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Weed Management in Dry Direct-sown Rice

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Introduction

Weeds are major biotic constraints in most rice growing areas of the world, causing about 33% of yield loss. Problems associated with weeds in rice are mounting due to changes in establishment methods in response to the declining availability of labour and water. Direct sowing of rice reduces labour and irrigation water requirements. There are 3 methods of direct-sown rice (DSR) i.e., dry seeding (sowing dry seeds in to dry soil), wet seeding (sowing of pre-germinated/sprouted seeds on wet puddled soils) and water seeding (seeds sown in to standing water). However, high weed infestation is a major constraint for adoption of DSR, as emerging seedlings in direct-sown fields are less competitive with concurrently emerged weeds and the initial flush of weeds cannot be controlled by maintaining water immediately after seeding. In DSR, atleast 2-3 manual weeding by engaging more than 100-150 person days per hectare is required to keep the weed population below the threshold level. Therefore, herbicide-based weed control or combination of herbicide and machine/weeder are considered as alternative to manual-weeding and most economical way to manage weeds.

This bulletin presents the strategies for effective and economical way of controlling weeds in dry DSR fields.

Major weeds in dry direct-sown rice

Grassy weeds and sedges emerge first and are prevalent in alluvial/sandy loam to clay loam soil; while few grassy weeds along with sedges and broad-leaved weeds are prevalent in lateritic soil, mostly in uplands. Major grassy weeds viz., Jungle rice (*Echinochloa colona*), Barnyard grass (*Echinochloa crus-galli*), Cockspur grass (*Echinochloa glabrescens*), Chinese sprangletop (*Leptochloa chinensis*), Crowfoot grass (*Dactyloctenium aegyptium*), Large crab grass (*Digitaria sanguinalis*), Torpedo grass (*Panicum repens*), weedy rice (*Oryza sativa* f. *spontanea*), etc. are the most competitive weed-flora that emerges early and grows simultaneously with the rice crop for a considerable time period depending on soil saturation/moisture condition.

Sedges viz., purple nut sedge (*Cyperus rotundus*), small flower umbrella sedge (*Cyperus difformis*), rice flat sedge (*Cyperus iria*), forked fringerush (*Fimbristylis mileacea*); bulrush (*Schoenoplectus articulatus*) etc. and broad-leaved weeds viz., sessile joyweed (*Alternanthera sessilis*), goat weed (*Ageratum conyzoides*), willow primrose (*Ludwigia octovalvis*), goose weed (*Sphenoclea zeylanica*), wild mustard (*Cleome viscosa*), etc. emerge subsequently at later stages of crop growth. Sometimes several flushes of weeds come up as seeds present in soil germinate as and when conditions are favorable. Aquatic weeds emerge when sufficient water accumulates in lowland direct-sown rice fields.



Echinochloa colona



Cyperus difformis



Sphenoclea zeylanica

*Leptochloa chinensis**Fimbristylis mileacea**Ludwigia octovalvis*

An integrated approach involving preventive measures along with adoption of improved crop management practices with direct control measures viz., herbicide-based weed control or integration of herbicide and mechanical/manual weed control not only reduce the weed thrust in DSR but also bring about substantial yield improvement.

A. Preventive measures

- ❖ Use certified seeds or clean seed from a known source free from admixture of weed seeds
- ❖ Avoid application of un-decomposed organic manures as it contains viable weed seeds
- ❖ Cleaning seeds by dipping in 2% brine solution (salt solution) helps in selection of high-density seeds and separation of floating weed seeds
- ❖ Clean all the implements and machinery properly after their use in infested areas and before using in new areas.
- ❖ Off-season ploughing after rice harvest reduces weed seed replenishment
- ❖ Deep summer ploughing once in three years not only exposes the vegetative propagules of certain weeds but also buries the weed seeds at a depth that prevents germination.

