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Different weeds and their management system in Direct Seeded Rice

Vikas Yadav*[1], Syed Danish Yaseen Naqvi[1], Akanksha Singh[1], Manjri[1] and Yadvendra Pal Singh[1]
[1]Department of Agriculture, Mangalayatan University, Aligarh, UP
*E-mail of Corresponding Author**:** vikas.yadav@mangalayatan.edu.in

ABSTRACT
Rice (Oryza sativa), the staple food of more than half of the population of the world, is an important target to provide food security and livelihoods for millions. Direct seeded rice (DSR) has emerged as an economically viable alternative to puddle transplanted rice to address emerging constraints of labor and water scarcity and the rising cost of cultivation. It is refers to the process of establishing the crop from seeds sown in the field rather than by transplanting seedling from the nursery. However, adoption of direct seeded rice is seriously constrained by weed management trade-off. Therefore, the availability of effective weed management options is critical for the successful adoption of direct seeded rice in India. Weed spectrum and degree of infestation in rice field are often determined by rice ecosystems and establishment methods. Integrated weed management for such type of weed like Echinochloa spp., Leptochloa spp., Cyanotis spp., Commelina sp., Digitaria spp. and Alternanthera sp. approach based on the critical period of crop weed competition, involving different direct and indirect control measures, has been developed and widely adopted by farmers to overcome weed problem in direct seeded rice. Weed competitive and allelopathic rice varieties, seed priming for increased weed competitiveness, higher seeding density should be considered as a weed management strategy for limiting of weed and improving crop yield.
Keywords: *Directseeded rice, Major weed flora and Weed management.*

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INTRODUCTION

In India agriculture research started with the establishment of Imperial agriculture research institute now (now called Indian agriculture research institute)at Pusa in Darbhanga district of Bihar in 1905.Central Rice Research Institute, Cuttack Odisha is mandated to conduct research on basic and applied aspects of rice crop, develop appropriate technologies and their dissemination to increase the production and productivity of rice.

Rice (*Oryza sativa* L.) is belong to Poaceae family and it is the major food commodity formore than 60% world's population hence called as "Global Grain", plays a significant role in the economic and social stability of the world. India contributes about 20% of total global rice production [13],hence, the stability of rice production in India would play a key role in the global food security. In India, rice occupied 39.16 million hectares area with a production of 85.59 million ton and average yield 2.2 tonnes per hectare [1].Rice is cultivated in 44.0 million hectare area of India of which eastern India comprising Assam, West Bengal, Odisha, Bihar, Eastern UP, Jharkhand and Chhattisgarh accounts for 27.0 million hectare. Among various biotic stress such as weeds inhibit rice production, particularly in direct-seeded rice (DSR) under aerobic condition. Rice yield losses can grow up to 50-60 per cent in puddled transplanted rice while 70-80per cent in DSR under weedy condition.

RICE PRODUCTION SYSTEM WITH ITS CONSTRAINTS

Cultivation of rice is done in several ecosystems range from shifting cultivation in undulating slopping hill top in freshly cleared, but undisturbed soil to the permanent agriculture system with wide range of agro-climatic conditions *viz.* deep water condition, with many intermediate system involving topography i.e. upland, medium land and low land, water system, inland valley swamps, marshes, valley bottoms with continuous flow of water, water-logged, tidal swamps, floods, controlled water (supply through canals, tube wells, open wells, pond irrigation etc.),seeding method (direct seeding in dry fields andwet fields, transplanting in un-puddled and puddled fields), soil texture (sandy to heavy clay soil with varying degree of water retention, infiltration, permeability and hydraulic conductivity with or without good

water stable system) and cropping systems (single season rice- fallow to continuously cultivated rice-based multiple cropping with 300% to 500% cropping intensity ranging from short duration pulses, oilseeds, root and tuber crops, vegetables, cereals and long duration commercial crops [22].Although, [20] has classify rice land ecosystems into four types. Although, [12] has estimated as irrigated(56.9%), rainfed lowland(30.9%), upland(9.4%) and deep water(2.8%)rice area in whole world. In Asia, 58.6% of rice growing area is under irrigated, 32.1% under rainfed lowland, 6.7% under upland and 2.6% under deep water cultivation. Although, Transplanting after puddling of rice field (a process where soil is compacted to reduce water seepage) has been a major traditional method of rice establishment.

