

Sustaining pulses production

through effective weed management options

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India is the world's leading producer of pulses. Pulses not only provide nutritionally rich food and feed, but they also improve soil health and crop productivity. Weeds are the most significant biological constraint in pulse production. According to research, weeds alone reduce pulse crop yields by 20 to 40%. Efficient weed management practices are critical in increasing pulse yield. Different weed management strategies such as broad-spectrum herbicides, bio-herbicides, biotechnological approaches along with improved resource conservation technologies must be used along with good agronomic practices to ensure efficient weed control. Integrated weed management has the potential to increase productivity and profitability by making better use of resources and suppressing weeds. For pulse productivity to be sustained, an economically viable weed management strategy must be identified.

Keywords: Bed planting, Herbicides, Integrated weed management, Pulses

India is the world's largest producer of pulses, accounting for about 25% of global production. In India, pulses are the second most important group of food grain crops after cereals. These are an important part of the vegetarian diet of a large portion of India's population. The important pulse crops are chickpea, pigeonpea, greengram, blackgram, lentil and fieldpea. Total pulses production during 2021–22 was estimated 26.96 million tonnes. Because of biological nitrogen fixation and the addition of massive amounts of organic matter, pulses play a critical role in improving and sustaining soil productivity. There is a significant opportunity to boost cropping intensity in cereal-based cropping systems by including pulse crops, which will not only increase system productivity and economic returns but also improve soil health quality. The pulse crops also disrupt pest dynamics, including weeds. Pulses contain 20–25% protein and essential amino acids needed for proper human growth

and development. To ensure self-sufficiency, the pulse requirement of the country is projected to be around 50 million tonnes by 2050, implying a 4.2% annual growth rate. Almost 84% of pulses are grown under rainfed conditions, often in conjunction with other non-legume crops, and are subjected to a variety of biotic and abiotic stresses. Of the total loss caused by various pests in agriculture, weeds account for 37%, followed by insects (29%), diseases (22%) and others including nematodes, rodents, mites, birds etc. (12%). Weeds are the most significant biotic constraint in pulse production. Weeds compete with crops for vital growth resources (moisture, nutrients and solar radiation) resulting in severe yield loss. Development of efficient weed-management technologies in pulses is vital for increasing productivity, sustainability and farmers' income.

Losses due to weeds in pulse crops

Weeds in pulses can have disastrous consequences. Crop-

weed competition is severe due to the short-statured crops such as lentil and chickpea, as well as the slow initial growth of some pulses such as pigeonpea, chickpea and lentil. It has been observed that the presence of weeds throughout the crop season can reduce chickpea seed yield by up to 68%. Weeds reduced yield significantly in pigeonpea (46.7%), urdbean (55.4%), chickpea (48.1%), lentil (58.8%), and field pea (47.1%) in a multi-location study. Weeds can sometimes cause allelopathic effects on crop plants, owing to their depressive root exudates. Weeds also act as an alternate host for a variety of diseases and insect pests. The critical period of crop-weed competition for short-duration pulses like urdbean and mungbean is up to 30 days, while it is up to 60 days for long-duration crops like pigeonpea, chickpea and french bean. Effective weed control during the critical period of crop-weed competition can result in near-maximum yield. A strategy should be developed to ensure that

weeds do not compete with pulses, or else production will be drastically reduced.



Weed infestation in soybean

Weed management options

To realize the yield potential of any pulse crop, effective weed management is required. Various weed management approaches, can be used to increase pulse production in the country based on crop and their ecology, as well as availability.

Preventive methods: Preventive weed control aims to minimize weed introduction, establishment, and spread into new areas while also preventing seed set on existing plants. To reduce weed seed rains into soil, methods include using clean seeds/certified seeds, preventing invasive and alien weeds, cleaning farm implements before use, cleaning farm bunds, applying well-rotten compost, and so on.

Cultural methods: Weed management relies heavily on cultural methods. Good agronomic practices such as proper sowing time, paired-row planting, soil solarization, stale seed bed, crop rotation, mulching, intercropping, cover crop, interculture and maintaining residue cover over soil are examples of these methods. Crop competitiveness against weeds can be increased by using these approaches, which can provide low-cost and safe weed management tools. Pulses are an important component of conservation agriculture systems and can be grown profitably with proper weed management.

Manual and Mechanical methods: Manual weeding is effective, but it is uneconomical due to the higher costs involved. Although herbicides

are rapidly replacing other weed-management practices, mechanical methods are still required to make weed control more effective, manageable, and cost-effective. Mechanical weeding includes the use of a hand chisel (khurpi), hand hoe and wheel hoe, hand fork, finger weeder and other tools. Line sowing can help with weed control by using weeding tools. The use of a rotary hoe and cultivator can be beneficial for weed control in soybean, with approximately 70% weed control possible until the weeds reach the 1–3 leaf stage.

