TECHNIQUES OF WEED MANAGEMENT IN CHICKPEA – A Review

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ABSTRACT

Chickpea (Cicer arietinum) is one of the most important pulse legumes in many parts of the world. India is largest producer of chickpea in the world, sharing 65 and 70 % of the total global area and production, respectively. However productivity of chickpea in India is quite low. Out of several factors responsible for low productivity losses caused due to weeds is one of the most important which averaged out to be 30-54 %. Different weed control practices such as crop architecture, use of appropriate cultivars and use of herbicides were followed for better management. Differences in weed suppression among crops at cultivars have long been established. Cultivars for sustainable system should be both high yielding and competitive against weeds. Application of herbicide at critical growth stages followed by one or two hand weeding at proper time or manipulation of row spacing for improving the weed suppressing effect of crops gives marginal improvement in crop yield.

Pulses are the cheapest source of dietary protein, valuable animal feed also plays a key role in improving and sustaining soil productivity on account of biological nitrogen fixation and addition of huge amounts of organic matter. Pulses are integral part of the cropping system because these crops fit well in the crop rotation and crop mixture and are most suited diversifying crops in cropping systems. The decreasing per capita availability of pulses from 69.0 g in 1961 to 35.9 g in 2004 has created an alarming situation calling for concerted and expeditious efforts in improving their productivity (Moorthy and Dubey, 2004). Chickpea is the most important pulse crop of India, which account for 47% of total pulse production from 33% of total pulse area. The major chickpea growing states are M.P., Rajasthan, U.P., Haryana, Maharashtra and Karnataka, which together contribute 60% area and 90% production in the country (Ahlawat et al., 2005).

Of the different components of production technology, adoption of proper and timely weed management practices plays a pivotal role in boosting crop yields as weed inflict severe loss due to competition with crop for essential growth factors like nutrient, moisture, space, light etc. Weed management influences production, eco-environment and sustainability in chickpea production. Among various pests, weeds in general reduce yields by 30-54% in chickpea. Pest management in general and weed management in particular, has tremendous scope for increasing food production. In intensive agriculture, which largely depends on herbicides for weed control, indiscriminate use of herbicides could cause adverse changes on soil micro flora, poor quality of produce, human and animal health problems. So, integrated weed management is an only alternative for improving the pulse production. Non-chemical weed management is quite difficult in this crop. However scientists are doing their long strenuous efforts on this aspect.

Losses caused by weeds

At Jabalpur in Madhya Pradesh, Vicia sativa, Cichorium intybus (Chicory), Phalaris minor and Chenopodium album were dominant weeds of chickpea. Chenopodium album caused 17.8, 18.7, 27.4 and 24.2 per cent reductions in yield at densities of 50, 100, 150 and 200 plants m⁻², respectively (Paradkar et al., 1997). The presence of weeds like Chenopodium album, Polygonum plebejum caused 8.7 % reduction in chickpea yield at Pantnagar (Singh and Auckland, 1975)
whereas *Chenopodium album*, *Asphodelus tenuifolius* and *Cyperus rotundus* caused 50% reduction in yield at Kanpur (Panwar and Pandey, 1977). Losses in crop yielded up to 48% in chickpea has been reported by Vaishya et al. (1999). Unchecked weed growth caused yield loss of 90.9% in chickpea at Faizabad (Singh et al., 2000). Moorthy et al. (2004) reported that the losses in seed yield due to increasing density of *Cuscuta* ranged 28 to 100% in chickpea.

**Weeds flora present in chickpea fields**

Weed flora infesting chickpea fields varies from location to location under different agroecological conditions in the country. Tripathi and Misra (1971) observed that *Anagallis arvensis*, *Asphodelus tenuifolius*, *Chenopodium album*, *Euphorbia dracunculoides*, *Vicia hirsuta* and *Vicia sativa* were some of the *rabi* weeds infesting chickpea fields at Varanasi and out of these weed species *Anagallis arvensis* and *Chenopodium album* were the most dominating weeds.

