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Weed management in clusterbean: A review

Dr. BT Patil, BB Handal and CB Bachkar

Abstract
Cluster bean [*Cyamopsis tetragonoloba* (L.) Taub] is a versatile and multipurpose under exploited leguminous vegetable crop of arid and semi-arid region belonging to the family Fabacae or Leguminosae. The crop is grown for green fodder, fresh vegetable, green manuring, gum and seed purpose. A year's seeding is seven year's weeding" and thus Indian agriculture has been defined as a "confrontation with weeds". The welfare of mankind is highly dependent on farmer's ability to control the growth of weeds. Thus, it is necessary to concentrate more on weeding out the undesirables than for any other activity related to increasing agricultural production. Weeds pose most serious problem in legume crops because of the liberal use of farm yard manure, chemical fertilizers and frequent irrigations that help the weeds to grow vigorously. Weeds reduce yield by competing with crops for water, nutrients, and sunlight. Season long competition with weeds in clusterbean causes severe yield reduction ranging from 29-48 per cent and severity may even be higher (70-98%) depending on the weed infestation. Hand weeding is a traditional and effective method of weed control, but untimely rains, unavailability of labour at peak time and increasing labour cost are the main limitations of manual weeding. Under such situations, the only alternative that needs to be explored is the use of suitable herbicides which may be effective and economically viable. Herbicide like pendimethalin, Imazthapyr with or one weeding or alone found effective for control weeds. Use of suitable herbicides alone or integrated with hand weeding needs to be explored as an effective and economical method of weed management in cluster bean.

Keywords: Cluster bean, weed, herbicide, weed intensity, biomass, species

Introduction
The word Guar [*Cyamopsis tetragonoloba* (L.) Taub] represents it's derivation from Sanskrit word "GAUAAHAR" which means cow fodder or otherwise fodder of the livestock. Gaur commonly known as Cluster bean [*Cyamopsis tetragonoloba* (L.) Taub] is a versatile and multipurpose under exploited leguminous vegetable crop of arid and semi-arid region belonging to the family Fabacae or Leguminosae. It is commonly known as guar, chavli kayi, guari, khutti guar. The origin of *Cyamopsis tetragonoloba* is unknown, since it has never been found in the wild. It is assumed to have developed from the African species *C. senegalesis*. It was further domesticated in India and Pakistan, where it has been cultivated for many centuries. This legume is a very valuable plant within a crop rotation cycle, as it lives in symbiosis with nitrogen-fixing bacteria. In fact, agriculturists in semi-arid regions of Rajasthan follow crop rotation and use guar as a source to replenish the soil with essential fertilizers and nitrogen fixation, before the next crop. The crop is grown for green fodder, fresh vegetable, green manuring, gum and seed purpose. The guar seed consists of three parts: the seed coat (14-17%), the endosperm (35-42%), and the germ (43-47%). Guar gum is derived from endosperm; this endosperm contains significant amounts off galactomannan gum (19-43% of the whole seed). Clusterbean seed is used as concentrate for animal feed and for extraction of gum. Guar gum is used in almost all types of industries *viz*., fertilizers, papers, petroleum, pharmaceuticals, food processing, food additives, textile printing, water treatment, sausages beverage, unique binding, dairy, cosmetics, mining explosive, oil drilling etc. The byproduct from gum extraction process is of a high value protein feed for cattle as it contains about 40 per cent protein. Guar as a plant has a multitude of different functions for human and animal nutrition; its gelling-agent-containing seeds (guar gum) are today the most important use. About 80 % of world production occurs in India and Pakistan, but, due to strong demand, the plant is being introduced into new areas.
It is a *kharif* pulse crop, considered as one of the most drought tolerant grain, deep-rooted and annual legume in India. In India, the crop is mainly grown in the dry habitats of Rajasthan, Haryana, Gujarat and Punjab and to a limited extent in Uttar Pradesh and Madhya Pradesh. Rajasthan alone comprises almost 78 per cent area and 81 per cent production to the national basket of Guar.

It is being cultivated on very less area in Maharashtra for vegetable purpose.

"A year's seeding is seven year's weeding" and thus Indian agriculture has been defined as a "confrontation with weeds". The welfare of mankind is highly dependent on farmer's ability to control the growth of weeds. Thus, it is necessary to concentrate more on weeding out the undesirables than for any other activity related to increasing agricultural production. Weeds pose most serious problem in legume crops because of the liberal use of farm yard manure, chemical fertilizers and frequent irrigations that help the weeds to grow vigorously. It has been well established that losses from weeds accounts for 45 per cent more than when compared to insect pests and diseases of about 30 and 20 per cent, respectively (Rao, 1983). Jain and Singh (2000) [45, 24] stated that an unchecked weed growth in clusterbean caused 47 per cent reduction in seed yield. In order to obtain higher seed yield of clusterbean the crop should be kept free from weeds for the first 30 days after sowing. As a guar is a rainy season crop and due to frequent rains the weed population increases tremendously which compete for nutrients, moisture and space with main crop causing considerable yield reduction. Weed control is an essential part of all crop production systems. Critical period of crop-weed competition in clusterbean is about 20 to 30 days after sowing, during this period, weeds reduce yield by competing with crops for water, nutrients, and sunlight. Season long competition with weeds in clusterbean causes severe yield reduction ranging from 29-48 per cent and severity may even be higher (70-98%) depending on the weed infestation. Hand weeding is a traditional and effective method of weed control, but untimely rains, unavailability of labour at peak time and increasing labour cost are the main limitations of manual weeding. Under such situations, the only alternative that needs to be explored is the use of suitable herbicides which may be effective and economically viable (Gupta 1984) [21]. The predominant weed flora that hampers the growth and yield of the crop vary with soil type, moisture condition and other climatic factors. Weed pose most serious problem in vegetable crops because of the liberal use of farm yard manure, chemical fertilizers and frequent irrigations that help the weeds to grow vigorously. In most of the vegetables, the early growth period is the most critical stage at which stress of any kind affects the economic yield. Weed competition is such an important stress during this period. This growth period is often marked by weather conditions that do not permit the traditional methods of weed control. Besides, this period coinciding with the season of peak labour activity leading to scarcity of labour for weeding. Hand weeding is a common practice of weed control but incessant rains in vertisols and unavailability and high labour wages at weeding peaks are the major constraints (Vyas and Kushwah, 2008) [65]. All this add to high cost of production. Under such situations, use of suitable herbicides alone or integrated with hand weeding needs to be explored as an effective and economical method of weed management. So proper weed control method, is the prime need and very much essential to give the herbicide usage its due share to obtain maximum productivity.

