile fibres. It is not only a major textile fibre but also a raw material for non-traditional and value added products. One such example is jute agrotexiles. The intrinsic properties of jute have made it possible to develop different types of agrotexiles suitable for specific applications. It has many advantageous properties like high tensile strength, high moisture absorption & retention capacity, unique drapability, porous structure, thermal resistance etc.

It is one of the most commonly used and accepted natural fiber that has been used to provide higher agricultural productivity by improving agronomical characteristics of soil and by reducing growth of unwanted vegetation. Main application areas in the agro textile market can be listed as soil conservation and reduction of

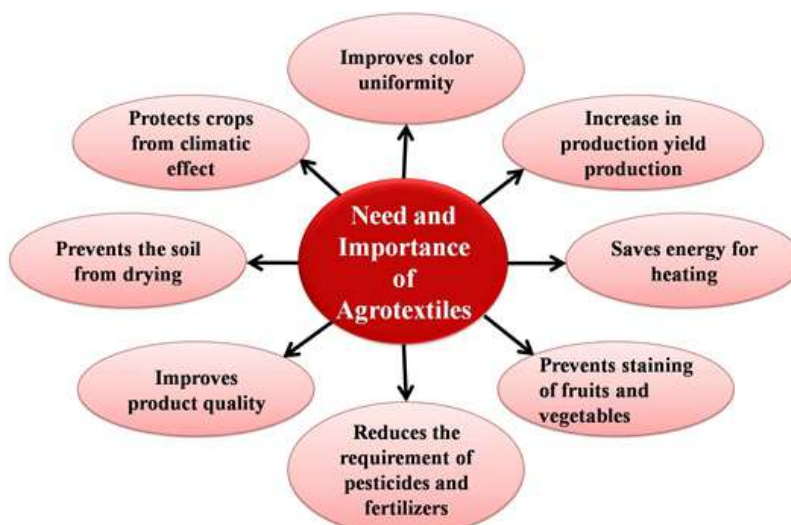


Fig-1 : Need and importance of agrotexiles in modern farming.

Table-1 : Major agrotextiles with constituent fibers.

Product	Constituent fibre	Product image
Sunscreen	Polyethylene	
Root ball net	Cotton, Polyester, Cotton-polyester blend	
Soil protection fabric	Polypropylene, Jute	
Insect meshes	Polyethylene mono filament & multi filament, Nylon	
Cold and frost control fabrics	Polypropylene	
Anti wind nets	Nylon	
Weed control fabric	Polyethylene, Jute	

Table-1 : Contd....

Product	Constituent fibre	Product image
Mulch mat	HDPE, LDPE, Polypropylene, Wool	
Filter for milking	Cellulose, Viscose, Cotton, Polyester	
Anti-hailstone nets	Polyethylene mono filament	
Plant net	Polyolefin type fiber	
Bird protection net	Co-polymer nylon, Polyethylene, Polypropylene	
Shade cloth	Polyethylene	

Source : (Chowdhury *et al.* 2017, Annapoorani and Saranya 2019).

nutrient loss; nursery seed bed cover; shade over nursery; weed management & agro-mulching; afforestation in semi-arid zone; sleeves for growth of sapling; air layering and wrapping/covering of plants. Mulch mat, sleeve for nursery use and agro bags are some of the main agro textile product group (Kumar 2017).

Composition and properties of jute fibres used in agrotextiles :

Table-2 shows the chemical composition of major constituents and physical properties of jute fibre, which is widely used in agrotextiles.

Table-2 : Physico-Chemical Properties of Jute/ chemical composition.

Properties	Composition
Density	1.48
Fineness (denier)	20
Tenacity (g/denier)	4.2
Elongation (%)	1.2
Cellulose (%)	61-63
Hemicelluloses (%)	13
Lignin (%)	5-13

Area-wise applications of jute agro textiles :

Mulch mat : Mulch mats are used to suppress weed growth in horticulture applications. Weed control has traditionally been achieved with bark chips, jute or black plastic (polypropylene), which cover the soil, blocking out light and preventing the competitive weed growth around seedlings. Wool and coir nonwoven fabrics are also effectively used as mulch mats (Annapoorani and Saranya 2019).



