

Herbicides for pocket friendly

weed control in rice

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Weeds are a major biotic constraint to rice production in most rice growing areas of the world, causing about 33% of total yield losses. Changes in rice establishment methods with direct seeding being practiced increasingly to reduce dependence on labour and cultivation cost has further aggravated the problems associated with weeds in rice. A mixed population of grassy weeds, sedges as well as broad-leaved and aquatic weeds is dominating rice fields depending on prevailing agro-climatic conditions, soil types, water management, crop establishment practices, weed seed bank in soil and cropping system adopted in different rice ecologies. Manual weeding 2-3 times in a season is a costly deal. Mechanical weed control by using machines or chemical weed control by using herbicides are alternate options. Machine-based weed control is possible only when crop is established in rows at proper spacing. However, herbicide-based weed control using safest low dose new generation herbicides/ or herbicide mixtures is best alternative and most economical way to manage weeds in rice fields.

Keywords: Economical, Herbicide, Rice, Weed

PRE-EMERGENCE herbicides like butachlor, pretilachlor, pendimethalin, oxadiazon, anilofos, oxadiargyl etc. are recommended to control of early flashes of weeds in direct-sown rice fields. However, these herbicides suffer from several limitations. They are narrow spectrum and have differential effects on weeds. Their efficacy depends on soil moisture as adequate soil moisture is necessary to activate them before and after application, and are ineffective in dry soil conditions. Soil saturation (wet top 2 cm layer) is important to reduce degradation and volatilization. On light soils, heavy rains may move these herbicide down in the soil to the germinating crop seeds and cause severe injury. Many pre-emergent herbicides also show severe phyto-toxic effects to rice crop emergence causing 50-90% mortality when heavy rain occurs immediately after herbicide application. Subsequent flashes of weed that appear 3-4 weeks after rice establishment, can't be controlled by

early application of herbicide. The application rate of pre-emergent herbicides is very high and most of them show detrimental effect not only to rice crop but also to the beneficial microorganisms in soil. The flowering time and total duration of rice crop extends up to 2 weeks due to application of pre-emergence herbicides.

Post-emergent herbicides

New post-emergent herbicides with low dosages (bispyribac sodium, cyhalofop butyl, fenoxaprop-p ethyl, ethoxysulfuron, penoxulam, azimsulfuron, flucetosulfuron etc.) and herbicide mixtures (azimsulfuron + bispyribac sodium, fenoxaprop-p ethyl + ethoxysulfuron, bensulfuron methyl + pretilachlor, cyhalofop butyl + penoxulam, metsulfuron methyl + chlormuron ethyl etc.) have shown promise for controlling weeds in rice fields. The rate and time of application of these new generation herbicides/ herbicide mixtures are standardized in such a way that it

may keep the weeds under control during first 5-6 weeks of rice crop establishment. These low-dosage high-efficacy post-emergent herbicides/herbicide mixtures having broad spectrum of weed control are expected to suppress the weeds during critical period of crop-weed competition up to 35-40 days of weed emergence.

However, for successful control of weeds by herbicides, correct identification of key weeds is very much essential for the users because these 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 handled or used improperly.

Most of the herbicides are available in liquid form and the chemical is mixed with water. Very few granular formulations are also available and these are generally applied in rice field as sand-mix. For best weed control, instructions given in the package should be carefully read and followed (Label states the rate/doses, adjuvant, combinations and other requirements of the product).

Combitorial/Sequential application of herbicides

Correct information about weed flora and mode of application of herbicides is needed to use them safely and efficiently. Proper selection of herbicides either alone, in combination or in sequence provides adequate weed control. Herbicide rotation especially the sulfonyl urea herbicide not only helps for controlling the weeds effectively in rice fields but also reduces the chance of weed flora shift and herbicide resistance. By combining/mixing and matching the herbicides, a complete spectrum of weed control is possible. Tank mix combinations or ready-mix product can reduce the cost of application further and often reduce the doses of one or more herbicides. It also reduces the chance of herbicide resistance. The main purpose of combinations is to broaden the spectrum of weed control so that each herbicide in the mix can control the weeds missed by its partner. It is always important to follow the label of each herbicide with regard to tank mixes.