As guar is a rainy season crop and due to frequent rains the weed population increases tremendously, which compete for nutrients, moisture and space, causing considerable reduction in yield. Season long competition with weeds in cluster bean causes severe yield reduction and severity of loss depends on the weed infestation and its duration. Major weed flora of cluster bean includes *Digera arvensis* Forsk., *Trianthema Portulaca strum* (L.), *Cleome viscosa* (L.), *Dactyloctenium aegyptium* Beauv., *Physallis minima* (L.), *Echinochloa colona* (L.) Link, *Cenchrus echinatus* (L.), *Corchorus* sp., *Acrachne racemosa* (Heyne) ohwi., *Commelina benghalensis* (L.), *Digitaria sanguinalis* (L.) Scop, *Eragrostis ciliaris* (L.) R. Br, *Leptochloa chinensis* (L.) Nees., *Mollugo nudicaulis* (Lamk), *Mollugo cerviana* (L.) Ser., *Celosia argentea* (L.), *Bulbostylis barbata* (Rottb.) Clarke., *Phyllanthus niruri* L., *Portulaca oleraceae* L., *Brachiaria* sp., *Amaranthus* sp., *Cyprus* sp., and *Cynodon dactylon* (L.) Pers etc. Crop types and soil properties have greatest influence on the occurrence of weed species (Streibig *et al*. 1984 and Andreasen *et al.* 1991) [61, 3]. Various other factors like type of irrigation, cropping pattern, weed control measures and environment also have a significant influence on the intensity and infestation of weeds (Saavedra *et al.*1990) [48]. So, the knowledge of weed species associated with crops in a region is, therefore, necessary and requires to plan and execute a sound and economical weed management schedule depending upon various factors affecting weed distribution in different areas.

The potential yield of most of the varieties range from 18-20 q/ha, but the productivity in the state as well as of the country is far less than the potential average. There are many constraints for this low yield, but weed infestation is one of the main constraint (Yadav *et al*. 1993) [74]. On an average 20% crop yield is lost due to pest infestation, out of which 37% reduction caused by weed infestation (Planning Commission, 2006) [42]. Cluster bean is a poor competitor with weeds and suffers heavily in early growth stage due to favorable environment for weeds to thrive. Critical period of crop weed competition in cluster bean has been identified as 20-30 DAS and presence of weeds beyond these results in yield reductions by 47 to 92% (Bhadoria *et al*. 2000 and Yadav, 1998) [7, 67].

In the last four decades, considerable developments have been taken place in chemical weed control, thereby increasing the crop returns by reducing the cost of production. However, much needed information on the right kind of herbicides, the time, rate and method of application and residual effects on the succeeding crops are lacking in our country, especially with regard to vegetable crops.

Review of literature is a necessary step for any scientific study. It provides a theoretical framework, previous work and the basic interpretation of findings to the study. An attempt has been made to review the literature, which is meaningful and had direct relevance to this study.

Clusterbean is most vulnerable for weed interference during its early growth stages. Weeds are the greatest bottleneck for successful crop husbandry. Weeds compete with cultivated crops for the nutrients, moisture and sunlight. Control of weeds is therefore, tedious and is being accomplished by using manual labour which is expensive and is scarce too. Hence, use of herbicides/ chemicals have assumed a greater significance, particularly in intensive agriculture due to their ability of providing quick, effective, selective and economical weed control in terms of time and labour. Sequential application of herbicides aims at controlling broad spectrum control and consistent control of weeds throughout the growing season of crop. Brief reviews of earlier studies on crop weed competition and its effect on growth, yield components and yield and weed control through the use of herbicides are reviewed here with suitable headings.

1. Weed species associated with cluster bean
2. Effect of herbicides on Weed density and Weed dry matter
3. Weed control efficiency
4. Phytotoxicity effects of herbicides
5. Effect of herbicides on Growth and yield parameters
6. Effect of herbicides on succeeding crops

Weed species associated with cluster bean

Weed infestation is one of the constraints in crop production. The degree of damage caused by weeds is related to the type and density of weeds growing in a crop community. Weed species are known to vary with season and type of cultivation. Persistence of weeds in a particular location is largely influenced by edaphic (soil), biotic factors and climatic factors, which affect their occurrence, abundance, range and distribution. Before embarking on any purposeful work on weed control in any crop, it is essential to study the weed flora in that particular crop and in the field where it has to be grown.