B. Improved management practices

- ❖ Plough the field by rotavator or cultivator to get a fine tilth.
- ❖ Remove the weeds and crop stubbles before proper leveling for uniform germination and crop stand.
- ❖ In heavily infested areas, adopt stale seed bed technique.
- ❖ Sow either by seed drill or behind plough in rows 20 cm apart with seed rate of 35-40 kg ha⁻¹ to ensure better crop stand and canopy coverage, thereby reduces weed growth. In case of mechanical weed control by power weeder, sowing should be done in rows 25 cm apart.

- ❖ Avoid basal N application as it stimulates weed growth. Apply the recommended N fertilizer in 3-4 equal splits depending upon the duration starting from 15-20 days after emergence (DAE), and rest at 15-20 days interval i.e., 35-40 and 55-60 days after sowing.

C. Recommended direct control measures

- ❖ Pre-emergence application of pendimethalin 3 DAE followed by mechanical weed control using finger weeder at 25-30 DAE is found useful in rainfed uplands. However, weeder can be used only in the line-sown crop and enough moisture should be available in soil during operation.
- ❖ Spray bispyribac sodium (30 g ha^{-1}) at 8-10 DAE (2-3 leaf stage of weeds) to suppress early emergent grassy weeds and sedges. Sometimes, efficacy of herbicides is reduced because of the continuous rain or dry spell following their application. If there is new flashes of grassy weeds, spray fenoxaprop-p-ethyl (60 g ha^{-1}) at 25-28 DAE (3-4 leaf stage of weeds).
- ❖ In shallow lowland or irrigated areas, tank-mix application of fenoxaprop-p-ethyl + ethoxysulfuron ($50+15 \text{ g ha}^{-1}$) at 15-18 DAE (2-4 leaf stage of weeds) is found effective against mixed population of grassy weeds, sedges and broadleaved weeds.
- ❖ Integration of chemical weed control by spraying bispyribac sodium at early stage followed by mechanical weed control by operating power weeder at 30 DAE is also found very effective in lowlands/irrigated areas. Under this management option, crop should be established at 25 cm apart rows. The mechanical weeder also increases soil aeration and consequently tiller production.
- ❖ Manually-operated cono-weeder or push type rotary weeder can also be operated at late stage (30-35 DAE) with 3-5 cm depth of water. However, power weeder is found more effective and also it needs less time for operation and reduces drudgery than manual weeder.



Post emergent herbicides application stage



Mechanical weed control by power weeder

Protocol for application of herbicides

1. Apply post-emergent herbicides on moist soil at 2-5 leaf stage of weeds based on the recommendation.
2. Ensure selection of correct herbicide suited for the type and stage of weeds to be controlled, as new generation herbicides are often weed-specific.
3. Always read and follow the instructions cited on the product label to understand the toxicity and safety measures.
4. Use clean, fresh and recommended rate/dilution of water
5. Ensure field conditions are suitable for application. Spray on saturated soil with thin film of water only on sunny days. Avoid irrigation for next 24 hours.
6. Use knapsack sprayer with flat fan nozzle with spray volume of 300 L ha⁻¹. Ensure nozzles are functioning and providing uniform output.
7. Do not use cone type nozzle for herbicide spraying. Use multiple-nozzle boom fitted with flat-fan nozzle.
8. Apply granular herbicides by mixing with little wet sand at 10-12 kg ha⁻¹.
9. Identify the type of weeds and extent of damage and chose the recommended herbicide accordingly.
10. Fill the tank half with water; add herbicide before complete filling of the tank. Add surfactant for enhancing efficacy and stir well for proper mixing before spray.
11. Spray immediately after mixing. Apply uniformly across the field. Maintain steady pressure, steady walking speed and uniform application rate with swath overlap.
12. Set spraying speed and nozzle swath by adjusting the spray height and nozzle spacing.
13. Spray from a height of around 50 cm above the target weeds. Spray perpendicular to the wind, so that product is blown away from the applicator.
14. Avoid application during strong winds and rainy/cloudy day.
15. Check the spraying equipment and accessories before spraying, mainly the nozzle, in case of repeated spray within a day.
16. Reduce drift loss by minimizing application in non-target areas.
17. Rotate the herbicides based on recommendation to reduce chances of developing herbicide resistance.



