



Weed Management Strategies in Chickpea (*Cicer arietinum*): A Review

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ABSTRACT

Chickpea (*Cicer arietinum*) is one of the most important pulse crops but its productivity in India is quite low. There are various reasons for low productivity. Weed control is the basic requirement and the major component of crop management. Weeds on an average reduce the crop yield by 40-87 per cent. Deciding time to control weeds requires detailed knowledge of the weed populations in the field. Different management practices like altering spacing, competitive cultivars, etc. can help in enhancing the productivity. With the world entering the precision-farming era, more emphasis is being put on the use of post-emergence herbicides. Application of two or more herbicide at the same time or as a double knockdown and integrating with hand-weeding provides desirable control of different weed species besides reducing the hazard of chemical weed control.

Key words: Chemical control, Chickpea, Herbicides, Integrated approach, Non-chemical method, Weeds.

India has achieved self-sufficiency in food grain production through increased productivity and Green Revolution, particularly in cereal crops. India is the largest producer as well as consumer of pulses, where production lags behind consumption. The net availability of food grains per capita per day has increased from 144.1 kg year⁻¹ in 1951 to 179.6 kg year⁻¹ in 2019 in spite of an increase in population whereas the net availability of pulses has reduced from 25 kg year⁻¹ in 1961 to 17.5 kg year⁻¹ in 2019 (Anonymous, 2020). In developing countries, particularly India, where vegetarian populace predominates, pulses are the second most important component of the diet after cereals. Pulses play a significant role in diversifying the traditional cropping systems because of their ability to fit well in the crop rotations. Due to their ability to fix atmospheric nitrogen, they can produce protein efficiently (Havlin *et al.*, 2014). Chickpea is one of the most important *rabi* pulse crops in India accounting for 44.50% of the total pulse production from 35.21 per cent of the total pulse area during 2017-18. It also has qualities like low glycaemic index, gluten-free and acts as a functional food (Rao, 2002).

Chickpea, being slow in its early growth and short stature, is highly susceptible to weed competition and often considerable yield losses up to 75 per cent (Chaudhary *et al.*, 2005) may occur if weed growth remains unchecked at appropriate time. They compete with the crop for nutrients, space, light, water and carbon dioxide. Thus weed management in chickpea is an important component of plant protection and improving production potential of the crop.

Crop-weed competition

Losses caused by weeds

Chickpea crop is not a competitive crop, especially when weed competition occurs at early stages (Barker, 2017). Yield losses caused by weeds in chickpeas have been estimated at 40 to 87 per cent in India, 41 to 42 per cent in the former

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Union of Soviet Socialist Republics (USSR) and 23 to 54 per cent in West Asia (Bhan and Kukula, 1987).

However at Indian Institute of Pulses Research, yield losses due to weed in chickpea varied between 29-70 per cent over the years (Anonymous, 2009). Mohammadi *et al.* (2005) reported that severe infestation of weeds caused reduction in seed yield of about 66.4 and 48.3 per cent throughout the crop growing season of chickpea. However, maximum yield to the extent of 81 to 97 per cent has also been reported by Barker (2017). In addition to this, losses from weeds include extra cost on harvest and reduced crop quality (Miller *et al.*, 2002). Hassan *et al.* (2007) reported an increase of 12-14 per cent with pre-emergence application of herbicides and 6-23 per cent with post emergence application of herbicides. Bhalla *et al.* (1998) reported that the herbicidal treatment resulted in 50-54 per cent weed control in chickpea.

Weed flora in chickpea

Weeds are major challenge in realizing potential chickpea production. In order to control weeds, detailed knowledge of the weed population is acquired from the field. It is critical to identify weeds during early stages which can be

challenging since many species mimic crop plants. Knowledge regarding weed flora of a particular location is the first and foremost step for an effective weed management strategy.

The weed species infesting the chickpea fields vary from one location to another depending on the agroclimatic conditions in the country. The field was infested with *Chenopodium album*, *Fumaria parviflora*, *Spergula arvensis* and *Lepidium sativa* at Ludhiana (Singh *et al.*, 2003). Dewangan *et al.* (2016) observed that *Medicago denticulata*, *Convolvulus arvensis*, *Chenopodium album*, *Melilotus indica* and *Brachiaria mutica* were some of the dominant weed flora in the experimental field at Raipur. Out of these weeds *Medicago denticulata* was the most dominant followed by *Convolvulus arvensis*.

Among monocots *Brachiria mutica*, *Echinochloa crusgalli* L. and *Cynodon dactylon* L.; *Cyperus rotundus* among sedges and *Amaranthus viridis* L., *Digera arvensis*, *Physalis minima*, *Euphorbia hirta*, *Parthenium hysterophorus* and *Alternanthera sessilis* among dicots were the prominent weeds at Parbhani, Maharashtra (Gore *et al.*, 2018). At Kanpur, *Chenopodium album* L., *Parthenium hysterophorus*, *Cynodon dactylon*, *Asphodelus tenuifolius*, *Fumaria parviflora* Lamk., *Anagallis arvensis*, *Cronopus didymus* and *Spergula arvensis* were some of the weeds that dominated the experimental field (Pooniya *et al.*, 2009). The field at Jodhpur during the *rabi* season observed the infestation of *Chenopodium murale*, *Chenopodium album* and *Rumex dentatus*. Among these *Chenopodium murale* was the most dominant weed species (Yadav *et al.*, 2018).