Kumar *et al.,* (1996) [29] reported that *Trianthema portulacastrum*, *Digera arvensis*, *Amaranthus viridis*, *Cyperus rotundus* and *Cynodondactylon.* The predominant weed flora associated with clusterbean. Yadav (1998) [67] observed that the xerophytic weeds *Gisekia pharnacioides*, *Mollugo cerviana* and *Tribulus terrestris* were dominant in the low and erratic while grassy weeds, such as *Eragrostis pilosa*, were predominant during rainy season. Sumanth Kumar (2005) [62] reported that the important monocotyledonous weeds observed were *Cynadon dactylon*, *Poaannua*, *Cyperusiria*, *Panicum repens*, *Digiteria marginata*, *Setaria glauca*, *Cyperus rotundus*. While the common dicotyledonous weeds noticed are *Tridax procumbens*, *Portulaca oleraceae*, *Partheniumhysterophorus*, *Ageratum conyzoides*, *Urena lobata*, *Chenopodium murale*, *Convolvus arvensis*, *Lagasca mollis* and *Chenopodium album*. Dhaker *et al.,* (2009) [14] conducted a field experiment Weed management in clusterbean, during *kharif* season. Weed flora of experimental field was comprised *Cynodondactylon*, *Cyperus rotundus*, *Echinochloa colona*, *Echinochloacrus-galli* among monocot weeds and *Amaranthus viridis*, *Amaranthus spinosus*, *Commelina benghalensis*, *Partheniumhysterophorus* and *Trianthema portulacastrum* among dicot weeds. Overall the experiment was dominated by population of dicot weeds over monocots. Punia *et al.,* (2011) [44] found that weed flora of the experimental field was dominated by *Digera arvensis*, *Trianthema portulacastrum*, *Physallis minima*, *Corchorus olitorius*, *Solanum nigrum* and *Cyperus rotundus*. Yadav *et al.* (2011) [69] reported that, the experimental field was infested with different weed flora like *Amarathus viridis* (5.0%), *Amaranthus spinosus* (6.5%), *Commelina benghalensis* (13.9%), *Partheniumhysterophorus* (12.3%), *Trianthima portulcastrum* (15.0%), *Cynadon dactylon* (8.0%), *Cyperus rotundus* (6.5%), *Echinochloa colona*, (27.4%) and *Echinochloa crus-galli* (5.4%) at 20 DAS in clusterbean field. Singh *et al.* (2013) [57] reported that *Amaranthus viridis*, *Gisekiapoiedious*, *Digera arvensis*, *Cenchrus biflorus*, *Eragristis pilosa* and *Eragristis tannela*. These are the major weed flora of experimental field of clusterbean. Yadav *et al.,* (2013) [68] studied effect of weed management practices in Cluster Bean, major weed flora found in experimental field i.e. *Dactyloctenium aegyptium*, *Digera arvensis*, *Cyperus rotundus*, *Chenopodium* a*lbum*, *Eleusine indica*, *Euphorbia hirta*, *Boerhavia diffusa*, *Cynodon dactylon* and *Phyllanthus niruri.* Patil *et al.,* (2014) [41] studied weed management in clusterbean and observed the important grass weeds *viz., Echinochloa colonum, Dinebra Arabica, Bracheria mutica and Eragratis minor* while common broad leaves weeds were *Amaranthu viridis, Amaranthus polygamous, Euphorbia geniculata, Portulaca oleracea, Parthenium hysterophorus and Physelis minima*. Sangwan (2014) [46], studied Efficacy of imazethapyr + imazamox (Ready mix) in clusterbean and its residual effect on mustard in two texturally different soils and observed major weed flora infesting crop consisted of *Digera arvensis, Trianthema portulacastrum, Cleome viscosa, Dactyloctenium aegyptium, Echinochloa sp., Cenchrus echinatus, Corchorus sp., Acrachne racemosa, Commelina sp., Digitaria sanguinalis, Eragrostis ciliaris, Mollugo cerviana, Celosia argentea, Bulbostylis barbata, Phyllanthus niruri, Portulaca oleraceae, Brachiaria sp., Amaranthus sp., Cyprus sp.,* and *Cynodon dactylon.* Sharma *et al.,* (2017) [52] studied different weed control treatments in cluster bean during *kharif*, the weed flora observed mainly broad leaf weeds *viz., Digera arvensis, Commelina benghalensis, Alternanthera sessilis* and *Trianthema monogyna*. Among narrow leaf weeds *viz. Cyperus rotundus, Dactyloctenium aegyptium, Eragrostis sp.* and *Leptochloa chinensis*. These eight species were most dominant, contributing about 95 per cent of the total weed flora.

