



POPULAR ARTICLE

Integrated weed management for sustainable pulse production in India

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Intricacies of the subject

Pulses are highly susceptible to weed competition, particularly during the early stages of crop growth, which can cause substantial reductions in growth, yield and resource-use efficiency. Integrated Weed Management (IWM) combines preventive, cultural, mechanical and chemical weed-control methods to achieve effective and sustainable weed suppression. Practices such as clean seed, proper land preparation, optimum plant population, competitive cultivars, timely intercultivation and crop rotation can reduce weed pressure, while judicious use of pre- and post-emergence herbicides provides effective control of diverse weed flora. Integration of these approaches helps delay herbicide resistance, reduces dependence on a single control method, improves nutrient and water-use efficiency, and supports stable pulse production. Thus, IWM offers a practical approach for achieving higher productivity and sustainable weed management in pulse-based cropping systems. Integrated weed management (IWM) combines preventive, cultural, mechanical, chemical and biological methods to keep

weeds below a harmful level while the crop is most sensitive

Introduction

Pulses are the main source of protein for many people in India, and they improve the soil by fixing nitrogen from the air, which suits rainfed, low-input farming. India is the largest producer, consumer and importer of pulses in the world. The main crops are chickpea, pigeonpea (tur), blackgram (urdbean), greengram (mungbean), lentil and field pea. Pulses are important sources of plant protein and contribute to sustainable agriculture through biological nitrogen fixation. However, weed infestation is one of the major constraints to pulse productivity, reducing pulse yields by 30 to 80%. Pulses grow slowly in the first few weeks, have a weak canopy and are mostly grown on poor, rainfed soils, so weeds easily take their nutrients and water, reduce the root nodules that fix nitrogen, and shelter insects and diseases. The yield losses of 30–80% in kharif pulses and 18–80% in rabi and summer pulses under unchecked weed competition. Pulses are particularly sensitive during the early growth period because of their



slow initial growth and poor canopy development. Hand weeding is now costly and often late because labour is scarce, but herbicides are few, especially after the crop comes up, and they can injure the crop, leave residues and lead to resistant weeds. Integrated weed management (IWM) combines preventive, cultural, mechanical, chemical and biological methods to keep weeds below a harmful level while the crop is most sensitive.

Weed flora and critical period

The weed flora of pulses varies with season, soil, climate and management practices. Kharif pulses are commonly infested with grasses and broadleaf weeds such as *Echinochloa*, *Digitaria*, *Dactyloctenium*, *Trianthema* and *Digera*. Rabi pulses are mainly affected by *Chenopodium album*, *Fumaria parviflora*, *Rumex dentatus*, *Anagallis arvensis*, *Phalaris minor* and *Avena ludoviciana*. In summer pulses, important weeds include *Cyperus rotundus*, *Cynodon dactylon*, *Amaranthus viridis*, *Portulaca oleracea* and *Commelina benghalensis*. Parasitic weeds such as *Orobanche* spp. can also pose serious problems in some pulse crops. Regular monitoring of weed flora is therefore important for developing site-specific management strategies. The critical period of crop–weed competition differs among pulse crops. Long-duration crops such as pigeonpea require weed control mainly during the first 30–60 days after sowing (DAS), whereas short-duration crops such as greengram, blackgram and cowpea require early weed control within approximately 15–30 DAS. Chickpea, lentil and pea generally have a critical period of about 30–45 DAS. Field dodder (*Cuscuta*) is a parasitic plant that twines around the crop and feeds on it. It is common in rice-fallow blackgram, lentil and chickpea, and it can reduce yield by about 30% in greengram and blackgram and by about 85% in chickpea and lentil. Its tiny seeds

stay alive in the soil for many years, so it is very difficult to remove. The timing of weed control matters as much as the method. A crop must be kept weed-free during its critical period, roughly the first quarter to one third of its life. Timely weed management during these periods is essential to protect crop yield.

Integrated weed management

Integrated weed management (IWM) combines preventive, cultural, physical/mechanical, biological and chemical approaches to maintain weed populations below economically damaging levels. No single weed-control method provides effective and sustainable long-term management in pulse crops.