Sequential application of herbicides is another option to achieve broad-spectrum weed control, particularly in direct-sown rice fields where weeds come up in several flashes during critical period of crop-weed competition. The most important aspect of sequential application is to protect against the buildup of weed resistance by using herbicides of different modes of action. For example, sequential

Advantages of herbicide use

- Require less labour (1 person-day per hectare per application)
- Very cost-effective, if proper schedule of application is followed
- Easy to keep weed emergence suppressed at critical period and no need to wait for weeds to grow up as in the case of manual weeding
- It can distinguish between rice plants and weeds, even at early stages when it is difficult for farmers to differentiate particularly with grasses
- Ensures weed control at early/ critical stages of crop-weed competition thus minimizes yield penalty

application of bispyribac sodium followed by fenoxaprop-p-ethyl shows effective control of both the early and late emergent weeds besides the left over grassy weeds in direct-sown rice fields.

Protocol for application of herbicides

1. Apply new generation post-emergent herbicides on moist soil at 2-5 leaf stage of weeds based on the type of weeds and crop stages.
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. Use clean, fresh and recommended rate (300 l/ha) of water for spraying.
4. 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.
5. Use knapsack sprayer with flat fan nozzle with spray volume of 300 l/ha. Ensure nozzles are functioning and providing uniform output.
6. Do not use cone type nozzle for herbicide spraying. Use multiple-nozzle boom fitted with flat-fan nozzle.
7. Apply granular herbicides by mixing with little wet sand at 10-12 kg/ha.
8. 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.
9. Spray immediately after mixing. Apply uniformly across the field. Maintain steady pressure, steady walking speed and uniform application rate with swath overlap.
10. 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.

11. Avoid application during strong winds and rainy/cloudy day.
12. Check the spraying equipment and accessories before spraying, mainly the nozzle, in case of repeated spray with in a day.
13. Reduce drift loss by minimizing application in non-target areas.
14. Rotate the herbicides based on recommendation to reduce chances of herbicide resistance.

Safety measures during application

1. Use appropriate cover for head, eyes, nose, mouth and hands. Wear long sleeved shirts and pants with covered footwear.
2. Always clean the blocked nozzles by non-abrasive implement. Never clean nozzles by blowing on them with the mouth.
3. Wear protective clothing during mixing the product, especially face protection.
4. 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.
5. Wash the sprayer machine properly before and after each application.
6. Wash contaminated clothes separately from other household clothes.
7. Unused herbicides in the spray tank should be disposed at safe place either in pits or in the waste land.

Major weed flora prevalent in rice fields

Grassy weeds: Jungle rice (*Echinochloa colona*), Barnyard grass (*Echinochloa crus-galli*), Cockspur