Singh *et al.* (2016) reported that *Melilotus alba*, *Chenopodium album*, *Cynodon dactylon*, *Phalaris minor* and *Medicago hispida* were the major weeds in *rabi* season in the experimental field at Varanasi. Khope *et al.* (2011) revealed that *Chenopodium album*, *Fumaria parviflora* and *Phalaris minor* were the major weed flora in their experimental field at Hisar (Haryana). *Convolvulus arvensis*, *Anagallis arvensis*, *Melilotus alba*, *Cronopus didymus* and *Spergula arvensis* were the minor weed species infesting the chickpea field. Merga and Alemu (2019) reported that *Solanum nigrum*, *Medicago polymorpha*, *Galinsoga parviflora*, *Commelina benghalensis*, *Parthenium hysterophorus* and *Cyperus rotundus* were the prominent weeds infesting the chickpea at Haramaya, Ethiopia.

Weed threshold

An economic threshold for weed control, or the “break-even point” is the level of weed infestation at which the cost of controlling the weeds is equal to the increase in crop value obtained as a result of controlling the weeds. They are often used in the decision-making process for weed management.

Knowledge of economic threshold level and growth habits of weeds in chickpea is essential to implement timely, effective and economical weed control treatments. Mohammadi *et al.* (2005) estimated a 1 per cent reduction in chickpea seed yield for every additional 3.85 g m⁻² of weed

dry weight. The effect of weed density on growth and yield performance in chickpea using dragon spurge (*Euphorbia dracunculoides*) as a test weed was investigated (Tanveer *et al.*, 2015). Dragon spurge density levels of 5, 10, 15, 20, 25, 30, 35 and 40 plants m⁻² were compared with weed-free plots. Each increment in densities of dragon spurge from 5 to 40 plants m⁻² reduced plant height, number of fruits, seeds and dry weight per plant. Chickpea grain yield losses varied between 1 to 63 per cent with dragon spurge density ranging from 5 to 40 plants m⁻². The seed protein content of chickpea was found to be significantly reduced above a weed density of 25 plants m⁻². Thus, dragon spurge should be controlled at densities above 5 plants m⁻² to achieve optimum chickpea yield. *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).

Critical period of weed interference

There are certain crops that are able to tolerate the interference caused by weeds to certain period of time. After that time period this competition causes decline in yield which cannot be reversed later (Dawson, 1986). The time span or duration growth when crop must be kept free from weeds to prevent losses in the yield due to their interference (Weaver and Tan, 1987; Van Acker *et al.*, 1993) is called critical period of crop weed interference. Most crops are sensitive to weed competition in early stages of crop growth (Ramamoorthy *et al.*, 2004). This period differs for depending upon the time of weed emergence. If weeds emerge early, then the critical period will also be early (Knezevic *et al.*, 2002). Thus, the weed density is an important parameter for determining the critical period for the crops (Martin *et al.*, 2001).

The critical period of crop weed competition (CPWC) for a given crop species varies greatly and depends on the density of weed infestation, crop species characteristics, climatic conditions and environment (Knott and Halila, 1986). The CPWC can also differ with differing planting densities (Ahmadvand *et al.*, 2009) and the length of the CPWC can be affected by weed densities and weed emergence time (Knott and Halila, 1986; Mohammadi *et al.*, 2005). The CPWC concept typically assumes that weed emergence, species composition and density are spatially homogenous across an environment (Knezevic *et al.*, 2002). Variability in environment, crop characteristics and other factors results in CPWC estimates specific to a crop only within a given region.

Mohammadi *et al.* (2005) estimated a CPWC 17 to 49 days after emergence (DAE) or between the four leaf and beginning of flowering stages, but in a second location the CPWC was between 24 and 48 DAE or between the five leaf and the full flowering stages. In western Iran Mashhadi and Ahmadi (1998) estimated a CPWC 27 to 44 DAE, between the 6 and 14 leaf stage and 205 to 385 growing degree days (GDD). Al-Thahabi *et al.* (1994) in Jordan estimated 35 to 49 DAE; Masood-Ali (1993) in India

estimated 0 to 56 DAE; Ahlawat *et al.* (1981) in India estimated 28 to 56 DAE and Saxena *et al.* (1976) in India estimated that hand-weeding's at 30 and 60 DAE would prevent unacceptable yield loss from weeds. The average of these estimates is 23 to 52 DAE, but the estimates for the lower and upper limit ranged from 0 to 35 and 42 to 60 DAE, respectively (Yenish, 2007).

Based on a 5 per cent yield loss threshold, Smitchger (2010) found that the CPWC for the 'Sierra' chickpea was 16 to 26 DAE. Alternatively, the CPWC could be expressed as 162 to 256 GDD or the 9 to 13 node stage in terms of crop development. Crop yield, crop biomass and 100 seed weight declined with an increasing duration of weed competition. Singh and Singh (1992) reported that grain yield of chickpea was reduced by 17.1 per cent due to competition with weeds during the first 30 days of sowing. Grain yield was increased when the initial weed-free duration was extended up to 60 days and further increase in the duration of weed-free had no beneficial effect on grain yield.