*Chenopodium album*, *Polygonum plebogenum*, *Anagallis arvensis*, *Chenopodium album* and *Cyperus rotundus*, *Fumaria parviflora*, *Meli/otus indica*, *Meli/otus alba*, *Vicia sativa*, *Anagallis arvensis* and *Phalaris minor* (Singh et al., 1980; Lal and Singh, 1984; Singh and Sahu, 1996) were the major weeds at Pantnagar in Uttaranchal. At Kanpur, *Chenopodium album*, *Asphodelus tenuifolius*, *Anagallis arvensis*, *Meli/otus indica*, *Trifolium alexandrium* and *Cyperus rotundus* (Panwar and Pandey, 1977; Ali, 1993) were the major *rabi* weeds infesting chickpea crop. *Anagallis arvensis* followed by *Vicia hirsuta* and *Chenopodium album* infested the chickpea crop with the highest density at Faizabad (Vaishya et al., 1999). Carita (1993) reported that *Chenopodium album*, *Asphodelus tenuifolius*, *Meli/otus spp.* and *Vicia spp.* are the most serious broadleaf weeds, *Phalaris minor* and *Avena ludoviciana* are the annuals grassy

in winter season pulses cultivated on irrigated and productive soils. At Jabalpur *Cuscuta chinensis* and common lambsquarters is most serious weed problem in late sown chickpea (Mishra and Singh, 2003; Moorthy et al., 2004). Banga et al. (2003) reported that *Asphodelus tenuifolius*, *Chenopodium album* and *Avena ludoviciana* were the prominent weed infesting the experimental field at Hisar.

**Crop weed competition**

Aldrich (1984) diagrammed the weed - crop ecosystem (Fig. 1). For too long, weed scientists have focused primarily on weed-crop interactions and on protecting crops from weeds. This suggests that weed management must deal with interaction of all factors rather than just two.

The weeds reduce the crop yield and quality by competing for light, space, nutrient and water. Weeds act as host and thereby they intensify the problems of disease, insect and other pest. Saxena et al. (1976) reported that initial four to six weeks were the most critical for weed competition. Kolar et al. (1982) while studying the competition between some *rabi* crops and *Chenopodium album* competition was the greatest in chickpea. Singh and Singh (1982) found that weed free conditions maintained for the first 60 days yielded similarly to a completely weed free treatment. Weed competition or first 30 days and beyond caused significant reduction in the crop yield. Species of weeds vary in the losses which they inflict on chickpea competition is equally important in rainfed and irrigated chickpeas. So, the initial 60 days period appeared to be critical period of weed competition in rainfed chickpea dominated with *Asphodelus tenuifolius* weed community as reported by Tewari et al. (2001).

**WEED MANAGEMENT PRACTICES**

Both dryland and irrigated chickpea crops are badly infested with weeds because of their short growing nature. Being a dwarf stature crop suffers severely by infestation of
weeds. Narrow rows of these crops make mechanical weeding almost out of question, although hand-weeding, particularly in light soils, is feasible.

(A) Chemical method of weed control

Herbicides are effective tools in man’s eternal struggle with weeds. When properly used, herbicides can safely and effectively accomplish their objective (Calcagno et al., 1987). Pandey (1981) while conducting experiments in chickpea observed that pre-emergence application of fluchloralin at 0.75 kg, penoxalin @ 1 kg, bifenox @ 1.6 kg, terbutryn @ 0.5 kg, nitrofen @ 1 kg and prometryne @ 1 kg ha\(^{-1}\) gave an effective control of weeds populations. However, no herbicide was effective against *Cirsium arvensis*.

In Czech Republic by Tesar and Smolikova (1996) revealed that phytotoxic effect of metribuzin @ 0.35 kg in chickpea and kabuli chickpeas were found to be the more herbicide tolerant than desi chickpea. Pendimethalin @ 1.32 kg ha\(^{-1}\) and terbutryn + terbuthylazine @ 0.875 + 0.35 kg ha\(^{-1}\) were the most effective treatment in kabuli and desi chickpeas, respectively for control of dicotyledonous weeds. Bhalla et al. (1998) reported from Jabalpur that linuron @ 0.75 kg ha\(^{-1}\) and isoproturon @ 1.0 kg ha\(^{-1}\) reduced the population of broadleaf weeds which included *Medicago hispida*, *Cichorium intybus* and *Trifolium fragiferum* and these weeds were poorly controlled by alachlor, pendimethalin, metribuzin, oxyfluorfen, fluchloralin and metolachlor application in chickpea crop. However, weed control efficiency was the greatest under hand weeding (85 %) closely followed by isoproturon (64 %) and linuron (50 %).