Effect of herbicides on Weed density and Weed dry matter

Balyan *et al.,* (1991) [5] reported that pendimethalin at 1.5 and 1.0 kg/ha and hand weeding at 25 DAS proved quite effective in minimizing the density and dry weight of weeds in clusterbean. However, Sumanth Kumar (2005) [62] observed that the application of pendimethalin @ 0.75 and 1.0 kg a.i. /ha significantly decreased weed density and the weed dry matter in clusterbean crop Yadav *et al.,* (2013) [59] reported that the significantly lesser number of total weeds density (9.98 no./m2) and dry weight (21.80 g/m2) at 25 DAS was registered under the pre-emergence application of pendimethalin at 1000 g/ha Ahuja and Yaduraj (1995) [1] assessed the efficacy of a few herbicides in clusterbean, and reported that the pre-emergence and post-emergence herbicidal treatments were more effective in reducing the weed growth. Balyan *et al.,* (1996) [6] reported that the PoE of imazethapyr at 90 g/ha in controlling broad-spectrum weed in clusterbean were found effective. Dhaker *et al.,* (2009) [14] revealed that imazethapyr 100 g/ha at 20 DAS + one hand weeding at 35 DAS was significantly superior to rest of the treatments in minimising weed densities and weed dry matterin clusterbean Punia *et al.,* (2011) [44] mentioned that PoE (post-emergence) application at 21-28 DAS at 80-100 g/ha of imazethapyr provided season long control (85-95%) of clusterbean weeds. Yadav *et al.* (2011) [69] reported that Imazethapyr alone and with hand weeding at 40 DAS effectively controlled both monocot and dicot weeds, while quizalofop ethyl controlled only monocot weeds However, Gupta *et al.* (2015) [22] reported that imazethapyr at 60 g/ha at 25 DAS as post-emergence in combination with hand weeding recorded significantly least number of weeds (1.47/m^2) and dry weight (1.78 g/m^2) than any other treatment except weed-free. All weed control treatments significantly reduced the density as well as dry weight. Sharma *et al.,* (2001) [53] found pendimethalin 1.5 kg/ha superior to imazethapyr 90 g/ha in reducing weed dry weight of

clusterbean but the same was at par with hand weeding at 20 DAS. Application of imazethapyr alone at 40 g/ha applied at 3-4 leaf stage (around 20 DAS) significantly reduced the density and dry weight of broadleaved weeds but not effective significantly against grassy weeds in clusterbean rep[orted by Gupta *et al*. (2015) [22]. Singh *et al.,* (2001) [56] in clusterbean reported that weed management practices decreased the weed population and dry weight over weedy check. during *kharif* season.. Lhungdim *et al.,* (2013b) [32] observed that imazethapyr was the most effective for *Cyperus* and *Chenopodium* weed control whereas, pendimethalin incorporated integrated package was effective on *Chenopodium* while imazethapyr associated integrated system was effective on *Cyperus* weeds. Singh *et al.* (2013) [57] reported that the imazethapyr + imazamox (factory mix) 40 g/ha and imazethapyr alone at 40 g/ha applied at 3-4 leaf stage significantly reduced the density and dry weight of broad leaf weeds in clusterbean as compared to weedy check, however grassy weeds were effectively controlled by quizalofop-ethyl 37.5 g/ha and fenoxaprop-ethyl 50 g/ha than imazethapyr + imazamox, imazethapyr alone at 40 g/ha. Density of grassy weeds was lower than broad leaved weeds in the experiment. Manhas and Sidhu (2014) [34] recorded that in clusterbean. Pendimethalin 750 g/ha followed by imazethapyr 40 g/ha results minimum weed intensity and weed dry matter accumulation. Patil *et al.,* (2014) [41] studied weed management in clusterbean and recorded that the Odyssey 70% WG @ 70 a.i./ha with MSO adjuvant @ 2 ml/litre found effective and were recorded significantly minimum weed intensity of grasses at 40 days (4.89) and 60 days (3.01) and lower values for broad leaved weeds (5.04 and 4.44) respectively at 40 and 60 days after application, lowest total weed dry matter. Gupta *et al.* (2015) [22] reported that, all the treatments resulted in significant reduction in weed density and dry weight of weeds over weedy check Weed-free treatment resulted in the lowest weed density and dry weight of weeds.

Singh *et al.* (2016) [60], reported that among herbicidees, post-emergence application of imazethapyr + imazamox (ready mix) 40 g/ha applied at 3-4 leaf stage (around 20 DAS) recorded lowest weed density and dry weight of both grassy and broad-leaved weeds with maximum weed control efficiency (88.1%).. Kumawat *et al.* (2017) [30], results revealed that among various weed management practices in clusterbean, two handweeding 20 and 40 DAS recorded significantly lower weed dry matter during both the years over rest of the treatments except sequential application of pendimethalin fb imazethapyr which was statistically at par. Sharma *et al.,* (2017) [52] studied different weed control treatments in cluster bean during *kharif*. Weed free check recorded significantly higher reduction in weed dry weight at 20, 40, 60 DAS.

Yadav and Mundra (2017) [72] reported that the minimum weed dry matter of narrow-leaved (129 kg per ha), broad-leaved (106 kg per ha) and total weed dry weight (235 kg per ha) was recorded under two hand weeding treatment which was closely followed by sequential application of pre emergence application of pendimethalin 0.75 kg per ha followed by post emergence application of imazethapyr 0.075 kg per ha.

Weed indices

Singh *et al.,* (2001) [56] in clusterbean reported that weed management practices decreased the weed population and dry weight and consequently increased the weed control efficiency over weedy check. Dhaker *et al.,* (2009) [14] conducted a field experiment Weed management in clusterbean, during *kharif* season, results revealed that, the highest weed control efficiency (90.78%) was recorded under two hand weedings followed by imazethapyr 100 g/ha at 20 DAS+one hand weeding at 35 DAS (89.38%), while it was minimum (33.32%) under quizalofop-ethyl 40 g/ha applied at 20 DAS. Patil *et al.,* (2014) [41] studied weed management in clusterbean and recorded that the Odyssey 70% WG @ 70 a.i./ha with MSO adjuvant @ 2 ml/litre found effective and were recorded significantly higher weed control efficiency at 20 days (61.0%), 40 days (73.0%) and 60 days (81.0%) respectively for grass weeds and highest weed control efficiency for broad leaf weeds at 40 days (86.0%) and 60 days (88.0%). Godara and Singh (2015) [18] in a study conducted in clusterbean reported that, imazethapyr 60 g at 20 DAS showed highest values weed control efficiency (90.1, 88.9 per cent at 30, 60 DAS and at harvest, respectively) and minimum weed index (4.7). Saras *et al*., (2016) [39], observed that in clusterbean maximum weed control efficiency was recorded with the intercultering followed by hand weeding at 20 and 40 days after sowing. Kumawat *et al.* (2017) [30], results revealed that among various weed management practices in clusterbean, two handweeding 20 and 40 DAS recorded higher weed control efficiency during both the years over rest of the treatments except sequential application of pendimethalin fb imazethapyr which was statistically at par.