Weed management practices

The slow growth habit of chickpea is the reason that the crop is severely infested by the weeds both in the irrigated as well as the dryland areas.

Non-chemical control

Before the advent of chemical herbicides, cultural practices played vital role in intensifying crop competitiveness against weeds at very low cost. It was an eco-friendly strategy. It attempts to minimize the introduction, establishment and spread of weeds into new areas and check seed set. While, herbicides may be able to control the weeds effectively during the crop growth but time of crop establishment also significantly influences the competitive abilities of the crop. Malik *et al.* (1988) observed the decline in density of *Chenopodium album* and increase in *Lathyrus aphaca* with delay in sowing date from 20th November to 5th December.

Blessdal (1960) informed that increasing crop densities through manipulation of seed rate and row spacing effectively subdues niches accessible to weeds and diminish the growth of weeds. Whish *et al.* (2002) while conducting their experiments at New South Wales concluded that the chickpea yields from the crops sown in narrow rows (32 cm) were consistently higher than yields with wide row (64 cm) spacing under weed free conditions. Narrower row spacing considerably advanced the competitive ability of the crop as consequence of earlier canopy closure.

Balwan *et al.* (2014) reported maximum uptake of nitrogen, phosphorus and potash by grain and stover and minimum uptake of nitrogen, phosphorus and potash by weeds, maximum protein content (21.37 per cent) and minimum losses by weeds (11.69 per cent) under hand weeding at 20, 40, 60 DAS. Numan *et al.* (2017) found two times hand weeding is the most economical and beneficial method for controlling weeds in chickpea and increasing yield and yield components due to maximum nutrient availability for the crop, makes the soil porous for

penetration of roots and increases water holding capacity of soil. Singh *et al.* (2003) found Hoeing at 30 or 60 days after sowing (DAS), was effective in chickpea.

Dixit *et al.* (2014) observed that among different tillage operations, zero-tillage registered significantly lower weed density and weed dry matter, 87.9 number m⁻² and 6.76 g m⁻², respectively. It was lower than the conventional tillage by 19.5 and 14.5 per cent, respectively. Chauhan *et al.* (2017) at Jabalpur also concluded that bed planting of chickpea was significantly better than the conventional tillage due to better weed management, better root development and favourable soil environment. Post-emergent harrowing is not recommended for weed control as it can spread disease and cause severe crop injury. Intercropping of safflower, linseed and wheat with chickpea exhibited significant suppression of weeds from 43-60 per cent (Anonymous, 2009).

Allelopathy

Allelopathy involves the synthesis and release of bioactive chemical compounds that affect the growth and development of neighbouring plants. Putnam (1988) described six classes of allelochemicals from different plants. They have the capability of damaging the normal growth of weeds by affecting their metabolic pathways (Weston and Duke, 2003).

Allelopathy is a chemical (biochemical) relationship among plants (Rice, 1984). At the same time, mulching is a recent and effective non-chemical weed control method (Ramakrishna *et al.*, 1992). Regar *et al.* (2010) reported that straw mulching resulted in better grain yield and significantly enhanced water use efficiency in different chickpea cultivars. Khan *et al.* (2018) found better weed control using *Eucalyptus* leaf mulch, crop or weed straw mulch, *Asphodelus tenuifolius* mulch, *Cyperus rotundus* extract and *Sorghum halepense* extract.

Chemical control

Herbicides are the most effective weed control tools. In all of these considerations, there are opportunities to reduce the risks associated with herbicide use.

Sesharee *et al.* (1996) revealed that fluchloralin was more effective than pre-emergence alachlor or isoproturon in Andhra Pradesh. In recent years, it has been demonstrated that the application of two or more chemicals at the same time provides control of different weed species.

Lyon and Wilson (2005) at Sidney, US observed that pre-plant incorporation of Ethalfuralin @0.84 kg ha⁻¹ and pre-emergence application of Pendimethalin @1.12 kg ha⁻¹ were not significantly different from each other and hand weeding maintained total weed densities 4 weeks after emergence. Further study revealed that herbicides containing Sulfentrazone @0.11 kg ha⁻¹ or in combination that is Sulfentrazone + Dimethenamid-P @0.11 + 0.72 kg ha⁻¹, Sulfentrazone + Pendimethalin @0.11 + 1.12 kg ha⁻¹ and Sulfentrazone + Imazethapyr @0.11 + 0.026 kg ha⁻¹ also provided good and consistent weed control in both irrigated as well as dryland areas. Metachlor 83% +

Pendimethalin 13% @2230 ml ha⁻¹ showed promising results in controlling weeds (Abbas *et al.*, 2016).

Kachhadiya *et al.* (2009) revealed that significantly lower dry weight of weeds was recorded with pre-emergence Oxyfluorfen @0.12 kg ha⁻¹ + 1 Hand-weeding + 1 Inter-cultivation at 30-35 DAS and also with pre-emergence Fluchloralin @0.675 kg ha⁻¹ + post-emergence Imazethapyr @0.05 kg ha⁻¹. These treatments also exhibited significantly higher weed control efficiency and higher herbicide efficiency index. However, Yadav *et al.* (2019) observed that sequential application of pre-emergence Pendimethalin @0.60 kg ha⁻¹ + post-emergence Imazethapyr @60 g ha⁻¹ at 20 DAS recorded significantly higher yield and was at par with pre-emergence Pendimethalin @0.60 kg ha⁻¹ + post-emergence Imazethapyr @40 g ha⁻¹. Pendimethalin @0.75-1.5 kg ha⁻¹ as pre-emergence and Quizalofop-p-ethyl @40-100 g ha⁻¹ as post emergence was found effective (Pedde, 2016; Dixit and Varshney, 2009). Malik *et al.* (2001) found post-emergent Fluazifop butyl @0.75 kg ha⁻¹ effective in controlling weeds.

