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WEED MANAGEMENT IN RICE BASED CROPPING SYSTEM — AN OVERVIEW

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ABSTRACT

Rice based cropping system is a major cropping system practiced in India, which include the rotation of crops involving rice, wheat, maize, pulses, oil seeds, cotton, sugarcane, green manures, vegetables, etc. Diverse rice-based cropping systems have been reported from different parts of India ranging from rice-rice-rice to rice followed by different cereals, pulses, oilseeds, vegetables and fibre crops. Rice-based cropping systems may include lowland and upland crops. So far, most people have been focusing on individual crops disregarding the fact that each crop is only a component of a cropping system. Intensification of rice-based cropping systems in India has essential to people, directly or indirectly for food security, poverty control and world's peace. Among the weeds *Phalarisminor, Polypogonsps* and *Avena sativa* were found to be major weeds in rice-wheat system while *Echinochloa*sp. and *Cyperus*sp. in rice-rice and *Cyanotisaxillaris*, *Euphorbia hirta* and *Ipomeaaquatica* in rice—maize system. Now a day Zero tillage practices reduced the population of *Phalaris minor* and *Chenopodium album*in different cropping system. Weed competition is a major constraint in all the rice production systems in India.

Key words : *Cropping system, rabi, rice,sesbania,weeds flora.*

Rice-based cropping systems in India

Rice-cereal based cropping system : Rice, maize, and wheat are majorcereals contributing to food securityand income in India. Thesecrops are grown either as amonoculture or in rotations in India. In the irrigated and favourable rainfed lowland areas, rice-rice (R-R), rice-wheat (R-W), and rice-maize (R-M) are the predominant cropping systems (Yadav and Prasad 1998) (Table-1).

Dominated weed flora inpredominant cropping systems of Indo-Gangetic Plains : The problem of weeds in the same cropvaries with cropping system andproduction environments. Therefore,understanding the weed flora species inrelation to cropping system, season andproduction environment is a must foreffective and economical weedmanagement. The dominated weed flora indifferent cropping systems of IGP are given as below :

Rainy season (Kharif) weeds

I. *Echinochloacrusgalli*

II. Echinochloacolona

III. Wild rice

IV. *Leptochloachinensis*

V. *Paspalum distichum*

VI. *Amaranthus viridis*

VII. *Digera arvensis*

VIII. *Trianthemaportulacastrum*

IX. *Physalis minima*

X. *Cyperusiria*

XI. Cyperusrotundus

XII. *Fimbristylismiliacea*

XIII. *Commelinabenghalensis*

XIV. *Cyanotisaxillaris*

Winter (Rabi) Weeds

I. Avenafatua

II. Avena sativa

III. Melilotus alba and *Melilotusindica*

IV. Chenopodium album & *Chenopodium murale*

V. Daucus carota

VI. Fumaria parviflora

VII. Argemone Mexicana

VIII. Cirsium arvense

IX. Anagallis arvensis

X. Coronopusdidymus

XI. Cichoriumintybus

XII. Rumexdentatus and *Sonchus sp*

XIII. Polygonum plebejum

XIV. Convolvulus arvensis

XV. Phalaris minor

Round the Year

I. Parthenium hysterphorus

II. Alternanthera sessilies

III. Cyperusrotundus

IV. Solanum incanum

V. Oxalis corniculata

VI. Marsileaquadrifolia

Weed management in Rice based cropping system : Weeds are a major concern for high productivity of the rice. Effective weed management in rice crop depends on several factors, including the timeliness of the control operations during the early crop growth stages and in some cases, good control in preceding crops. In transplanting rice, weed control is conducted just before transplant and the rice has a significant size and competitive advantage over subsequently emerging weeds. Integrated approaches to weed management combine multiple tactics and knowledge of site-specific field conditions are essential to increase the efficacy and sustainability of weed control.

Cultural methods

Stale seedbed : In this technique, weed seed germination is encouraged by applying light irrigation and then emerged seedlings are kill edusinganon-selective herbicide before cropsowing. It has been observed that this technique can reduce weed population by 53%.

Good crop establishment : Spatially uniform establishment of healthy, vigorous rice seedlings increases crop competitive ability and suppresses weed growth.

Surface mulch and cover crops : Surface retention of crop residue sprovidesa physical barrier to emerging weeds, thereby delaying emerging and increasing seedling mortality. In addition decomposing residues release allelochemicals seeds remain on or near the soil surface.