Chemical methods: The inability of farm labourers to perform manual weeding on time necessitates the use of herbicides for season-long weed control in pulses. Furthermore, manual weeding is costly, inefficient, and cannot be performed in adverse soil and weather conditions. Pendimethalin is the most widely used herbicide in all pulse crops. Application of pendimethalin (0.5 kg/ha) as pre-emergence followed by one-hand weeding 60 days after sowing (DAS) could be an effective weed control technology

in blackgram. Imazethapyr, a broad-spectrum post-emergence herbicide, has been suggested for use in *kharif* season pulses such as pigeonpea, urdbean and mungbean. Imazethapyr's effectiveness in controlling grasses and broad-leaf weeds increases up to 80 g/ha, but for control of *Cyperus* spp., 100 g/ha is required. Post-emergence herbicides for weed control in *rabi* pulses should be identified and developed. Pendimethalin + imazethapyr (pre-mix) application at 0.8–1.0 kg/ha resulted in a nearly weed-free condition in greengram until 40 DAS. Herbicides such as fenoxaprop, pendimethalin and quizalofop effectively control grassy weeds, whereas post-emergence applications of fenoxaprop-p-ethyl at 50 g/ha + chlorimuron-ethyl at 4 g/ha (fenoxaprop + chlorimuron) in greengram provide optimal control of sedges and broad-leaf weeds. The use of nano-herbicides in weed control is a new strategy for addressing the problems associated with conventional herbicides. These herbicides primarily rely on biodegradable polymeric

Table 1. Promising herbicides for pulses

Crop	Herbicide	Dose (g/ha)	Remarks
Pigeonpea	Pendimethalin (PE)	1000 to 1500	Controls annual grasses and some broad-leaf weeds
Greengram	Pendimethalin (PE) <i>fb</i> imazethapyr (PoE at 25–30 DAS)	750 and 100	Broad-spectrum weed control
Blackgram	Pendimethalin (PE) <i>fb</i> quizalofop-ethyl (PoE at 25–30 DAS)	750 and 50	Broad-spectrum weed control. Quizalofop should be used where grassy weeds are dominant.
Chickpea	Topramezone (PoE at 25 DAS)	20.6	Broad-spectrum weed control
Lentil, field-pea	Pendimethalin (PE)	750 to 1000	Controls annual grasses and some broad-leaf weeds
	Quizalofop-ethyl (PoE at 15–20 DAS)	50 to 100	Controls annual grasses
	Clodinafop (PoE 25–30 DAS)	60	Controls annual grasses
	Pendimethalin (PE) <i>fb</i> quizalofop-ethyl (PoE at 20–25 DAS)	1250 and 100	Broad-spectrum weed control
Soybean	Pendimethalin (PE) <i>fb</i> imazethapyr (PoE at 25–30 DAS)	750 and 100	Broad-spectrum weed control
	Fenoxaprop + Chlorimuron (PoE at 20–25 DAS)	80 and 9	Controls annual grasses and broad-leaf weeds

DAS, Days after sowing; *fb*, followed by; PE, Pre-emergence; PoE, Post-emergence

substances, which improve herbicide efficacy through controlled release mechanisms and can be useful in exhausting the soil weed seed bank. Some of the most promising pulse herbicides are listed in Table 1.

Biological methods: Biological weed control with bacteria, fungi, nematodes, insects, fish, birds and other animals is an effective method for controlling many problematic weeds that is also cost-effective and environmentally friendly. Collego®, based on *Collectotrichum gloeosporioides* f.sp. *aeschynomene*, is used in Arkansas, Mississippi, and Louisiana to control *Aeschynomene virginica* (northern joint vetch), a leguminous weed in soybean.

Biotechnological methods: Herbicide-tolerant crops offer broad-spectrum weed control, reduce crop injury and phytotoxicity, and reduce herbicide carry-over effects on succeeding crops. However, there is a problem with herbicide-resistant weeds that must be addressed through integrated weed management and new biotechnological innovations. The only herbicide-tolerant pulse crop is glyphosate and glufosinate-tolerant soybean varieties. These crops have been engineered to withstand specific broad-spectrum herbicides that kill neighbouring weeds without harming the cultivated crop.

Improved resource conservation technologies-cum-weed control methods

Conservation tillage (Zero/minimum tillage): Conservation agriculture (CA) is being promoted and adopted to achieve sustainable crop intensification. The most important aspect of CA is conservation tillage, which is thought to protect soil health, plant growth and the environment. The retention of 30% surface cover by residues is typically used as the lower limit of classification for conservation tillage, but other conservation goals for the practice include conservation of time, fuel, earthworms, soil water, soil structure and nutrients. The CA has paved the way for pulse cultivation in diverse cropping systems. Crop

residue retention on the soil surface can limit weed seedling emergence, extend the period of emergence, and allow the crop to gain an advantage over weeds in zero tillage (ZT) systems.