Phytotoxicity symptoms

The length of time for which an herbicide remains active or persists in the soil is extremely important as it relates to the length of time that weed control can be expected. Residual toxicity is important, as it relates to phytotoxic after effects that may cause injury which may disappear when large amounts of water is given, due to leaching and with repeated cultivation or mixing of the soil. Sumanth Kumar (2005) [62] conducted experiment on Physiological studies on weed control efficiency in clusterbean and reported that oxyfluorfen @ 0.20 kg a.i. /ha has been found to be phytotoxic to clusterbean compared to other herbicides. Pendimethalin @ 0.75 and 1.0 kg a.i. /ha did not cause any phytotoxic effect in cluster bean. Punia *et al.,* (2011) [44] studied bioefficacy and phytotoxicity of imazethapyr and chlorimuron in clusterbean PoE application of imazethapyr @ 80 and 100 g/ha although caused mild injury to clusterbean in terms of yellowing of leaves and stunted crop growth upto 7 DAT, but it diminished within three weeks without any yield reduction.

Manhas and Sidhu (2014) [34], observed that the application of imazethapyr, imazethapyr + imazamox (Odyssey), quizalofop-ethyl, fenoxaprop-p-ethyl and pendimethalin in clusterbean at all doses and combinations resulted no phytotoxicity symptoms on cluster bean crop at all the stages of crop growth. Sangwan (2014) [46], studied Efficacy of imazethapyr + imazamox (Ready mix) in clusterbean and observed that no crop injury was observed under PRE applied herbicides. Slight yellowing and checked growth was observed only at initial stages due to different PoE herbicides. Higher rate of imazethapyr + imazamox and imazethapyr applied POE resulted in chlorosis of leaves and suppression of growth, though plants recovered within 2 weeks and no injury was observed at later stages.

Growth and yield parameters

Many workers have emphasized that the effect of weeds on growth and yield components ultimately decides the yield. The reduction may occur as a result of competition between the crop and weed for nutrients, space, light and water (Klingaman, 1961). Weeds thrive better than the crop plants when left uncontrolled and they can grow taller than the crop plants and suppress the growth to a considerable extent.

Yadav (1998) [73] reported that removing weeds at 20 or 30 DAS increased the number of pods per plant, water use efficiency and seed yield of clusterbean. Sharma *et al.,* (2001) [53] found pendimethalin 1.5 kg/ha superior to imazethapyr 90 g/ha in improving seed yield of clusterbean but the same was at par with hand weeding at 20 DAS. Singh *et al.,* (2001) [56] in clusterbean reported that weed management practices increased the yield attributes (number of branches per plant, seed/pod and also seed weight per plant), seed yield and mean net return over weedy check. Sharma and Singh (2003) [51] reported that the weed management practices significantly increased the yield attributes (number of branches per plant, number of seeds per pod, pod length, seed weight per plant and 1000-seed weight) and yield over the weedy control. Weed management practices increased the seed yield of clusterbean by 54-80% over the weedy control. Saxena *et al*., (2004) [49] concluded critical period of competition between weeds and clusterbean crop. The competition between weeds and crop caused 53.7% reduction in seed yield. Clusterbean required an initial 40 days weed-free period for better seed yield. Keeping the crop weed-free for initial 40 days gave maximum net returns. Patel *et al*., (2005) [38] observed that maximum seed yield and yield attributes recorded under weed-free check were at par with trifluralin 0.50 kg /ha + interculturing (IC) at 30 DAS, pendimethalin 0.50 kg /ha + IC and oxadiazon 0.25 kg /ha + IC and oxadiazon 0.50 kg /ha were significantly superior to rest of the treatments. Singh *et al.* (2008) [58] in an experiment to find out the critical period of competition between weeds and clusterbean crop concluded that the competition between weeds and crop caused 53.7% reduction in seed yield. Dhaker *et al.,* (2009) [14] imazethapyr 100 g/ha at 20 DAS+one hand weeding at 35 DAS recorded maximum yield attributes *viz*., pods/plant, seeds/pod and test weight and seed, haulm and biological yield. The higher yield and yield attributes under these treatments were attributed to lower weed density, weed dry weight and better weed control efficiency. The maximum seed yield (1597 kg/ha) was obtained under two hand weedings which was at par with imazethapyr 100 g/ha at 20 DAS+one hand weeding at 35 DAS (1580 kg/ha).