Dubey *et al.* (2018) observed the toxic effect of post emergence Oxyfluorfen @200 g ha⁻¹ + Clodinafop @60 g ha⁻¹ at 35 DAS on the formation of root nodules whereas Pendimethalin @1 kg ha⁻¹ + post-emergence Clodinafop @60 g ha⁻¹ effectively controlled grassy as well as the broad-leaf weeds. The pre-emergence Pendimethalin @1 kg ha⁻¹ + post-emergence Clodinafop @60 g ha⁻¹ or Quizalofop @60 g ha⁻¹ were the most effective treatment with respect to weed control efficiency, grain and straw yield of chickpea. Khope *et al.* (2011) recorded higher chickpea yield with Quizalofop @50 g ha⁻¹ at 30 DAS. On comparing the different doses of Quizalofop i.e. 40 g ha⁻¹ and 50 g ha⁻¹ at 20 and 30 DAS with Imazethapyr i.e. 25 g ha⁻¹ and 40 g ha⁻¹ at 20 and 30 DAS, Quizalofop recorded highest grain yield except for Quizalofop @40 g ha⁻¹ at 20 DAS. The performance of Chlorimuron-ethyl was not effective to control weeds due to its severe phyto-toxicity which resulted in mortality of the chickpea.

Rupareliya *et al.* (2018) revealed that pre-emergence Oxyfluorfen @0.18 kg ha⁻¹ + pre-mix of Imazamox + Imazethapyr @0.03 kg ha⁻¹ as post-emergence at 40 DAS recorded lowest dry weight of weeds (83 kg ha⁻¹) and weed index (6.63%). Besides, highest weed control (92.23%) and herbicide efficiency (6.11) was obtained with the application of Imazamox + Imazethapyr @0.03 kg ha⁻¹. Kumar *et al.* (2020) concluded that application of pre-emergence Pendimethalin @1 kg ha⁻¹ + post-emergence Quizalofop @60 g ha⁻¹ recorded lowest nutrient depletion by weeds, highest nutrient uptake by crop and highest crop yield followed by pre-emergence Pendimethalin @1 kg ha⁻¹ + post-emergence Imazethapyr @40 g ha⁻¹.

Dewangan *et al.* (2016) revealed that with the use of tank-mix pre-emergence application of Oxyfluorfen + Metribuzin @125 + 350 g ha⁻¹ there was a notable increase in the yield (73.10%), over the control. While Metribuzin @250 g ha⁻¹ at 20 DAS and Oxyfluorfen @125 g ha⁻¹ at 12 DAS showed phytotoxic effects on chickpea plant.

Kantar *et al.* (1999) revealed that Terbutryne + Fluazifop-P-butyl @125 g ha⁻¹ + 100 g ha⁻¹ was the most effective herbicide followed by pre-emergence Imazethapyr @20 g ha⁻¹ and pre-emergence Linuron + Propyzamide @200 g ha⁻¹ + 50 g ha⁻¹. These herbicides were able to control *Cirsium arvensis*, *Chenopodium album*, *Amaranthus retroflexus* and *Equisetum arvense* effectively.

Balyan *et al.* (1987) found application of fluchloralin and pendimethalin alone at 1.0 and 1.5 kg ha⁻¹, respectively and combination of fluchloralin + pendimethalin and fluchloralin + metribuzin at higher rates produced better growth and reproductive characters of crop than their combinations at lower rates. Metribuzin @0.5 kg ha⁻¹ also produced significantly better growth and yield of chickpea as compared to the weedy check.

Integrated weed management

Weed management, a system approach, not only minimizes the invasion of weeds in aggressive forms but also gives a competitive advantage to the crop plants. As Indian agriculture is moving towards intensive agriculture from subsistence farming, dependency on the use of herbicides for weed control is increasing. Due to indiscriminate use of herbicides, the problems like poor quality produce, deteriorating human and animal health and of herbicide resistance may arise. At such times, Integrated Weed Management (IWM) is the only alternative that combines all the weed control methods to keep the weed population well below the economic threshold level (ETL) and also improves the pulse production.

Singh *et al.* (2003) found application of pendimethalin and isoproturon pre- or post-emergence and application of pendimethalin pre-emergence in combination with hoeing 45 DAS were effective in *C. arietinum*.

Rathod *et al.* (2017) concluded from the two years study that pre-emergence application of pendimethalin 0.75 kg ha⁻¹ + HW at 25-30 DAS was the best option for controlling weeds. Further, application of imazethapyr 30 g ha⁻¹ at 10 DAS was found effective for the control of weeds and resulted in higher grain yields and net returns. Merga and Alemu (2019) found that S-metolachlor 1.0 kg ha⁻¹ supplemented with hand weeding 5 weeks after emergence (WAE) recorded lowest total number of weeds (21.78 m⁻²) following the weed free. Pendimethalin @ 0.75 kg/ha + one hand weeding at 45 days after sowing was found effective (Chandrakar *et al.*, 2015).