Bed planting (Narrow/broad beds): Crops are grown on raised beds separated by furrows in bed planting. Beds are generally 0.6–1.0 m wide, with 2–3 rows of crops planted on the beds. This planting method reduces weed populations on the tops of beds. Thus, weed management, which primarily affects the furrows, becomes easier. Furthermore, bed planting methods save seed, water, nutrients and other inputs while increasing resource-use efficiency. These methods also make crop diversification easier.

Residues retention for mulch: Permanent or semi-permanent crop/plant residues cover on soil, which can be a growing crop or dead mulch, serves to protect soil physically from sun, rain and wind, as well as to feed soil biota/microorganisms that take over tillage function and soil nutrient balancing. Crop residues have a significant impact on the physical, chemical and biological properties of soil. Several studies have found that ZT with residue retention improves weed control

in grain legumes by suppressing weed seedling emergence. It may also reduce the need for herbicide applications.

Micro-irrigation: Drip irrigation can provide a limited amount of water to the area immediately surrounding the crop root zone, limiting weed growth. In arid growing regions, the use of plastic mulch in conjunction with drip irrigation may result in acceptable weed control without the use of herbicides. Many organic growers depend exclusively on manual or mechanical weeding methods. It has been found that the use of subsurface drip irrigation in conjunction with precision cultivation technologies can result in complete weed control on an organic farm in an environment that receives 25 cm or more of rain on a regular basis, during the growing season.

Integrated weed management: The goal of integrated weed management is to maintain manageable weed densities by preventing weed shifts to more difficult-to-control species and managing weed biodiversity. It emphasizes preventing weed reproduction and establishment, as well as minimizing weed competition with crops. Preventive measures are pre-requisite for weed



Pigeonpea in narrow bed with residue retention



Pigeonpea in flat bed with residue retention



Greengram in narrow bed with wheat residue



Greengram in broad bed with wheat residue

Source: Authors' research farm

Table 2. Integrated weed management options in pulses

Pulse crop	Integrated weed management options
Chickpea	Pendimethalin (PE) at 0.75 kg/ha <i>fb</i> one hand-weeding at 45 DAS Pendimethalin (PE) 1.0 kg/ha <i>fb</i> hand-weeding at 30 DAS
Lentil	Pendimethalin (PE) 0.75 kg/ha <i>fb</i> hand-weeding
Pea	Pendimethalin (PE) 1.0 kg/ha <i>fb</i> hand-weeding at 30 DAS
Greengram	Imazethapyr at 100 g/ha at 20 DAS <i>fb</i> 1 hand-weeding at 40 DAS
Pigeonpea	Raised bed planting + PE application of pendimethalin at 1.0 kg/ha <i>fb</i> application of quizalofop-ethyl (PoE) at 50 g/ha with or without residue retention
Cowpea	Pendimethalin (PE) 0.75 kg/ha <i>fb</i> hand-weeding at 30 DAS

DAS, Days after sowing; *fb*, followed by; PE, Pre-emergence; PoE, Post-emergence

control, and mechanical and cultural weeding should be used in pulse crops based on their suitability to local conditions. Herbicides used indiscriminately may have a negative impact on soil microflora, produce quality, and human and animal health. Herbicide resistance in weed populations is a growing source of concern for growers. Over 400 biotypes of resistant weeds have been discovered worldwide. As a result, integrated weed management could boost pulse production while minimizing environmental impact. Integrating herbicides with non-monetary, low-input, low-cost resource conservation techniques such as zero tillage, change in establishment methods,

line sowing, FIRB sowing, good water and fertilizer management, soil solarization, stale seed bed, crop residue incorporation, mulching, timeliness of operations, and other cultural methods could be a component of integrated weed management. It has been shown to be more effective than any single method in reducing weed growth in crop land. Most pulse crops use an integrated weed management approach that includes pre-emergence herbicide application followed by mechanical weeding after about a month of sowing. Integrated weed management has the potential to increase productivity and profitability by making better use of resources and suppressing

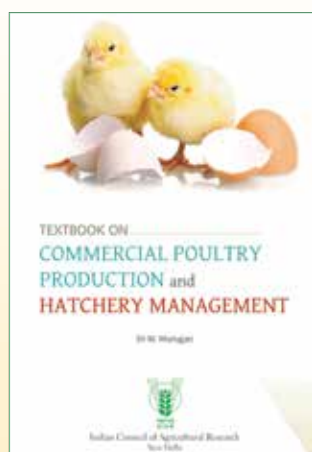
weeds. Some integrated weed management options for pulses are listed in Table 2.

SUMMARY

To sustain and improve pulse production in the country, the problem of weed management must be addressed urgently. The development and identification of suitable post-emergence herbicides for pulses should be the focus of research. Continuous efforts should be made to improve pulse productivity in various production systems by incorporating effective weed management strategies. Nano-herbicides, herbicide-tolerant crops and other emerging technologies can be combined with integrated weed management practices to increase their efficacy. Various integrated weed management modules should be studied across pulses and pulse-based cropping systems for different agro-ecological regions of the country for efficient weed management. Long-term strategic research for weed management in pulses is urgently needed.

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