Rice production with transplanting method has been limited by a number of factors i.e. insufficiency of water, high input costs, shortage of skilled labor and low plant population. To eliminate this problem, direct seeding of rice (DSR) seems only feasible alternatives in rescuing farmers. Loss of rice yield due to unlimited growth of weed population which is least in transplanted rice (12%) but otherwise large (85%) where rice had been sown to dry cultivated lands or to puddle soil, upswing to 98% in direct-seeded rice sown without soil tillage.

DIRECT-SEEDED RICE (DSR) SCENARIO IN INDIA

Direct-seeded rice **is** the process by which the crop is established from seeds sown in the field instead of transplanting seedlings from the nursery [15]. DSR avoids three basic operations, namely, puddling, transplanting and maintenance of standing water. Besides, there are three principal methods of establishment of direct-seeded rice *viz*. dry seeding (sowing dry seeds into dry soil), wet seeding (sowing pre-germinated seeds on wet puddle soils) and water seeding (seeds sown into standing water). Wet-DSR is primarily conducted under labour shortage condition and it is currently practiced in Malaysia, Thailand, Vietnam, Philippines, and Sri Lanka [23] and [34].

In India, dry-seeded rice is broadly practiced in the northwest Indo-Gangetic Plains because dry-seeded rice in this region provides the highest opportunity to achieve optimal plant density and high water and labour efficiency [10].

In addition to higher economic yields, DSR crops are faster and easier to plant, having shorter duration, require less labour intensive and consume less water [6], conducive to mechanization have less methane emissions [33] and thus offer an opportunity for farmers to earn from carbon credits than TPR system [5].The risk of greater crop yield losses due to weed competition in direct-seeded rice systems than in transplanted rice is mainly because of the absence of the seedling size differential between rice and weeds and the absence of the suppressive effect of standing water on weed emergence and growth at crop emergence time.[31] as reported that seasonal long weed competition in direct-seeded rice may cause yield reduction more than 80%. However, we interpret some of the present approaches and possible future strategies to control weeds in direct-seeded rice cropping systems.

Major weed flora and their ecosystem in direct-seeded rice:

Direct-seeding of rice, instead of transplanting rice crop, offers opportunities for water savings but at the expense of the absence of the suppressive effect of standing water on the growth of weed. Direct-seeding of the rice crop faces serious weed infestation which is one of the major biotic constraints in rice production. Hence, effective weed management is crucial for cultivation of direct-seeded rice. We are trying to addressing the problem of weeds from two fundamental perspectives: weed control and weed management. Control approach only emphasizes on reduction of weed pressure while, the management perspective focuses on keeping weed infestation at a level compatible with environmentally and economically sustainable production. Consequently, knowledge of the behavior of weed species in a specific region *viz.* time of weeds germination, emergence of first vegetative organ and fruiting period in weed plant *etc.* is critical in weed management. In the present scenario, weed management strategies should focus on preventing the build-up of a weed seed bank; however, knowing under what conditions is require to weed seeds germinate and grow may help farmers improve their weed management strategies. The most important survival mechanisms of weeds are seed dormancy and germination. Therefore, weeds can be controlled by attain appropriate knowledge about the requirement for the promoting germination of weeds at a time when seedlings can be easily destroy or by providing an environment that induces very low germination [8]. Various types of weeds are widespread in rice field, divided into aquatic, semi-aquatic and terrestrial weeds, which are cultivated under various agricultural climatic conditions, cultivation sequences and irrigation systems. Nearly 350 species have been reported as rice weeds, of which the grasses are classified as the first serious problem, followed by sedges and broad-leaf weeds, causing significant losses to rice production worldwide. The maximum number of weeds related to DSR in India has been noted in Table.

Table: Weed species in direct-seeded rice.