Pandey (1981) observed the superiority of fluchloralin (0.75 kg ha\(^{-1}\)) and bifenox (1.6 kg ha\(^{-1}\)) in increasing higher seed yield over penoxalin (1 kg ha\(^{-1}\)), terbutryn (0.5 kg ha\(^{-1}\)), nitrofen (1 kg ha\(^{-1}\)) and prometryne (1 kg ha\(^{-1}\)). However, bifenox caused tip burning one month after application but yield was not adversely affected of the chickpea crop.

Singh (1985) obtained chickpea cv. Gaurav yields of 92, 79 and 68 per cent higher with application of hoeing at 25 or 25 + 45 days after sowing, fluchloralin @ 1.5 kg ha\(^{-1}\) and methabenzthiazuron @ 1.5 kg ha\(^{-1}\), respectively compared to unweeded control. Among three evaluated herbicides at different rates, fluchloralin @ 0.5 kg ha\(^{-1}\) and pendimethalin @ 1.0 kg ha\(^{-1}\) effectively controlled weeds and increased chickpea yields and benefit: cost (B : C) ratios. Pandey (1989) at IARI, New Delhi found the highest chickpea yield with imazethapyr @ 0.05 and 0.075 kg ha\(^{-1}\) which was similar to that achieved with hand weeding.
Balyan et al. (1991) reported that grain yield, number of pods plant\(^{-1}\) and number of branches plant\(^{-1}\) differed significantly with various treatments of herbicides and hand weeding. Further observation revealed that fluchloralin pre-planting application at 1.5 kg ha\(^{-1}\) in chickpea significantly lowered weed density and dry weight and increased the grain yield in comparison to other herbicides and untreated control. Singh and Singh (1997) recorded that the most effective weed control treatment was 1.5 kg ha\(^{-1}\) fluchloralin gave seed yields of 1.47 t ha\(^{-1}\) and the highest net return in chickpea grown under dry land condition. Bhalla et al. (1998) reported that among herbicides linuron at 0.75 kg ha\(^{-1}\) was found more effective in controlling weeds.

**B) Non chemical methods of weed management**

Most of the cultural practices employed by farmers as part of their production system are designed to create an environment that allow the crop interference with weeds to the greatest extent possible. Prior to the introduction of herbicides cultural practices played an important role in this regard. Enhancing crop competitiveness against weeds could provide a low cost and safe tool for integrated weed management. Differences in weed suppression among crops or cultivars have long been established. Aggressive cultivars growing in association with weeds leave smothering effect over weeds. Anagallis arvensis and Chenopodium album are serious weeds of chickpea in eastern region of U.P. (Singh et al., 2003a). These weeds are annual plants and usually occur in fertile soil. Anagallis arvensis prefers moist soil, whereas Chenopodium album occurs in both moist as well as dry soils. The main features contributing to success of these species are its similar ecological requirements to that of chickpea crop. Following non-chemical methods of weed management are adopted for optimum chickpea production.

(a) **Prevention**

An important step in avoiding competition with chickpea for resources is to prevent the presence of weed species. Preventive control attempts to minimize the introduction, establishment, and spread of weeds into new areas and prevent seed set on existing plants. Preventing the introduction of seeds and propagule into new areas includes use of seeds and transplants that are free of weed seeds or other propagule (certified seed and soil free transplants help achieve this goal). Screen and traps in irrigation channels, and sanitation of field and canal borders, vehicles, Ox carts, tillage and harvesting equipment are practical preventive measures (De et al., 1995).

(b) **Mechanical method**

Weeding by mechanical methods include the use of hand chisel (khurpi), hand hoe and wheel hoe etc. Effectiveness of mechanical means of weed control was advocated by Yadav et al. (1983). In a field trial, he found that Asphodelus tenuifolius, Chenopodium album, Fumaria parviflora and Convolvulus arvensis as the dominant weeds and hand hoeing was the most effective in controlling weeds which produced higher seed yield (897 kg seed ha\(^{-1}\)) compared to 373 kg ha\(^{-1}\) in unweeded plots. Since the competition is more in the initial growth stage, two hands weeding (3 to 4 weeks and 6 to 8 weeks after sowing) should be done. Under the conditions where weeds reappear following late rains or delayed irrigation, a third weeding may also be needed around 9 to 12 weeks after sowing (Bhan and Kukule, 1987). At Jaipur, Rajasthan in irrigated chickpea, Kumar et al. (1989) obtained that manual weeding once reduced weed dry weight at harvest from 1.76 to 0.23 t ha\(^{-1}\) and increased the highest chickpea grain yield from 0.55 to 1.08 t ha\(^{-1}\) compared to unweeded control values.