Punia *et al.,* (2011) [44] Maximum seed yield (1424 kg/ha) of clusterbean was obtained with imazethapyr at 100 g/ha PE which was at par with weed free check. Yadav *et al.* (2011) [69] reported that the Highest grain yield was obtained with weed free check (1840 kg/ha) followed by two hand weedings (1720 kg/ha) and imazethapyr 100 g/ha + hand weeding 40 DAS (1711 kg/ha) and it was significantly higher than all other treatments. Singh *et al.* (2013) [57] reported that the application of imazethapyr + imazamox at 40 g/ha and imazethapyr alone at 40 g/ha significantly increased the yield attributes and seed yield and net return of clusterbean compared to weedy. Patil *et al.,* (2014) [41] studied weed management in clusterbean and recorded that the pod yield was significantly higher in Odyssey 70% WG @ 70 a.i./ha with MSO adjuvant @ 2 ml/litre. Godara and Singh (2015) [18] in a study conducted in clusterbean reported that, imazethapyr 60 g at 20 DAS showed highest values of yield attributes, seed yield (11.65 q/ha), haulm yield (31.12q/ha). Sharma *et al.,* (2017) [52] reported that Combined application of imazethapyr + imazamox @ 40 g a.i./ha (PoE) at 20 DAS was found most effective herbicides to enhance the plant height and number of branches/plant and it was significantly superior over rest of treatments. All the weed control treatments significantly increased dry weight/plant over weedy check.

Effect on succeeding crop

Herbicide may also have carryover effect to sensitive crops in the next cropping season. Duration of persistence is very important for season long weed control. Herbicide should persist during current crop season, but carryover effect to next cropping season is not desirable. Finding the duration of herbicide persistence at applied rate will be helpful for determining the toxicity of herbicide to sensitive crop. Curran *et al.,* (1992) [9] studied the effect of herbicide application method and tillage on carryover effect of clomazone, imazaquin and imazethapyr using corn bioassay and chromatography and found that when these herbicides applied as PPI they dissipated slowly than PRE application. Corn injury was less with clomazone and more with imazethapyr and imazaquin in reduced till system than in conventional till system. Shaner and Hornford (2005) [50] reported that imazamox and imazethapyr applied early POE, did not have residual activity. Manhas and Sidhu (2014) [34] observed that the Imazethapyr, imazethapyr + imazamox, quizalofop-ethyl, fenoxaprop-p-ethyl and pendimethalin at all doses and combinations observed no residual effect on succeeding wheat crop.

Literature Cited

1. Ahuja KN, Yaduraj. Efficacy of few herbicides in clusterbean and pearlmillet under rainfed conditions. Annals of Agricultural Research 1995;16(2):251-253.
2. Aichele TM, Penner D. Adsorption, desorption, and degradation of imidazolinones in soil. Weed Technol 2005;19:154-159.
3. Andreasen JC, Streibig, Hass H. Soil properties affecting the distribution of 37 weed species in Danish fields. Weed Research 1991;31:181-187.
4. Babu C, Siddeswaran K, Chinnusamy C, Priya RS. Influence of imazethapyr on weed control and yield of groundnut and its residual effect on succeeding sunflower and pearl millet. Madras Agri. J 2013;100(1/3):123-126
5. Balyan RS, Malik RK, Panwar RS, Malik RS. Weed management studies in clusterbean (*Cyamopsis tetragonoloba*). Haryana Journal of Agronomy 1991;72(2):166-168.
6. Balyan RS, Ahuja KK, Pawar US, Jat MM. Weed management studies in clusterbean (*Cyamopsis Tetragonoloba*). Haryana Journal of Agronomy 1996;7(2):161168.
7. Bhadoria RBS, Jain PC, Tomclar, Tomar SS. Crop-weed competition in clusterbean [*Cyamopsis Tetragonoloba* (L.) Taub)] under rainfed condition. Indian Journal of Agronomy 2000;45(4):737-739.
8. Chopra, Nisha, Singh HP, Chopra NK. Effect of herbicides and weeding on weeds in clusterbean. Indian Journal of Weed Science 2001;33(3 and 4):194-197.
9. Curran WS, Libebel RA, Simmons FW. Effects of tillage and application method on clomazone, imizaquin and imazethapyr persistence. Weed Sci 1992;40:482-489.