Kaushik *et al.* (2014) observed that post-emergence Imazethapyr @75 g ha⁻¹ + Hand weeding at 50 DAS recorded lowest no. of weeds/m² to the tune of about 2.91 which was followed by integrated use of pre-emergence Pendimethalin @0.75 g ha⁻¹ + Hand weeding at 25 DAS with 3.19 weeds/m². Highest Net return of Rs 24,648/ha was also achieved through the integrated use of Pendimethalin + Hand weeding 25 DAS. In contrast, the highest number of weeds/m² were recorded with the pre-emergence Alachlor @2 kg ha⁻¹ with 5.34 weeds at 60 DAS.

Tiwari *et al.* (2019) in their field trials concluded that the integrated treatments performed significantly superior to alone application of herbicides. Amongst treatments, pre-emergence Pendimethalin @1 kg ha⁻¹ fb post-emergence Imazethapyr @50 g ha⁻¹ at 20 DAS fb manual weeding at 40 DAS recorded highest weed control efficiency (69.5 and 71.4 per cent, 60 and 90 DAS respectively) and lowest weed index of 6.7. Pre-emergence Pendimethalin @1 kg ha⁻¹ fb post-emergence Imazethapyr @50 g ha⁻¹ at 20 DAS fb manual weeding at 40 DAS recorded the lowest weed density at 30, 60 and 90 DAS with the corresponding value of 7.7, 6.6 and 5.8, respectively which was tailgated by pre-emergence Pendimethalin @1 kg ha⁻¹ fb post-emergence Imazethapyr @50 g ha⁻¹ at 20 DAS.

It was also revealed the integration of pre-emergence Pendimethalin @0.5 kg ha⁻¹ fb Hand weeding at 45 DAS resulted in dry matter accumulation to the tune of about 1.80 q ha⁻¹ which was followed by integration of pre-plant Trifluralin @0.5 kg ha⁻¹ fb Hand weeding at 45 DAS resulting in 2.33 q ha⁻¹ dry matter accumulation. Hence, the integrated treatments performed better than the alone applications of Pendimethalin @0.75 and 1 kg ha⁻¹ and Trifluralin @0.75, 1 and 1.25 kg ha⁻¹ (Singh *et al.*, 2008).

Future prospects

In regards to agriculture, weeds are still the major constraint to crop production. Agricultural practices have evolved over time and scientific community concluded that single method is insufficient to control this problem and integrated approach is the future of weed control. During the recent years, the concept of precision agriculture has hugely increased and it has not yet ceased. The use of herbicides when required is being stressed in order to reduce the carry over effects of herbicide. Keeping this in view, the use of post-emergence herbicides is being advocated. The influence of other agricultural practices like irrigation and nutrient management on the weed emergence has not been discussed due to insufficient research. This may be attributed to the fact that pulses are generally grown in the semi-arid (dryland areas) of the country. Genetically enhanced crops, like soybean, with resistance to broad-spectrum post-emergence herbicides such as glyphosate, have been developed through genetic engineering. Similar trends can also be the future of Chickpea and other pulse crops where mechanisation is a serious constraint to the production.

CONCLUSION

Pulses due to their readiness to adapt to a wide range of edaphic and climatic conditions constitute a crucial segment of climate-change mitigation and adaptation strategy. The poor productivity of chickpea can be attributed to stress by weeds and insect-pests. Weeds are the most serious problem and if unchecked, can cause 20-90 per cent yield losses in different pulse crops (Poonyia *et al.*, 2015). Weeds compete with the crops for resources like light, water, space, nutrition etc. thereby reducing the crop yield. They act as

alternate host sheltering pests and diseases. Das (2008) reported that Lambsquarters (*Chenopodium album* L.) acts as an alternate host for greasy cut-worm (*Agrotis ipsilon*) in chickpea. Besides, the weeds are able to reduce the crop growth due to their allelopathic affect. Weeds like *Chenopodium album* L. and *Matricaria chamomilla* L. reduced the chickpea germination by 20 and 22.5 per cent respectively (Kadioglu *et al.*, 2005). Pulses are precisely diverse agricultural share and profoundly impacted by weed stress. Hence, there is dreadful need to shift towards newer herbicide application for better weed control. However, with the modern concept of precision farming, the practice of post-emergence herbicide is being advocated. In the present setting, endeavours have been made to include the post-emergence herbicides that hold promise.