(c) **Tillage operation**

Tillage is single most important factor that influences weed infestations and causes
variations in crop yields and cost of production. Before sowing of chickpea seed deep tillage practices become more significant to control most of annual weed such as *Anagallis arvensis* and *Medicago denticulata* and perennial weed such as *Convolvolus arvensis* (Ali and Kumar, 2000).

(d) Cultivar selection

Aggressive cultivars growing in association with weeds leave smothering effect on weed. Crop varieties differ significantly for competition with weeds. Radhey genotype of chickpea reduced the weed dry matter accumulation as compared to Avarodhi and Pant G 114. Radhey recorded significantly higher grain yield in comparison to Pant G114. The index of competition was lower in Avarodhi and Pant G114 as compared to Radhey and Pant G 114 (Singh et al., 2003b).

(e) Light interception

Light is another environmental resources, which influences chickpea growth. Gram, being a dwarf stature crop and many time weeds smother its growth and yield reduces severely (Donald, 1963). Light regulates many aspects of plant growth and development. It varies in duration, intensity and quality. Neighboring plants particularly weeds may reduce light supply to crop. Light competition is most severe when there is high fertility and adequate moisture because plants grow vigorously. Plants with large leaf area indices (LAl)s have a competitive advantage and normally compete plants with smaller leaf area. In one of field studies, chickpea cultivar with taller height and lateral canopy development (Avarodhi) proved better competition for weeds than dwarf varieties such as BG 244, GNG 146, CG588, Radhy and Pant G114 (Moorthy and Dubey, 2004a).

(f) Crop geometry

Blessdal (1960) reported that increasing crop densities through manipulation of seed rate and row spacing effectively reduces niches available to weeds and decrease the weed growth. Increasing seed rate has reduced the weed population and weed dry matter production, which has impact in increasing grain yield. Increasing seed rate from 75 to 100 kg ha⁻¹ has significantly reduced the dry matter production of weed. Cultivars for sustainable system should be both high yielding and competitive against weeds. Manipulations of row spacing for improving the weed suppressing effect of crops gave marginal improvement in crop yield. However, since no cash inputs are involved, even a small improvement can be economical. Row spacing of 45 cm recorded lower plant height and more crop canopy cover and weed dry matter accumulation than 30 cm row spacing. Avarodhi had the maximum plant height, canopy cover and less weed dry weight than Radhey and Pant G 114. Weedy check recorded more plant height and more weed dry matter accumulation as compared to weed free treatment. Row spacing of 45 cm recorded more grain yield in comparison to 30 cm row spacing. The maximum grain yield was recorded in cultivar Avarodhi and minimum in Pant G114 (Singh et al., 2003a). Similar kind of observation was also reported by Singh et al. (1990).

(g) Timing of planting

Timing of planting can significantly influence crops competitive ability over various weed. Malik et al. (1988) recorded that the density of *Chenopodium album* decreased and that of *Lathyrus aphaca* increased with delay in sowing date from 20 November to 5 December. Similar kind of result was seen by Singh et al. (2001) at Varanasi. Saini and Faroda (1997) observed that crop sown during first week of November produce significantly higher grain yield ha⁻¹ than the crop sown during third week of October. The grain yield significantly increased with the increasing seed rate up to 100 kg ha⁻¹. In late sown chickpea, Lambsquarters
problem increased at Jabalpur. Early sowing of chickpea from first week of October was found to be best to check the growth of Euphorbia geniculata and Chenopodium album. (Mishra and Singh, 2003).

INTEGRATED METHOD OF WEED CONTROL

Integrated weed management system is the coordinated management of weed population with effective dependable and workable techniques, which are economically sound and eco-friendly in improving and sustaining the agricultural productivity (Singh, 1998).