Preventive measure

Prevention is the cheapest method. Use of certified weed-free seed, cleaning of farm machinery, removal of weeds from bunds and irrigation channels, and preventing the movement of weed seeds through irrigation water and livestock can reduce weed introduction and spread. Physical cleaning of seed is particularly important for preventing the introduction of parasitic weeds. Clean seed drills, harrows and combines before moving them from a weedy field to a clean one, and use only well-decomposed farmyard manure. Keep field bunds, irrigation channels and borders free of weeds before they set seed, remove *Parthenium* before it flowers, and if *Cuscuta* appears, pull out the affected patch along with the host plants before the parasite flowers.

Cultural measures

These ecological practices improve the competitive ability of the crop. Crop rotation helps disrupt weed life cycles and prevents the dominance of weeds associated with continuous cropping. Good land preparation



buries weed seeds and controls emerged weeds. Competitive cultivars, optimum plant population, timely sowing, appropriate row spacing, intercropping, relay cropping and cover crops promote rapid canopy development and suppress weeds. These practices can also reduce dependence on herbicides. A stale seedbed is more effective: the field is irrigated or exposed to rainfall to encourage weed emergence, followed by shallow tillage or a non-selective herbicide before sowing with minimum soil disturbance. This works best when weed seeds are concentrated in the upper soil layer and require light for germination. In pulses grown after rice, zero-till sowing into residue after controlling emerged weeds reduces new weed emergence, in mungbean, zero tillage reduced weed density and dry weight and improved yield over conventional tillage. Timely sowing, optimum seed rate and line sowing produce a uniform crop that competes strongly with weeds and permits inter-row cultivation. Delayed sowing increased weed infestation and reduced pigeonpea yield, while closer spacing and early canopy development generally improve weed suppression. Intercropping with cereals or short-duration legumes can reduce weed growth by increasing crop competition. Pigeonpea intercropped with soybean, cowpea, blackgram or greengram has shown better weed suppression than sole cropping. Crop rotation disrupts weed seed cycles and permits rotation of herbicide modes of action.

Mechanical and manual methods

This includes hand weeding, hoeing, rotary weeding and inter-cultivation. These methods are particularly useful during the early crop stages in line-sown pulses. Stale seedbed preparation, soil solarisation and deep summer ploughing can further reduce early weed flushes and perennial weeds. However, labour requirements can limit the feasibility of

repeated manual weeding. Two hand weedings are still the standard practice at 20-25 and 40-45 days after sowing in short-duration pulses, and at 30 and 60 days in pigeonpea, chickpea, lentil and other long-duration or winter pulses. Hand weeding often gives the best control, but it is costly, tiring and often late, and when labour is short the second weeding is usually missed. One or two hoeings at the critical stages give satisfactory control of both annual and perennial weeds, and in greengram hand hoeing at 25 and 40 days after sowing gave a much higher yield than the unweeded control. Because pigeonpea is sown in wide rows, tractor-mounted cultivators can also be used during its early stages. These tools remove only the weeds between the rows, so weeds within the row need hand pulling or a herbicide, and one hand weeding combined with a pre-emergence herbicide is often almost as effective as two hand weedings. Small and fragmented holdings, broadcast sowing and uneven fields limit the use of mechanical weeders in many regions.

Herbicides based control

Herbicides are important components of pulse weed management, particularly where labour is scarce or expensive. They provide rapid and cost-effective weed control and are compatible with conservation-tillage systems. Pre-emergence herbicides are generally applied soon after sowing, while post-emergence herbicides are used during the early crop growth period. Herbicide performance depends on the active ingredient, dose, application timing and method. Mixtures and sequential applications can improve weed control. However, repeated dependence on herbicides can result in weed-flora shifts, herbicide resistance and residue-related concerns. The time and method of spraying decide how well a herbicide works. Pre-emergence herbicides should be sprayed



within a day or two of sowing, on moist soil, or they will not work well, high soil moisture, however, can also cause crop injury from pre-emergence herbicides. Early post-emergence herbicides work best when the weeds have only 2-4 leaves, usually 15-25 days after sowing, because larger weeds survive the normal dose. Use a knapsack sprayer with a

flat-fan nozzle with water volume of about 500 L/ha for pre-emergence and 350-400 L/ha for post-emergence sprays, and do not spray a crop that is under moisture stress. Therefore, herbicides should be integrated with cultural, mechanical and other non-chemical methods rather than used as the sole weed-management strategy.