10. Das TK. Weed science: Basics and Applications. Jain Brothers publications, New Delhi 2015,800p.
11. Daulay HS, Singh KC. Chemical weed control in green gram and clusterbean. Indian Journal of Agricultural Sciences 1982;52(11):758-763.
12. Deshmukh SB, Kumar, Vimal. Integrated weed management in soyabean. 25th Asian-Pacific Weed Science Society Conference on "Weed Science for Sustainable Agriculture, Environment and Biodiversity", Hyderabad, India 2015.
13. Devi KG, Karunakar AP, Gopinath KA. Integrated weed management in rainfed soybean (*Gliycine max* (L.) Merr.). Indian Dryland Agricul. Res. and Development 2013;27(2):51-54.
14. Dhaker Hemraj, Mundra SL, Jain NK. Weed Management in Clusterbean [*Cyamopsis Tetragonoloba* (L.) Taub.]. Indian Journal Weed Science 2009;41(3 & 4):224-227.
15. Dhonde MB, Kate SR, Pandure BS, Tambe AD. Integrated weed management in pigeonpea [*Cajanus cajan* (L.) Millsp.]. Indian J. Weed Science 2009;41(1&2):102-105.
16. Dungarwal HS, Chaplot PC, Nagda BL. Chemical weed control in clusterbean (cyamopsis tetragonoloba L.). Indian Journal of Weed Science 2002;34(3&4):208-212.
17. Gill GS, Vijaykumar. Weed index- a new method for reporting weed control trials. Indian J. Agron 1969;14(1):96-97.
18. Godara AS, Singh Ravindra. Weed control efficiency of post emergence herbicides and their effect on productivity of cluster bean [*Cyamopsis Tetragonoloba* (L.) Taub.]. Legume Research 2015;38(3):415-418
19. Gomez KA, Gomez AA. Statistical procedure for agricultural Research. An International rice research Institute book, a. Wiley-inter Science, John Wiley and Sons Inc. New york, United States of America 1983.
20. Greenland RG. Injury to vegetable crops from herbicides applied in previous years. Weed Technol 2003;17(1):73-78.
21. Gupta OP. Critical Period of Weed Crop Competition Scientific Weed Management in the Tropics and Sub-tropics, Today and Tomorrow's Printers and Publishers, New Delhi 1984.
22. Gupta Versha, Singh SP, Yadav RS. Yield performance and nutrient uptake as influenced by integrated weed management in clusterbean. Indian Journal of Weed Science 2015;47(1):82–84.
23. Hassan Deeba, Barla Sheela, Thakur HR, Puran AN, Upasani RR. Studies on time application of imazethapyr and its ready mix combination with imazamox against weeds in blackgram. 25th Asian-Pacific Weed Science Society Conference on "Weed Science for Sustainable Agriculture, Environment and Biodiversity", Hyderabad, India 2015,238p.
24. Jain, Singh. Integrated weed management in clusterbean. Haryana Journal of Horticultural Sciences 2000;2:146-149.
25. Jain Namrata, Jain Vinamarta, Patidar Ravi. Bioefficacy of sethoxydim on grassy weeds and yield of soybean. (25th Asian-Pacific Weed Science Society Conference on "Weed Science for Sustainable Agriculture, Environment and Biodiversity", Hyderabad, India 2015,216
26. Kamble AB, Danawale NJ, Rajendrakumar. Integrated weed management in Bt cotton. Indian Journal of Weed Science 2017;49(4):405-408.
27. Klingman GC. Weed Control Science, Jhon Willey and Sons, New York 1961,42p.
28. Krishnamurthy K, Raju BJ, Raghunath G, Jagnath MK, Prasad TVR. Herbicide efficiency index in sorghum. Indian J. Weed Sci 1975;7(2):75-79.
29. Kumar, Virender, Yadav BD, Yadav Ashok. Crop-weed competition in clusterbean under rainfed conditions. Annals of Arid Zone 1996;35(1):79-81.
30. Kumawat Priyanka, Kaushik MK, Meena VK, Chouhan Bhagwat Singh, Meena RK, Rakesh Kumar. Effect of weed management and fertility levels on productivity of clusterbean [*Cyamopsis Tetragonoloba* (L.)Taub]. Legume Research 2017;40(5):884-889.
31. Lhungdim J, Singh Y, Pd. Singh R. Integration of Chemical and Manual Weed Management on Weed Density, Yield and Production Economics of Lentil (Lens culinaris Medikus). International Journal of Bio-resource and Stress Management 2013a;4(4):593-598.
32. Lhungdim J, Singh Y, Pramod Kumar, Chongtham SK. Integrated weed management of lambsquarter and nut sedge in lentil. Indian Journal of Weed Science 2013b;45(3):192-197.
33. Mahajan MS, Pawar PP, Walile SC, Patil DB. Efficacy of herbicides on quality, yield and economics of soybean. Paper presented in 25th Asian-Pacific Weed Science Society Conference on "Weed Science for Sustainable Agriculture, Environment and Biodiversity", Hyderabad, India 2015,180p.
34. Manhas SS, Sidhu AS. Residual effect of cluster bean herbicides on succeeding wheat crop. Indian Journal of Weed Science 2014;46(3):278–282.
35. Mani VS, Pandita ML, Gautam KC, Bhagwandas. Weed killing chemicals in potato cultivation. Indian Farming 1973;23:7-13.
36. Mishra M, Mishra A. Estimation of integrated pest management index in jute-A new approach. Indian J. Weed Sci 1997;29:39-42.
37. Panse VG, Sukhatme PV. Statistical methods for agricultural workers. ICAR, New Delhi 1989.
38. Patel MM, Patel IC, Patel BS, Tikka SBS. Integrated Weed Management in Clusterbean under Rainfed Conditions. Annals of Arid Zone 2005;44(2):151-154.
39. Patel RI, Patel PH, Piyush Kumar Saras, Patel Neha V. Weed Management In Field Pea (*PisumSativum* L.). The Bioscan an International Quarterly Journal of Life Sciences 2016;11(3):1703-1706
40. Patil AG, Halepyati AS, Chittapur BM. Efficacy of Sequential application of Herbicides on soybean growth and yield in north eastern transitional zone of Karnataka. International Archive of Applied Sciences and Technology 2017;8(1):32-37
41. Patil BT, Bhalekar MN, Shinde KG. Weed management in cluster bean (*Cyamopsis Tetragonoloba* (L.) Taub). Journal of Agriculture Research and Technology 2014;39(3):501-504.
42. Planning commission. Working subgroup on Plant Protection, GOI, New Delhi 2006.
43. Prasanna B, Goverdhan M, Sridevi S, Venkata Ramana M. Bioefficacy of herbicides and integrated weed management practices in groundnut. 25th AsianPacific Weed Science Society Conference on "Weed Science for Sustainable Agriculture, Environment and Biodiversity", Hyderabad, India 2015,212p.