Sesbania co-culture (Brown Manuring) **:** "Brown Manuring" practice involves seeding of rice and *Sesbania* crops together and killing the *Sesbania* crop 25-30 days after sowing with 2,4-Dethylesterat 0.40-0.50kg/ha. Sesbania grows rapidly and suppress weeds. Co-culture technology can reduce weed population by nearly half without any adverse effect to rice yield.

Chemical weed control : The right herbicide for use in Transplanting/ DSR depends on the weed flora present in a given field; individual herbicides have strength and also weakness **(**Gopinath and Pandey 2003) e.g. Bispyribac is very good on grass esbutcan't control *Leptochloa*. Rotational use of herbicides with different modes of actions is also desirable to check the possible development of herbicide tolerant or resistant weeds biotypes.

A. Pre-plant herbicides : These are used to knockdown existing annual and perennial weeds prior to crop planting. Glyphosate is a non-selective, systemic herbicide that controls annual and perennial weeds and should be applied 5 to 7 days before seeding. If possible, weeds especially perennials, should be allowed to grow after irrigation to develop a canopy, so that they can receive enough glyphosate to kill under ground storage organs. Use flatfan nozzles for spraying. Best results are obtained when weeds are inactive growth stages. Glyphosate controls all weeds including *Cynadon dactylon* and *Cyperus rotundus*. Glyphosate is absorbed by the foliage and rapidly translocated throughout the plant.

B. Pre-emergence herbicides : These are generally used before emergence of weeds and are applied immediately after the sowing of the crops. Pendimethalin is applied @ 1000ga.i./ha for managing weeds in DSR. However, it should be applied on same day of sowing or pendimethalin should be applied within 3 days of sowing depending on soil moisture status. High soil moisture is a pre-requisite for application of this chemical. Pyrazo sulfur on is applied @ 20ga.i./ha for the control of grasses, broad leaf and sedges. High soil moisture is a pre-requisite for higher efficacy of this chemical.

C. Post-emergence herbicides : These are used to control emerged weeds. Bispyribac (Nomineegold) @ 25ga.i./ha at 15-25 DAS is effective in controlling all three types of weed flora (grasses, broad leaved and sedges). Penoxsulam @ 22.5ga.i./ha applied at 15 DAS is also effective in controlling all three types of weeds flora. 2,4-D @ 500ga.i./ha is an inexpensive herbicide for the control of broad leaf weeds. It is also very useful in managing *Fimbristy lismileacea.* Apply

Table-1 : Predominant Rice based cropping systems in India.

S. No.	Irrigated conditions	Upland condition	Rice under integrated farming system
1.	Rice-Rice-Rice	Rice-Chickpea	Rice-Fish-Poultry
2.	Rice-Rice-Cereal	Rice-Lentil	Rice-Fish-Duckery
3.	Rice-Rice-Pulses	Rice-Mustard/Linseed	-
4.	Rice-Wheat-Pulses	Rice-Barley	-
5.	Rice-Toria-Wheat	Rice-Wheat	-
6.	Rice-Wheat	Rice-Pea	-
7.	Rice-Mustard	-	-
8.	Rice-Wheat-Jute		

2,4-Dethyle aster when annuals egdes like *F.miliacea* starts germinating *(*10-30DAS*).*

2. Weed management in Rabi crops under rice based cropping systems

Wheat : Wheat is second most important crop in Indo Gangetic Plains and normally rotated with rice or maize. Wheat production in IGP took a quantum jump with the green revolution; however the dwarf wheat is more vulnerable to weeds, especially under high nutrient and water availability. Normally weeds offer severe competition to wheat and cause upto 40 to 50 % reduction in grain yield if not managed at critical period. Major weeds in wheat are affected by grasses and broad leaf weeds. *Phalaris minor*, *Avenaludoviciana*, *Polypogonmonspeleinsis* are grassy, where as *Chenopodium album*, *Melilotussps, Anagalis*, *Rumex*, *Fumeria, Vicea*, *Lathyrus*, *Circium, Solonum*, *Physalisminima*, and *Convolvulus arvensis* are common broad leaf weeds in region. Grassy weeds such as *Phalaris minor* are of great concern in the North West part of the IGP (Malik, R.K.,. 1998), where as broadleaf weeds and perennial weeds like *Cynodondactylon* are more important for wheat crop in the Eastern IGP.