Ramakrishna et al. (1992) observed the lowest weed dry weight, the highest grain yield and profit due to application of ametryn @ 1.0 kg ha⁻¹ in conjugation with hand weeding at 35 to 40 days after sowing (DAS). Combination of pendimethalin and fluchloralin with hand weeding also increased chickpea grain yield over individual application of either of these herbicides. Sekhon et al. (1993) stated that hoeing twice at 30 and 50 DAS resulted in the highest grain yield (1528 kg ha⁻¹) of chickpea. Vaishya et al. (1999) while studying weed control in chickpea with pre-emergence herbicides in eastern Uttar Pradesh found that pre-emergence application of pendimethalin @ 1.0 or 1.5 kg ha⁻¹ was more efficacious in weed control than metachlor applied @ 1.0 or 1.5 kg ha⁻¹, but the highest weed control efficiency (85.5 %) was recorded with manual weeding at 20 and 40 DAS closely followed by one hand weeding at 30 DAS and pre-emergence application of pendimethalin @ 1.0 or 1.5 kg ha⁻¹. Singh and Singh (2000) observed the integrated approach for controlling weed flora in late sown chickpea, pre-emergence application of pendimethalin @ 0.75 kg ha⁻¹ + one hand weeding at 45 DAS reduced the weed biomass with weed control efficiency (WCE) of 74% and gave significantly higher grain yield. Chopra et al. (2001) observed that the supplementing one weeding along with pre planting incorporation of fluchloralin @ 0.4 kg ha⁻¹ or pendimethalin @ 0.5 kg ha⁻¹ registered sharp decline in dry matter of weeds over sole application of pendimethalin, alachlor and fluchloralin.

Jain et al. (2002) recorded highest chickpea yield when fluchloralin was applied @ 0.5 kg ha⁻¹ + one hand weeding at 50 DAS, whereas, highest WCE was observed with application of fluchloralin @ 0.75 kg ha⁻¹. In late sown chickpea, two hand weeding at 30 and 45 days after sowing (DAS) completely controlled the weeds. Significantly lowest weed dry matter and highest weed control efficiency were observed when one hand weeding was done at 45 DAS followed by integration of one hand weeding at 45 DAS with pre-emergence application of pendimethalin @ 0.75 kg ha⁻¹ (Singh et al., 2003c). Pre-emergence application of Basalin @ 1 kg ha⁻¹ followed by one hand weeding at 45 days after sowing gave best result for weed control in chickpea (Panda et al., 2005).

INTERACTIVE EFFECT OF FERTILIZER AND WEED MANAGEMENT ON WEED CONTROL

Pandey (1981) recorded the highest yield with fluchloralin @ 0.75 kg and phosphorus application at 120 kg P₂O₅ ha⁻¹ in chickpea. Pandey (1982) reported that fluchloralin @ 0.75 kg, nitrofen @ 1 kg and pendimethalin @ 1 kg ha⁻¹ increased the chickpea yield with increasing phosphorus rates up to 60 kg P₂O₅ ha⁻¹.

Kumar (1988) while studying the interactive effect of Rhizobium inoculation and herbicide performance concluded that Rhizobium inoculation improved yields marginally and was not affected by the application of terbutryn @ 0.6 or 1.2 kg ha⁻¹, metabenzthiazuron @ 1 or 1.5 kg ha⁻¹ and pendimethalin @ 1 or 1.5 kg ha⁻¹. He further reported that due to more growth of crop due
registered highest weed control efficiency at different stages which enhanced yield attributes leading to higher seed yield (17.02 kg ha\(^{-1}\)) and net return (Rs. 6312 ha\(^{-1}\)).

**CONCLUSION**

Weed-crop competition is critical in obtaining optimum chickpea yields because of the greater competing ability of the former (weeds) than the later (crops). Weeds deplete a large quantity of mineral nutrients, moisture, shade the crop (light interception) and occupy the space. Besides, the weeds inflict their allelopathic effects on crop plants, which is largely through their depressive root exudates. Thevathasan *et al.* (1999) reported that juglone (5-hydroxy-1,4-napthaquinone) produced by *Juglans nigra* inhibited the growth and existence of some beneficial microorganisms including *Rhizobium japonicum* (*Bradyrhizobium japonicum*) and it inhibit growth of root of chickpea plant. Weeds are known to cause enormous losses due to their interference in agroecosystems of the chickpea by there root exudates of agrochemical (Taylor and Francis, 2003). Removal of weeds increases the nitrogenase activity as it reduces crop-weed competition for nutrients, moisture and light. Effective herbicidal control weeds in chickpea have been achieved with pre-plant soil treatment with fluchloralin or trifluralin @ 0.75 kg ha\(^{-1}\). Among the pre-emergence herbicides, pendimethalin, prometryn, terbutryn, and linuron hold promise. However, in present context integrated methods of weed management gets paramount important as it is eco-friendly.

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