Common Name	Scientific Name	Family
Wild rice	*Echinochloa colona*	Poaceae
Barnyard grass	*Echinochloa crus-galli*	Poaceae
Goosegrass	*Eleusine indica*	Poaceae
Large crab grass	*Digitaria sanguinalis*	Poaceae
Signal grass	*Brachiaria ramosa*	Poaceae
Bermuda grass	*Cynodon dactylon*	Poaceae
Khaki weed	*Alternanthera sessilis*	Amarathaceae
Redstem	*Ammania baccifera*	Asteraceae
Dayflower	*Commelina communis*	Commelinaceae
Digera kondra	*Digera arvensis*	Amarathaceae
Quail grass	*Celosia argentia*	Amarathance
Globefingerush	*Fimbristylis miliacea*	Cyperaceae
Small flower	*Cyperus difformis*	Cyperaceae
Flat sedge	*C. iria*	Cyperaceae

Weed strength depends on the main establishment method, cultivation method, crop rotation, water and soil management, location, weed control measures, climatic conditions, and local weed flora in the rice field. *Echinochloacolona* and *E. crusgalli* are the most grievous weeds in DSR. *E.colona* abundant in DSR because it requires less water. The other most important weeds of direct-seeded rice system are*Paspalum* spp., *Ischaemum rugosum*, *Leptochloa chinensis*, *Digitaria sanguinalis*, *Dactyloct-enium aegyptium*, C*ommelina* spp., *Caesulia axillaris,Cyperus iria*, *Fimbristylis miliacea* and *Cyperusdifformis.*

Yield reduction due to adverse effect of weeds in direct-seeded rice:

The reduction in yield due to weeds is more important for directly sown rice than for transplanted rice [19]. In direct-seeded rice, weeds adversely affect yield, quality and cost of production due to competition for various growth factors. The degree of loss depends on the cultivation method, rice varieties, rice ecosystem, weed species relevance, their density and the duration of competition. Loss of rice crop due to weeds and competition with crops for growth factors i.e. Nutrients, soil moisture, light, space, etc. [32]. Globally, actual yield losses due to pests have been estimated approximately 40%, of which weeds caused the highest loss (32%) [24].[4] estimated that the yield loss caused by grasses (mainly *E. crus-galli*), broad-leaved weeds and sedges was 41, 28 and 10%, respectively. Season-long weed competition in direct- seeded aerobic rice may cause yield reduction up to 80% [31]. In extreme cases, weed infestation may cause complete failure of aerobic rice [18]. Thus direct-seeded aerobic rice is highly vulnerable to weeds compared with other rice ecosystems [3].

Weed management:

A single weed management practice may not be able to keep weeds below the threshold level of economic damage. Forasmuch different weed management options available for rice are described below. Many researchers studying on weed management in direct-seeded rice believe that herbicides can be seen as a viable alternative to manual weeding [9] and[2].Some of the other strategies in which cultural weed control through adoption of different agronomic practices including tillage[24], competitive cultivar [35], seeding density [3], water[7], seed invigoration [16], mulching [27]. These agricultural tools help make crops more competitive against weeds while being environmentally friendly and economical, especially in aerobic soil conditions where weed pressure is very high. It may not provide acceptable levels of weed control. Therefore, the weed community is very sensitive to management practices and it is important to employ a variety of techniques for weed control. In addition, farmers are now increasingly interested in more comprehensive weed control strategies to reduce their dependence on herbicides. [7].

Seeding clean rice seeds is probably the most important weed control technique in DSR, as weed-contaminated rice seeds are a major cause of weed spread in DSR. To prevent weeds from invading the seeds of the main crop, the machines used for cultivation, sowing, harvesting and threshing also need to be cleaned before moving from one field to another.

Cultural control

Cultural approaches is eco-friendly but tedious and labor-intensive, and it play significant role to determine the competitiveness of a crop with weeds for above ground and below ground resources and hence might influence weed management [17].Primary tillage can reduce the population of annual weeds, especially if sowing is delayed, emergence of weed seeds appear before the final tillage.

Brown manuring practice involves seeding of rice together *Sesbania* crops and killing the *Sesbania* crop 25-30 days after sowing (DAS) by application of 2,4D @ 0.40-0.50 kg/ha. This will also help in meeting early nitrogen requirement of the crops and avoid early nitrogen and moisture stress [11]. Appropriate fertilization in DSR reduces weed competition and should be applied according to crop requirements.