Weed management practices in wheat

A. Cultural : The critical stage for weed competition in wheat ranges from 15 to 45 days after sowing of wheat as this is the stage where the crop is sensitive for weed competition. Therefore, weeds need to be controlled during this window of crop growth. Varieties with high early vigour or practices such as fertilizer placement, timely planting etc improves the competitive ability of wheat crop thereby reducing losses due to weeds (Gnanavel and Kathiresan, 2002). Adopting zero tillage and retention of crop residues on surface has been found very effective in reducing germination of *Phalaris minor*, *Chenopodium album*, *Physalis*, *Anagalis* etc. Hobbs PR (2007) . Managing water effectively in rice can be helpful in reducing populations of *Rumex* in wheat, as it appears mostly in wet soils.

B. Chemical weed control : In areas with high soil moisture, perennial weeds and some annual weeds germinate and start growing before wheat crop and offer a tough competition to wheat. These fields are often found full of tiny seedling of *Phalaris* or *Polypogonmonspeliensis* and farmers many times ignore these tiny seedlings and end-up with the severe infestation of weeds even after application of herbicides like metsulfuron or sulfosulfuron. Because these post emergence herbicides work well at 3-4 leaf stage of weeds and in situations where weeds are older, the effectiveness of herbicides becomes lesser and these weeds can be a potential source of herbicide resistance. In such conditions, pre-plant application of glyphosate at 1 kg ai/ha is effective for controlling pre-germinated or established weeds before wheat planting. Clodinafop (Topik) at 60 g ai/ha or sulfosulfuron (Leader) at 25 g ai./ ha applied post emergence after first irrigation at 30 DAS was found effective in controlling annual grassy weeds in wheat. Fenoxaprop at 100 g ai.ha at 30 DAS was found effective in controlling grasses especially *Cynodondactylon*. Clodinofop can also arrest growth of *Cynodondactylon* besides other grassy weeds. Sulfosulfuron has some control on broadleaf weeds too. Post emergence application of 2,4-D at 500 g ai/ha or metsulfuron (Algrip) 4 g ai/ha or carfentrazone (Affinity) at 20 g ai/ha at 30 DAS has been found effective in managing broad leaf weeds. It is important to remember that the herbicides need to be rotated across cropping seasons to avoid herbicidal resistance.

Weed management practices in Maize : Rabi maize after rice is becoming a popular and remunerative crop option for the farmers in non-traditional maize areas of Eastern Gangetic Plains. However with changed

ecologies, weeds are a potential threat to the maize crop especially in rabi season as it is planted widely spaced and grows very slow due to low temperatures. Weeds can cause 40-45 % reduction in Rabi/winter maize yields.

Major weeds in maize : The common weeds of Rabi maize are mostly broad leaveseg. *Chenopodium album*, *Melilotus*, *Anagalis*, *Rumex*, *Fumeria*,*Vicea*, *Lathyrus*, *Circium*, *Solanum*, *Physalis*, and *Convolvulus*. Grassy weeds such as *Avenaludoviciana*, *Polypogonmonspeleinsis* and *Cynodondactylon* are less competitive. Nevertheless, sedges such as *Cyperusrotundus* can create a serious problem in the eastern IGP.

Weed management practices in maize : *Cyperus rotundus*, one of the noxious weed can be controlled easily by adopting stale bed technique and zero tillage on flat or on permanent beds. Allow the *C. rotundus* to grow and apply tank mixture of Glyphosate 1 kg ai/ha with 250 g ai of 2,4-D ethyl ester at 7 to 10 days before planting.This combination is found to be very effective in controlling *C. rotundus* and *C. dactylon* throughout the year (Rana *et al*. 1998). Tembotrione 125-150 g/ha with surfactant(20 DAS) found effective against broadleaves weeds.Atrazine @ 1 kg a.i./ha can control most grassy and broadleaf weeds, however, it is weak on weeds like *Bracheria*, *Cynodon* and *Cyperusrotundus*. Acetachlor @1.5-2.0 kg/ha + safener using as preemergence.By application of Halosulfuran + Atrazine (90g + 500 g/ha) as post-emergence can control *cyperusrotundus* and broad leaves effectively. Tank mix application of atrazine + pendimethalin (500 g ai. each/ha) or alachlor + atrazine (1250 g + 375g a.i./ha) has been found effective in controlling complex annual weeds in maize(Walia *et al*. 2007). Intercropping of potato or pea as cover crop (1:1 or 2:1) in rabi maize has also been found effective in controlling complex weed flora.