REFERENCES

- Abbas, G., Ahmed, A., Amer, M., Abbas, Z., Mudassir-ur-Rehman, Hussain, A., Khan, G.A. (2016). Impact of pre-emergence herbicides for the control of weeds in Chickpea (*Cicer arietinum* L.) under hot arid climate. *Journal of Bioresource Management*. 3(2): 54-60.
- Ahlawat, I.P.S., Singh, A., Safar, C.S. (1981). It pays to control weeds in pulses. *Indian Farming*. 31:11-13.
- Ahmadvand, G., Mondani, F., Golzardi, F. (2009). Effect of crop plant density on critical period of weed competition in potato. *Scientia Horticulturae*. 121: 249-254.
- Al-Thahabi, S.A., Yasin, J.Z., Abu-Irmaileh, B.E., Haddad, N.I., Saxena, M.C. (1994). Effect of weed removal on productivity of chickpea and lentil in a Mediterranean environment. *Journal of Agronomy and Crop Science*. 5: 333-341.
- Anonymous, (2009). Twenty five years of Pulses research at IIPR Kanpur 1984-2009. Indian Institute of Pulses Research, Kanpur.
- Anonymous, (2020). Pocket book of Agricultural Statistics 2019. Directorate of Economics and Statistics, Department of Agriculture Co-operation and Farmers' Welfare, Ministry of Agriculture and Farmers' Welfare, Govt. of India, New Delhi.
- Balwan, D., Kumar, M., Virdia, H.M. (2014). Nutrient uptake by crop and weed as influenced by weed management practices in gram (*Cicer arietinum* L.). *Environment and Ecology*. 32(2): 579-581.
- Balyan, R.S., Malik, R.K., Vedwan, R.P.S., Bhan, V.M. (1987). Chemical weed control in chickpea (*Cicer arietinum* L.). *Tropical Pest Management*. 33(1):16-18.
- Barker, B. (2017). Critical Weed Free Period of Pulses. *Pulse Advisor*. Saskatchewan Pulse Growers. pp. 1-3.
- Bhalla, C.S., Maliq, R.K., Vewan, R.P.S., Bhan, V.M. (1998). Herbicidal weed control in chickpea (*Cicer arietinum* L.). *World Weeds*. 5(1-2): 121-124.
- Bhan, V.M. and Kukula, S. (1987). Weeds and their control in chickpea. In: Saxena MC, Singh KB editors. *The Chickpea*. Wallingford: C.A.B. International. pp. 319-328.
- Bhutada, P.O. (2015). Chickpea and weed management. *International Journal of Forestry and Crop Improvement*. 6(1): 77-78.
- Blessdal, J.K.A. (1960). *The Biology of Weeds* (Harper JL). Blackwell Science, Publ. Oxford, UK. pp. 133-142.