Crop rotation can be used to minimize crop loss due to weeds by breaking the cycles of weeds and is the most effective of all weed control methods. In addition, intensive cropping patterns can increase the competitiveness of crops, thereby reducing weed pressure. Rice and wheat are the main cropping pattern in northern India. However, it is possible to diversify this cropping pattern, especially using techniques such as direct-seeded rice and growing ofzero tilled wheat to allow an extra month between rice and wheat crops.

Physical control

Physical control can be manual or mechanical and is an eco-friendly weed controlling measures. Mechanical weeding i.e. harrowing has been shown to be effective for direct-seeded rice. Especially if the rice crop is larger than weeds to escape damage [25]However, the morphological similarities between grass weeds and rice seedlings make manual weeding difficult in the early growth stage of rice crops. In addition, manual weeding is very acceptable and environmental friendly, but boring and labor intensive. Therefore, it is not an economically viable option for poor farmers. It is estimated that 150-200 workers are required per day to eliminate rice weeds [26].

Biological control

Biological weed control using myco-herbicides is currently being investigated to reduce dependence on herbicides. The most promising fungi for biological control of barnyardgrass are *Exserohilum monocerus* and *Cocholiobolus lunatas*. *Setosphaeria* sp. *C. rostrata* were also found to effectively control *Leptochloachinensis* without harming rice plant. However, this is an interesting area of research where efforts can be made to developbiological control strategy that are compatible with other methods.

Chemical control

Chemical control is the most effective, economical and practical way to control weeds [2]. Under these circumstances, herbicides have made a significant contribution to agriculture. Despite some unwanted side effects, there are currently no viable alternatives available to change the chemical dependence of rice weed control. Applying penoxsulam @ 20, 22.5 and 25 g/ha provides better control over the density of grasses and broad-leaf weeds in DSR [29]. [28]Found that the effective control over the density of*C. rotundus* with the using of azimsulfuron +MSMetsulfuron-methyl. Lowest population of *E.colona* was recorded with application of pendimethalin @ 2.0 kg while of *C. axillaris* was with combined application of bentazone with pendamethalin [30]. Other herbicides known to be effective in DSR arepyrazosulfuron and oxadiragyl as pre-emergence andazimsulfuron, penoxsulam, cyhalopfop-butyl andethoxysulfuron as post-emergence [24].

Integrated weed management (IWM)

Various weed management practices were described in the previous section. However, because some weeds have different growing habits, applying individual management techniques cannot provide effective and sustainable weed control. Therefore, effective and sustainable weed management involves the combination of preventative, cultural, mechanical, chemical and biological weed control techniques in effective and economical ways. By integrating more seed rate and spring fertilizers and limiting the use of herbicides, weeds were effectively controlled and high yields were ensured[7]. The adoption of the IWM approach to sustainable rice production has been advocated by many researchers [18].

The efficiency and competitiveness of the herbicides used can be improved by integrating improved agricultural practices, optimal fertilization and water management, and incorporation of crop residues into the soil [10]. [27]Recorded that the sequential application of pre-emergence herbicide such as pendimethalin in dry seeded-rice, or early post-emergence application of anilophos / thiobencarb to control annual grasses in wet-seeded rice. Follow upapplication of 2,4-D and Almix (a ready mixture ofchlorimuron-methyl and metsulfuron-methyl) as post-emergence over preemergence application of pendimethalin in DSR provided effective control ofannual grasses, broad-leaf weeds and annual sedges.

CONCLUSION

Direct-seeded rice with good conservation practices can yield slightly lower or comparable yields than transplanted rice and appears to be a viable alternative to problem of labour and water scarcity issues. Weeds are a major obstacle to direct-seeded rice cultivation.In order to achieve influential long-term and sustainable weed control results in direct-seeded rice systems, there is a need to integrate different weed management practices such as high-yielding varieties for a reasonable period of time, appropriate agricultural practices i.e. row spacing, seed rate, manual or Mechanical weeding, and proper application of the herbicide mixture by proper timing and repetition.

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