Jute sleeve : For growth of seedling/sapling generally polythene bags (sleeve) are used in the nurseries. During transplantation of the grown up plants the poly sleeves are torn off and thrown away on the ground causing pollution to the environment. Moreover, the experts opine that during tearing the polythene, there is chance of damaging of some important root network of the plants. In addition, air and water circulation in the soil mass inside the polythene are also affected. Due to its inherent nature, temperature inside the sleeve sometimes goes up in tropical areas and ice formation is observed in high altitude zone, causing high degree of mortality in young

plants. Jute based woven as well as braided sapling bags are developed by IJIRA to overcome the problems associated with poly sleeves. Due to the inherent properties of jute and the porous structure of the woven and braided sleeves air and water circulation inside the sleeve is regulated thus stimulates the plant growth.



Agro bags : Jute has enjoyed a position of importance as packaging material since it had entered the packaging arena in 1793. Being a renewable and inexpensive natural fibre, abundantly available in Indian subcontinent, superior tensile strength and excellent frictional properties made jute the most etc. are packed in jute bags domestically as well as globally since more than two centuries and have thus played a very important role in the national and international trade and commerce (Bhavani *et al.* 2017).



Case studies and recent researches on jute agrotextiles :

Sarkar *et al.* 2020 conducted a study in the experimental farm of Bidhan Chandra Krishi Viswavidyalaya, West Bengal, India for two consecutive years from March to February of 2017-2018 and 2018-2019. The experiment was carried out using a randomized block design with four treatments and five replicates taken Banana (variety Singapuri) as a test crop. The treatments (T), composed of different strength of jute agro textile (JAT) used as mulching material. All the data regarding yield, yield attributes, crop water use efficiency and soil properties were recorded accordingly. The response of yield over control was 32.52 t/ha, 38.61 t/ha, 43.05 t/ha in treatments T2-500 GSM, T3-800 GSM and T4-1000 GSM respectively where GSM is gram per square meter.

Though the best results were obtained in T4-1000 GSM, in terms of cost-benefit ratio T3-800 GSM proved more beneficial than the other treatments. The average water use efficiency of the crop increased significantly by 96.9% (on an average) over control for using the jute agrotexile mulch. Among all the treatments, T3 exhibited the most promising effect on improving yield and other attributes along with maintaining sustainability because it provided the most favourable soil condition compared to other mulches for banana.

Adhikari et al. 2018 conducted a field experiment at the Central Research Farm under Bidhan Chandra Krishi Viswavidyalaya, Nadia district of West Bengal which is situated at 22° 58' N, 88° 30' E, with an altitude of 10.9 m above the mean sea level with a slope of 0 to 1% which is topographically medium in class to investigate the effect of various strength (gram per metersquare) of jute agro textiles on yield and changes of soil properties of tomato. Five treatment combinations viz., T1-800 GSM jute agro textiles, T2-600 GSM jute agro textiles, T3-400 GSM jute agro textiles, T4-200 GSM jute agro textiles and T5-Control (farmer's practice) were spread before transplanting of tomato seedlings along with the levels of N-P-K at 20-40-40 kg ha⁻¹ in randomise block design with four replications. Initial and final soil samples were analyzed for relevant physical and chemical properties by following standard methods. The yields of tomato were 39.80 t ha⁻¹, 42.69 t ha⁻¹, 37.08 t ha⁻¹, 30.84 t ha⁻¹ and 24.77 t ha⁻¹ in the plots of Jute agro textiles 800 GSM, 600 GSM, 400 GSM, 200 GSM and control (farmer's practice) respectively. Significantly highest (P<0.05) fruit yield was recorded in plots of jute agro textiles 600 GSM. Response of fruit yield of tomato over control due to each treatment were 15.03 t ha⁻¹ (60.68%), 17.92 t ha⁻¹ (72.34%), 12.31 t ha⁻¹ (49.70%) and 6.06 t ha⁻¹ (24.47%) in respectively plots of jute agro textiles 800 GSM, 600 GSM, 400 GSM, 200 GSM. The yield of tomato significantly increased (P<0.05) with the application of each of the different types of treatments over control (farmer's practice). The result showed the decreased bulk density and increased porosity under all treatments also improved the moisture retention capacity in soil. They also helped to improve moisture use efficiency. Better aggregation and their stabilization as well as tomato yield occurred with applied T2 - 600 GSM jute agro textile treatments.