Pulses crop in rice based cropping systems : Rabi legumes such as lentil and chickpea offer a huge opportunity for farmers to reduce 'rice fallows' after rainfed rice crop in low lying eastern-IGP. It is observed that many of these grain legume crops are heavily infested with pod borer which is best controlled by a spray of 'Spinosad 45% SC' at initiation of flowering.

Major weeds in Rabipulses : The Rabi legumes after rice in eastern IGP are mainly affected by a variety of weeds and this leads to lower productivity. Being slow growing and short stature crops, chickpea and lentil are affected by a variety of grasses and broad leaf weeds. *Vicia sativa*, *viciahirsuta*, *Chenopodiumalbum*, *Melilotus*, *Anagalis*, *Argemone mexicana*, *Fumeria*, *Lathyrus*, *Circium*, and *Convolvulus* are common broad leaf weeds in rabi season legumes in eastern IGP region.

Weed management in pulses

A. Cultural : Lentils, Peas (130 days) and Chickpea (140-150 days) are long duration crops however, critical stage for weed competition in these crops varies from 15 to 50 days after sowing. Therefore, weed management at initial crop growth stages are important in these rabi legumes.Farmers normally go for hand weeding by contractual labourers or sometimes prefer intercropping with mustard or wheat. In Tal lands, sometimes they also practice mix cropping with Lathyrus as a cover crop which is taken out as fodder. Surface seeding in standing rice crop is also effective practice in Tal lands for minimizing crop weed completion inrabi legumes. However, this traditional technology needs refinement with respect to cultivar choice and nutrient management (P and S) apart from mechanization for threshing riceimmediately after harvesting. Mechanized rice harvesting is important because farmers generally practice field drying after emergence of surface seeded legumes which causes seedling mortality due to high humidity under rice mulch.

B. Chemical weed control : In rabi legumes pre-emergence application of herbicides such as pendimethalin or alachlore at 1 kg a.i./ha and oxyfluorfen at 0.10-0.15 kg/haat 2-3 days after sowing can help in managing the complex weed flora. However, herbicides like clodinofop at 60 g a.i./ha, fenoxaprop 60-80 g a.i./ha or quizalofop at 50 g a.i./ha or Quizalofop-ethyl 30g + chlorimuron 4 g/ha can be used effectively for control of grassy& broad leaf weeds weeds. Imazethapyr 40 g a.i/ha applied at 10 to 15 DAS were the most effective forcontrolling weeds in pulses.Herbicides used correctly help farmers to produce higher yield at less cost. It maybe noted that some of the herbicides are toxic and can cause health hazards to human and live-stocks. Therefore, care should be taken while storing or using herbicides. Read the label carefully before use and always wear protective clothing while using herbicides. Also, use correct doses and clean water for making spray solutions. Best results of herbicides are obtainedwhen weeds are in active growth stages.If weeds are under stress, apply a lightirrigation before spraying. In noon, spraydroplets dry out immediately resulting inpoor

absorption and translocation of thechemical molecules, thereby significantlyreducing its efficacy.Integrated weed management is the best approach forcombating weed problems.

Herbicide can be used at low rates and can be integrated withhand weeding or other methods of control weeds. In pulses cultural practices like crop rotation, dates of sowing, planting patterns, seed rates, methods of fertilizer application,etc. can be integrated with chemical or hand weedingmethods if needed.

Weed management in Oilseed crops : Rapeseed-mustard is an important group of edible oilseed crops in India. Technological advancement in rapeseed-mustard production has resulted in increased productivity. But many biotic stresses such as weeds cause severe yield losses up to 45% in rapeseed-mustard. They reduce crop productivity and quality by competing with crop plants for available nutrients, water, land and light resources and also influence the agro-ecosystem. A variety of weeds affects these crops but the extent of damage in terms of yield and resources is location specific. Many of the weeds are specific to crop and/ or location, *Orobancheaegytptica* is becoming great menace in rainfed areas of India, whereas, *Chenopodium*, *Asphodelus*, *Melilotus* and *Trianthema spp*. cause serious yield losses in other areas. The weed management in oilseed is done by both cultural and herbicidal approaches. Economic analysis revealed that fluchloralin and pendimethalin alone or in combination with hand weeding at 30 days after sowing was the most economical.

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