- Chandrakar, S., Sharma, A., Thakur, D.K. (2015). Effect of weed management on weeds and yield of chickpea varieties (*Cicer arietinum* L.). *Advance Research Journal of Crop Improvement*. 6(1): 1-4.
- Chaudhary, B.M., Patel, J.J., Delvadia, D.R. (2005). Effect of weed management practices and seed rates on weeds and yield of chickpea. *Indian Journal of Weed Sciences*. 37: 271-272.
- Chauhan, A., Jha, G., Chourasiya, A., Jha, A., Joshi, J.K. (2017). Effect of tillage and weed management practices and growth productivity and energy analysis of late-sown chickpea. *International Journal of Agriculture Sciences*. 9(5): 3779-3781.
- Das, T.K. (2008). *Weed Science: Basics and applications*. Jain Brothers, New Delhi, India. pp. 666-679.
- Dawson, J.H. (1986). The concept of period thresholds. *Proceedings 1986 of the European Weed Research Society Symposium, Economic Weed Control, Stuttgart, Germany*. pp. 327-331.
- Dewangan, M., Singh, A.P., Chowdhury, T., Kumar, D., Kumar, B. (2016). Management of complex weed flora in chickpea. *Indian Journal of Weed Science*. 48(1): 79-82.
- Dixit, A. and Varshney, J.G. (2009). *Handbook on Herbicide Recommendations*. Directorate of Weed Science Research. pp. 58.
- Dixit, A.K., Kumar, S., Rai, A.K., Kumar, T.K. (2014). Tillage and irrigation management in chickpea (*Cicer arietinum*)-fodder sorghum (*Sorghum bicolor*) cropping system under semi-arid conditions of India. *Indian Journal of Agronomy*. 59(4): 575-580.
- Dubey, S.K., Kumar, A., Singh, D., Partap, T., Chaurasiya, A. (2018). Effect of Different Weed Control Measures on Performance of Chickpea under Irrigated Condition. *International Journal of Current Microbiology and Applied Sciences*. 7(5): 3103-3111.
- Gore, A.K., Chavan, A.S., Gokhale, D.N., Thombre, K.M. (2018). Evaluation of New Herbicides on Weed Flora and Productivity of Chickpea (*Cicer arietinum* L.). *International Journal of Current Microbiology and Applied Sciences*. 7(5): 3682-3687.
- Hassan, G., Khan, M.I., Khan, I. (2007). Effect of herbicides doses on fresh and dry biomass of different biotypes of *Asphodelus tenuifolius* at various growth stages. *Sarhad Journal of Agriculture*. 24(1):101-105.
- Havlin, J.L., Tisdale, S.L., Neslon, W.L., Beaton, J.D. (2014). *Soil Fertility and Fertilizers-An Introduction to Nutrient Management* 8th Edition. pp. 512.
- Kachhadiya, S.P., Savaliya, J.J., Bhalu, V.B., Pansuriya, A.G., Savaliya, S.G. (2009). Evaluation of new herbicides for weed management in Chickpea (*Cicer arietinum* L.). *Legume Research*. 32(4): 293-297.
- Kadioglu, I., Yanar, Y., Asav, U. (2005). Allelopathic effects of weeds extracts against seed germination of some plants. *Journal of Environmental Biology*. 26(2): 169-173.
- Kantar, F., Elkoca, E., Zengin, H. (1999). Chemical and Agronomical Weed Control in Chickpea (*Cicer arietinum* L. cv. Aziziye-94). *Turkish Journal of Agriculture and Forestry*. 23: 631-635.
- Kaushik, S.S., Rai, A.K., Sirothia, P., Sharma, A.K., Shukla, A.K. (2014). Growth, yield and economics of rain-fed chickpea (*Cicer arietinum* L.) as influenced by integrated weed management. *Indian Journal of Natural Products and Resources*. 5(3): 282-285.
- Khan, I., Khan, M.I., Ullah, H., Haroon, M., Gul, B. (2018). Assessment of integrated weed management approaches on *Asphodelus tenuifolius* in chickpea. *Planta Daninha*. 36: 1-8. DOI: 10.1590/S0100-83582018360100101.
- Khope, D., Kumar, S., Pannu, R.K. (2011). Evaluation of Post-emergence Herbicides in Chickpea (*Cicer arietinum*). *Indian Journal of Weed Science*. 43(1 and 2): 92-93.
- Knezevic, S.Z., Evans, S.O., Blankenship, E.E., Van Acker, R.C., Lindquist, J.L. (2002). Critical Period of weed control: the concept and data analysis. *Weed Science*. 50: 773-786.
- Knott, C.M. and Halila, H.M. (1986). Weeds in food legumes: problems, effects, control. In: Summer field, R.J. ed. *World Crops: Cool Season Food Legumes*. Dordrecht, Netherlands. Kluwer Academic. pp. 535-548.
- Kumar, N., Kumar, S., Sharma, S. (2020). Efficacy of Different Herbicides on Yield and Nutrient Uptake of Chickpea (*Cicer arietinum* L.). *International Archive of Applied Sciences and Technology*. 11(3): 91-97.
- Lyon, D.J. and Wilson, R.G. (2005). Chemical Weed Control in Dryland and Irrigated Chickpea. *Weed Technology*. 19(4): 959-965.
- Malik, M.R., Haqqani, A.M., Habib-ur-Rehman, Ozair, C.A., Malik, B.A. (2001). Economic efficacy of different pre- and post-emergence herbicides to control weeds in chickpea (*Cicer arietinum* L.). *Journal of Biological Sciences*. 1: 372-377.
- Malik, R.K., Balyan, R.S., Bhan, V.M. (1988). Effect of herbicides and planting dates on weeds in chickpea. *Indian Journal of Weed Science*. 20(2): 75-81.
- Martin, S.G., Van Acker, R.C., Friesen, L.F. (2001). Critical period of weed control in spring canola. *Weed Science*. 41: 62-68.
- Mashhadi, H.R. and Ahmadi, G.H. (1998). The critical period of weed control in rainfed chickpea (*Cicer arietinum* L.). *Bulgarian Journal of Plant Physiology. Special Issue*: 264.
- Masood-Ali, (1993). Studies on crop-weed competition in chickpea (*Cicer arietinum* L.)/ mustard (*Brassica juncea* L.) Czern and Coss) intercropping. *Proceeding of an Indian Society of Weed Science International Symposium, Integrated Weed Management for Sustainable Agriculture Hisar, India*. pp. 18-20.
- Merga, B. and Alemu, N. (2019). Integrated weed management in chickpea (*Cicer arietinum* L.). *Cogent Food and Agriculture*. 5: 1-18.
- Miller, P., McKay, K., Jenks, B., Riesselman, J., Bussan, A.J. (2002). Growing chickpea in the northern great plains. Fargo, North Dakota: North Dakota State University.
- Mohammadi, G., Javanshir, A., Khooie, F.R., Mohammadi, S.A., Zehtab Salmasi, S. (2005). Critical period of weed interference in chickpea. *Weed Research*. 45(1): 57-63.
- Mukherjee, D. (2007). Techniques of Weed Management in Chickpea-A Review. *Agricultural Reviews*. 28(1): 34-41.
- Numan, A., Ali, N., Khan, M.I., Rehman, M.U., Qadir, A. (2017). Yield and yield parameters of chickpea varieties under different weed population in Thal area of Khyber Pakhtunkhwa. *International Journal of Green and Herbal Chemistry*. 7(1): 119-129.
- Paradkar, N.R., Tiwari, J.P., Kurchania, S.P., Bhalla, C.S. (1997). Competitive stress of important weeds on growth and