Manna et al. 2018 in their study with broccoli in lateritic soil of West Bengal observed that the soil moisture content in 15, 30, 60 and 90 DAP was highest in 400 gsm NJATM treatment followed by moisture content in 350 gsm NJATM > 300 gsm NJATM > Black Polythene > Rice Straw > No Mulch treatment respectively in decreasing order. Mulched treated plot showed higher soil moisture

content compared to control because of their increased water retention, reduced evaporation and reduced weed population density. The lowest soil moisture content in bare soil or control was may be due to exposed surface to heat and wind losses moisture through evaporation.

Sarkar et al. 2018 carried out research work to understand the effect of different strength of jute agro textiles on yield and moisture use efficiency of green gram (*Vignaradiata* L.) grown for two successive years 2016 and 2017 during the pre-kharif season from last week of February to 2nd week of May at the farmer's field in the Kamalpur village, Chatna block, Bankura, West Bengal. The experiment was conducted with five treatments viz. T1 -1000 GSM, T2 - 800 GSM, T3 - 600 GSM, T4 - 400 GSM jute agro textiles and T5 - farmer's practices where GSM = g/m². Results showed that, the yield is increased with each treatment, attaining the highest value of 6.74 q/ha in T1 which is 185.6 % more than control. The moisture use efficiency of the crop, was increased significantly by 70.27% (approx.) due to the treatments over control. Though the best results were obtained in T1, but the increment occurred in a declining pattern from T2 to T1 i.e. further increase in strength after T2 was not proved to be efficient.

Das et al. 2017 also studied the efficacy of non-woven agro-textile mulches in conserving soil moisture content in surface soil in french bean after 15, 30, 60 and 90 days after sowing (DAS) and reported that highest moisture content (7.968 %) was recorded in 500 gsm non-woven agro-textile mulches in 15 DAS which was statistically at par with 300, 350 and 400 gsm mulch. In 30 DAS, however, the maximum value of soil moisture (14.56 %) was recorded in 500 gsm mulch which was statistically at par with 350 and 400 gsm mulch. At 60 DAS the maximum value was recorded in treatment 500 gsm mulch (12.79%) which was statistically at par with 300, 350 and 400 gsm mulch. Even in 90 DAS of the crop the highest level of soil moisture (12.30 %) was found in 500 gsm mulch and was statistically at par with treatment 300, 350 and 400 gsm mulch. The lowest level of moisture content was in the control plot in each days of soil sampling.

Datta et al. 2015 conducted field experiments in Tripura to find out the efficacy of jute agrotexiles viz., woven open mesh agrotexiles of 300 and 500 GSM and non woven and non woven agrotexiles of 500 GSM in the areas of soil erosion control, weed suppression and crop yield. Groundnut (Variety ICGS-76) was grown as test crop. Soil loss in the sloppy land was found to vary from 29.9 to 34.2 t/ha thus indicating 12.5 percent reduction in soil loss by the use of woven 300 GSM jute agrotexiles. Nearly 14.5 and 21.5 percent increase over control in pod and haulm yield of groundnut were recorded by the use of jute

agrotexiles. Weed density was also reduced from 3.5 to 3.1 kg/m².

Nag 2005 stated that the normal yield of sweet lime at Nagpur and Pune, Maharashtra, India, the traditional areas of cultivation, is 200–250 fruits/plant/year. Due to different constraints in the experimental area, the normal production was found to be 30–40 fruits/plant/year. It was evident from the results that with the increase of fabric weight, the yield of fruits increased and it was maximum with 300 g/m² jute felt. This increase in yield was due to the increased water holding capacity of the jute felt which is required to tide over the water-stress crisis condition occurring during flowering season of sweet lime plants which helps towards ensured pollination and higher yield and found significant at 1 % or less.

Conclusion

Jute agrotexiles have the capacity to be used for protecting the crops from water condensation, ice formation, sudden drop of temperatures, safety during dry spell. It also fosters vegetative cover and controls extremes of soil temperature. It is clearly the need of the hour in order to mitigate the impact of climate disparities thus safeguarding the future of Indian agriculture. As agriculture is the backbone of India, opportunities should be enhanced to utilize more and more agro-textiles.

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