Table 1. Herbicides recommended for pulses

Crop	Herbicides	Dose (g a.i./ha)	Time of application	Target weeds
Pigeon pea	Pendimethalin	750-1000	Pre-emergence (0-3 DAS)	Grasses and broadleaf weeds
	Pendimethalin + imazethapyr (RM)	1000	Pre-emergence (0-3 DAS)	Broadleaf weeds and grasses
	Quizalofop-ethyl	50	Post-emergence (20-25 DAS)	Grassy weeds
	Propaquizafop + imazethapyr (RM)	125	Post-emergence (20-25 DAS)	Broadleaf weeds and grasses
Green gram and black gram	Pendimethalin	750-1000	Pre-emergence (0-3 DAS)	Grasses and broadleaf weeds
	Pendimethalin + imazethapyr (RM)	1000	Pre-emergence (0-3 DAS)	Broadleaf weeds and grasses
	Imazethapyr	75	Post-emergence (20-25 DAS)	Broadleaf weeds and grasses
	Sodium acifluorfen + clodinafop-propargyl (RM)	245	Post-emergence (20-25 DAS)	Broadleaf weeds and grasses
	Fomesafen + fluazifop	220 + 220	Post-emergence (about 20 DAS)	Broadleaf weeds and grasses
Chickpea	Pendimethalin	750-1000	Pre-emergence (0-3 DAS)	Grasses and broadleaf weeds
	Pendimethalin + imazethapyr (RM)	1000	Pre-emergence (0-3 DAS)	Broadleaf weeds and grasses
	Oxyfluorfen	125-150	Pre-emergence (0-3 DAS)	Broadleaf weeds and grasses
	Quizalofop-ethyl	50	Post-emergence (20-25 DAS)	Grassy weeds
	Oxyfluorfen fb topramezone	125-150 fb 20.6	Pre-emergence (0-3 DAS) fb post-emergence (14-25 DAS)	Broadleaf weeds and grasses
Lentil	Pendimethalin	750-1000	Pre-emergence (0-3 DAS)	Annual grasses and small-seeded broadleaf weeds
	Oxyfluorfen	125-150	Pre-emergence (0-3 DAS)	Annual grasses and small-seeded broadleaf weeds

DAS = days after sowing; RM = ready-mix; fb = followed by



Conclusion

Weeds are a major constraint to pulse production in India, particularly during the early crop growth stages when competition can cause substantial yield loss. No single method provides reliable season-long control, therefore, integrated weed management (IWM) combining preventive, cultural, mechanical and chemical approaches is essential. Effective weed management in pulses requires integration of herbicides with cultural and mechanical methods, as the critical weed-free period and suitable herbicides vary among crops. Early sowing, suitable seed rate, zero tillage and pre-emergence pendimethalin or oxyfluorfen followed by hand weeding improve control; post-emergence quizalofop, propaquizafop or other grass herbicides can be used where required. Clean seed, timely sowing, optimum plant population, competitive varieties and

crop rotation help reduce weed emergence and replenish fewer seeds to the soil seed bank. Pre-emergence herbicides followed by suitable post-emergence herbicides or timely hand weeding can protect the crop during its critical weed-free period. The strategy should be adapted to the season and weed spectrum, kharif pulses require greater attention to grassy weeds and repeated weed flushes, while rabi pulses often face broadleaf weeds and herbicide-resistant grasses, summer pulses require rapid control of weeds emerging after irrigation. Rotating herbicide modes of action and integrating non-chemical methods can reduce the risk of resistance and crop injury. Overall, sequential herbicide use integrated with timely sowing, competitive varieties, intercropping, residue retention and mechanical weeding provides more reliable and sustainable weed management than any single method.

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