- yield of gram (*Cicer arietinum* L.). World Weeds. 4: 41-47.
- Pedde, K.C. (2016). Chemical weed control in chickpea (*Cicer arietinum* L.). M.Sc. Thesis. Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani. pp. 135.
- Pooniya, V., Choudhary, A.K., Dass, A., Bana, R.S., Rana, K.S., Rana, D.S., Tyagi, V.K., Puniya, M.M. (2015). Improved crop management practices for sustainable pulse production: An Indian perspective. Indian Journal of Agricultural Sciences. 85(6): 747-758.
- Pooniya, V., Rai, B., Jat, R.K. (2009). Yield and yield attributes of chickpea (*Cicer arietinum* L.) as influenced by various row spacings and weed control. Indian Journal of Weed Science. 41(3 and 4): 222-223.
- Putnam, A.R. (1988). Allelochemicals from plants as herbicides. Weed Technology. 2(4): 510-518.
- Ramakrishna, A., Rupela, O.P., Reddy, S.L.N., Sivaramakrishna, C. (1992). Promising herbicides for weed control in chickpea. Tropical Pest Management. 38(4): 398-399.
- Ramamoorthy, K., Lourduraj, A.C., Thiagarajan, T.M., Sekhar, M.P., Stewart, B.A. (2004). Weeds and Weed Control in Dryland Agriculture- A Review. Agricultural Reviews. 25(2): 79-99.
- Rao, B.S.N. (2002). Pulses and Legumes as functional foods. Bulletin of the Nutrition Foundation of India. 23(1): 1-4.
- Rathod, P.S., Patil, D.H., Dodamani, B.M. (2017). Evaluation of time and dose of imazethapyr in controlling weeds of chickpea (*Cicer arietinum* L.). Legume Research. 40(5): 906-910.
- Regar, P.L., Rao, S.S., Joshi, N.L. (2010). In-situ rainwater conservation practices on productivity of chickpea (*Cicer arietinum* L.) in the rainfed conditions of arid Rajasthan, India. Indian Journal of Soil Conservation. 38(2): 111-115.
- Rice, E.L. (1984). Allelopathy. 2nd edition. Orlando: Academic Press pp. 422.
- Rupareliya, V.V., Chovatia, P.K., Vekariya, S.J., Javiya, P.P. (2018). Evaluation of pre and post emergence herbicides in chickpea (*Cicer arietinum* L.). International Journal of Chemical Studies. 6(1): 1662-1665.
- Saxena, M.C., Subramaniyam, K.K., Yadav, D.S. (1976). Chemical and mechanical control of weeds in gram. Pantnagar Journal of Research. 1: 112-116.
- Sesharee, A., Prasad, P.V.N., Rao, K.L., Rao, K.H.P. (1996). Integrated weed management in gram (*Cicer arietinum*). Indian Journal of Agronomy. 41(3): 496-497.
- Singh, A., Vashist, K.K., Kang, J.S. (2003). Chemical weed control in irrigated desi gram (*Cicer arietinum* L.). Indian Journal of Weed Science. 35(1 and 2): 136-138.
- Singh, G. and Singh, D. (1992). Weed –crop competition studies in chickpea (*Cicer arietinum*). Indian Journal of Weed Science. 24(1 and 2): 1-5.
- Singh, R.P., Verma, S.K., Singh, R.K. (2016). Effects of herbicides on growth and yield of *Cicer arietinum* L. under rainfed condition. Bangladesh Journal of Botany. 45(2): 305-311.
- Singh, S., Walia, U.S., Singh, B. (2008). Effective control of weeds in chickpea (*Cicer arietinum*). Indian Journal of Weed Science. 40(1 and 2): 51-55.
- Smitchger, J.A. (2010). The critical period of weed control in chickpea and lentil. M.Sc. Thesis. Department of Crop and Soil Sciences Washington State University.
- Tanveer, A., Muhammad, J.M., Muhammad, I., Abdul, K., Muhammad, Y. (2015). Yield Losses in Chickpea with Varying Densities of Dragon Spurge (*Euphorbia dracunculoides*). Weed Science. 63: 522-528.
- Tiwari, R., Vivek, Naresh, R.K., Tyagi, S., Shivangi, Kumar, A. (2019). Evaluation of effective weed management strategy for enhancing productivity and profitability of chickpea (*Cicer arietinum* L.) under sub-tropical climate of western UP. International Journal of Chemical Studies. 7(5): 928-933.
- Van Acker, R.C., Weise, S.F., Swanton, C.J. (1993). The critical period of weed control in soybeans [*Glycine max* (L.) Merr.]. Weed Science. 41: 194-200.
- Weaver, S.E. and Tan, C.S. (1987). Critical period of weed interference in transplanted tomatoes and its relation to water stress and shading. Canadian Journal of Plant Science. 67: 575-583.
- Weston, L.A. and Duke, S. (2003). Weed and Crop Allelopathy. Critical Reviews in Plant Sciences. 22(3-4): 367-389.
- Whish, J.P.M., Sindel, B.M., Jessop, R.S., Felton, W.L. (2002). The effect of row spacing and weed density on yield loss of chickpea. Australian Journal of Agricultural Research. 53: 1335-1340.
- Yadav, V.L., Shukla, U.N., Mehriya, M.L. (2018). Weed Dynamics and Yield of Chickpea (*Cicer arietinum* L.) as Influenced by Pre and Post-Emergence Herbicides. International Journal of Current Microbiology and Applied Sciences. 7(7): 2523-2532.
- Yadav, V.L., Shukla, U.N., Raiger, P.R., Mandiwal, M. (2019). Efficacy of pre and post-emergence herbicides on weed control in chickpea (*Cicer arietinum* L.). Indian Journal of Agriculture Research. 53(1): 112-115.
- Yenish, J.P. (2007). Weed management in chickpea. Chickpea Breeding and Management. CAB International, Wallingford, Oxon, UK. pp. 233-245.