Sl. No.	Name	Target weeds	Time of application	Dose (g a.i./ha)
A. Dry direct-sown rice (Rainfed uplands and lowlands) Grassy weeds and sedges are prevalent in alluvial/sandy loam to clay loam soil; while few grassy weeds along with sedges and broadleaved weeds are prevalent in lateritic soil, mostly in uplands.				
1.	Bispyribac Sodium	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	Late emergent grassy weeds	18-20 DAS / OR at 3-5 leaf stage of weeds	60
3.	Cyhalofop-butyl	Grassy weeds	12-15 DAS / OR 2-4 leaf stage of weeds	100
3.	Ethoxysulfuron	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
6.	Bispyribac Sodium fb Fenoxaprop-p-ethyl	In case of several flashes of grassy weeds	8-10 DAS and 25-30 DAS	30 and 60
B. Wet direct-sown rice (Rainfed shallow lowlands and irrigated) Grassy weeds and sedges are prevalent at early stage; mixed weed population occurs at late vegetative stage; the weed dominance depends on water level in rice fields.				
1.	Bispyribac Sodium	Early emergent grassy weeds and few sedges	10 DAS / OR at 2-3 leaf stage of weeds	30
2.	Bensulfuron methyl + Pretilachlor (Ready-mix)	Mixed population of weeds	7 DAS	60 + 600
3.	Ethoxysulfuron	Sedges and broadleaved weeds	15 DAS / OR at 2-4 leaf stage of weeds	20
4.	Metsulfuron methyl + chlormuron ethyl (Ready-mix)	Sedges and broadleaved weeds	15-18 DAS / OR at 3-4 leaf stage of weeds	4
5.	Fenoxaprop-p-ethyl + Ethoxysulfuron (Tank-mix)	Mixed weed population	15-20 DAS / OR 3-4 leaf stage of weeds	50 + 15
C. Transplanted rice (Rainfed shallow lowlands and irrigated) Mixed weed population occurs with little dominance of grassy weeds and sedges at early vegetative stage; however the dominance depends on water level in rice fields.				
1.	Pyrazosulfuron ethyl	Nursery beds	1-3 DAS	20
2.	Bensulfuron methyl + Pretilachlor	Mixed weed (in shallow lowlands-saturated fields with early emergent of weeds)	7 days after transplanting (DAT)	10 kg/ha
3.	Penoxulam	Broadleaved and aquatic weeds with few sedges	15 DAT OR at 3-4 leaf stage of weeds	25
4.	Penoxulam + Cyhalofop-butyl (Ready-mix)	Mixed weed population	15-20 DAT OR at 3-4 leaf stage of weeds	135

grass (*Echinochloa glabrescents*), Chinese sprangletop (*Leptochloa chinensis*), Crowfoot grass (*Dactyloctenium aegyptium*), Large crab grass (*Digitaria sanguinalis*), Torpedo grass (*Panicum repens*), weedy rice (*Oryza sativa* f. *spontanea*) etc. They emerge early and grow simultaneously with the rice crop for a considerable time depending on soil saturation/moisture condition.

Sedges: Purple nut sedge (*Cyperus rotundus*), Small flower Umbrella sedge (*Cyperus difformis*), Rice flat sedge (*Cyperus iria*), Forked fringerush (*Fimbristylis mileacea*), Bulrush (*Schoenoplectus articulatus*) etc.

Broad-leaved weeds: Sessile joyweed (*Alternanthera sessilis*), Goat weed (*Ageratum conyzoides*), Willow primrose (*Ludwigia octovalvis*), Goose weed (*Sphenoclea zeylanica*), Wild mustard (*Cleome viscosa*), Alligator weed (*Alternanthera philoxeroides*)

Aquatic weeds: Fourleaf clover (*Marsilea quadrifolia*), Oval-leaved

pond weed (*Monochoria vaginalis*), Water lettuce (*Pistia stratiotes*); Tropical spiderwort (*Commelina benghalensis*), Stonewort (*Chara zeylanica*), Duck lettuce (*Otella alismoides*), Arrow head (*Sagittaria sagittifolia*), etc.)

Sedges and broad-leaved weeds 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 favourable. Aquatic weeds emerge when sufficient water accumulates in lowland rice fields.

Recommended herbicides for rice

The selection of herbicide depends on the type and stage of crops and weed status in rice fields. The following recommendations have been made based on the research results carried out at the Institute Farm as well as on-farm trials in farmers' field under different rice environment.

SUMMARY

Herbicides can provide effective and economical control of weeds in rice field. It saves labour cost up to 40% and reduces drudgery. It also plays important role in facilitating the adoption of direct-sown rice (DSR) technology, but over reliance on one type of herbicide or faulty way of application can lead to herbicide resistance development in weeds and adversely affect environment and human health. Herbicides, if not properly applied, may also cause problems of phyto-toxicity. Therefore, correct use of herbicide is essential to ensure that chemical residues on crops do not exceed the limits. Recommended doses of herbicides do not generally injure people, livestock, or crops if used properly following recommended precautions.

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