Safety measures during herbicide application

1. Apply herbicides only at a recommended dose and do not mix herbicides unless recommended.
2. Use appropriate cover for head, eyes, nose, mouth and hands. Wear long sleeved shirts and pants with covered footwear.
3. Always clean the blocked nozzles by non-abrasive implement. Never clean nozzles by blowing on them with the mouth.
4. Wear protective clothing during mixing the product, especially face protection.
5. Never eat, drink, or smoke while applying herbicides. Avoid spilling spray materials on skin or clothing. If such an accident occurs, wash immediately with soap and water.
6. Wash the sprayer machine properly before and after each application.
7. Bathe after applying herbicides and change into freshly laundered clothing.
8. Wash contaminated clothes separately from other household clothes.
9. Unused herbicides in the spray tank should be disposed at safe place either in pits or in the waste land.
10. Destroy the herbicide bottles/container after use.

Calculation of application dose from commercial product/herbicide

The dose of commercial formulation of the herbicide required for application on field can be calculated by the following formula:

$$\text{Application dose} = \frac{\text{Recommended dose} \times \text{Area} \times 100}{\text{Active ingredient (as mentioned in label)}}$$

Example:

Herbicide A

Active ingredient = 10%; Recommended dose = 30 g a.i. ha⁻¹, Area = 2 ha

Application dose = (30 × 2 × 100)/10 = 600 g

Recommended herbicides for dry direct-sown rice

The selection of herbicide depends on the type and stage of crops and weed status in field. For weed management in rice, a number of herbicides and ready mix/ or tank mix combinations of herbicides are recommended and those are available in the market. The details are cited below

Sl. No.	Name	Target weeds	Time of Application	Dose (g a.i. ha ⁻¹)
1.	Bispyribac Sodium (Nominee gold)	Early emergent grassy weeds and few sedges	8-10 days after sowing (DAS) / OR at 2-3 leaf stage of weeds	30
2.	Fenoxaprop-p-ethyl (Rice star)	Late emergent grassy weeds	18-20 DAS / OR at 3-5 leaf stage of weeds	60
3.	Cyhalofop-butyl (Clincher)	Grassy weeds	12-15 DAS / OR 2-4 leaf stage of weeds	100
3.	Ethoxysulfuron (Sunrise)	Sedges and broadleaved weeds	15 DAS / OR at 2-4 leaf stage of weeds	20
5.	Fenoxaprop-p-ethyl + Ethoxysulfuron (Tank-mix)	Mixed weed population	15-20 DAS / OR 3-4 leaf stage of weeds	50 + 15

Conclusion

For successful control of weeds, it is essential for the farmers for correct identification of key weeds because the new generation herbicides are highly selective. It is also important to know different types of herbicides, specific herbicides to control different types of weed species, their doses and time of application, and safe handling and accurate application technologies for effective and environmentally safe weed control. Correct use of herbicides is also essential to ensure that chemical residues on crops do not exceed the limits. Recommended herbicides do not generally injure people, livestock, or rice crops if used properly and if recommended precautions are followed. However, the herbicides are potentially dangerous if improperly handled or used. Most of the herbicides are available in liquid form and the chemical is mixed with water. However, very few granular formulations are also available and these are generally applied in rice field as sand-mix. For best weed control, instructions are given in the package that should be carefully read and followed the label which states the rate/doses, adjuvant, combinations and other requirements of the product. In case of mechanical weed control, it is very much essential to establish the crop at proper row spacing and also to use machine at proper crop growth stage. Adequate (3-5 cm) standing water is required in the field for successful operations of machines.



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