44. Punia SS, Singh Samunder, Yadav Dharambir, Bioefficacy of imazethapyr and chlorimuron-ethyl in clusterbean and their residual effect on succeeding crops. Indian Journal of Weed Science 2011;43(1&2):48-53.
45. Rao VS. Principles of weed science, Oxford and IBH Publiushing Co. New Delhi 1983,24-42p.
46. Sangwan Meenakshi. Efficacy of imazethapyr + imazamox (Ready mix) in clusterbean and its residual effect on mustard in two texturally different soils. M.Sc. Agri.thesis submitted to College of Agriculture CCS Haryana Agriculture University Hisar, India 2014.
47. Saras Piyush Kumar, Patel BD, Parmar Sejal K, Patel RB. Weed Management in Late Kharif Cluster Bean (*Cyamopsis Tetragonoloba* (L.) Taub) and its Impact on Crop Growth and Yield. International Journal of Bio-resource and Stress Management 2016;7(1):047-051
48. Saavedra KL, Torres G, Bermejo EH, Hildag B. Influence of environmental factors on the weed flora in the Guadalquivir valley. Weed Research 1990;30:363-374.
49. Saxena, Anurag, Singh YV, Singh Raj. Crop-weed competition in clusterbean in arid region. Journal of Arid Legumes 2004;1(1):41-43
50. Shaner DL, Hornford R. Soil interactions of imidazolinone herbicides used in Canada. Soil residual herbicides. Sci. Manage 2005,23-30p.
51. Sharma RP, Singh P. Effect of weed management and phosphorus levels on yield and quality of clusterbean (*Cyamopsis Tetragonoloba* L.). Annals of Agricultural Research 2003;24(3):605-609.
52. Sharma Kalpana, Rawat GS, Gaur Dharmendra, Sharma Anju. Effect of post-emergence herbicides on weed control, growth and yield of cluster bean [*Cyamopsis Tetragonoloba* (L.) Taub.] in M.P. Agricultural Science Digest - A Research Journal 2017;37(3):179-184.
53. Sharma RP, Singh P, Nepalia V. Effect of weed management and phosphorus levels on weed dynamics and crop- weed competition for nutrients in clusterbean (Cyamopsis tetragonoloba (L.). Indian Journal of Weed Science 2001;33(3 and 4):147150.
54. Shete BT, Patil HM, Kolekar PT. Effect of cultural practices and post emergence herbicides against weed control in soybean. Internat. J. Agric. Science 2007;3(2):273-275.
55. Shyam Lal, Kewat ML, Tarun Suryavanshi. Weed Indices as Influenced by Propaquizafop and Imazethapyr Mixture in Soybean. Int. J. Curr. Microbiol. App. Sci 2017;6(8):3109-3115.
56. Singh A, Ahlawat IPS, Saraf CS. Studies on weed control in clusterbean (*Cyamopsis Tetragonoloba* (L.). Indian journal of Agronomy 2001;31(3):269-272.
57. Singh Guriqbal, Sekhon HS. Integrated weed management in pigeonpea [*Cajanus cajan* (L.) Millsp.] World J. Agricul. Sci 2013;9(1):86-91.
58. Singh SK, Jain AK, Punia BL. Integrated weed management in clusterbean (*Cyamopsis Tetragonoloba* (L.). Indian Journal of Agrilcutural Science 2008;70(2):850-852.
59. Singh SP, Yadav RS, Sharma Vikas, Bairwa RC. Efficacy of weed control measures on weeds and yield of clusterbean. Biennial Conference of Indian Society of Weed Science on "Emerging Challenges in Weed Management' 2013,52p.
60. Singh SP, Yadav RS, Vikas Sharma. Weed control in clusterbean through post-emergence herbicides. Indian Journal of Weed Science 2016;48(2):202-205.
61. Streibig JC, Gottshau A, Dennis B, Hass H, Molgaar P. Soil properties affecting weed distribution. In: 7th Int. Symp. Weed Biol. Ecol. Systematics, Paris 1984,147-154p.
62. Sumanth Kumar. Physiological studies on weed control efficiency in cluster bean (*Cyamopsis Tetragonoloba* (L.) Taub). M.Sc. Agri. thesis submitted to Univ. of Agri. Sci., Dharwad, India 2005.
63. Tripathi, Singh SS, Rohiteshev Singh, Govindra, Singh, Rajesh Kumar. Critical period of weed competition in summer cowpea. Indian Journal of Weed Science 2001;33(1&2):67-68.
64. Vaghasia PM, Nadiyadhara V. Effect of post- emergence herbicides in groundnut and its residual effect on succeeding crops. International Journal of Forestry and Crop Improvement 2013;4(2):54-58.
65. Vyas MD, Kushwah SS. Effect of cultural and chemical methods on growth and yield of soybean in Vindhynagar Plateau of Madhya Pradesh. Indian Journal of Weed Scince 2008;40:92-94.
66. Walia US. Weed management. 3rd Ed. Kalyani publishers, New Delhi 2010,373p.
67. Yadav. Effects of weed removal in clusterbean. (*Cyamopsis Tetragonoloba*) under different rainfall situations in an arid region. Journal of Agronomy and Crop Science 1998;181(4):209-214.
68. Yadav JK, Patel BD, Roshan Choudhary, Jat AL, Choudhary HR, Yadav SM. Effect of Weed Management Practices on Weed Dynamics, Growth Characters and Productivity of Cluster Bean (*Cyamopsis Tetragonoloba* (L.) Taub.) during Summer Season. Environment & Ecology 2013;31(3A):1504-1507.
69. Yadav SL, Kaushik MK, Mundra SL. Effect of weed control practices on weed dry weight, nutrient uptake and yield of clusterbean [*Cyamopsis Tetragonoloba* (L.) Taub.] under rainfed condition. Indian Journal of Weed Science 2011;43(1&2):81-84.
70. Yadav SL, Kaushik MK, Singh Shailendra, Yadav RK. Productivity and quality of clusterbean [*Cyamopsis Tetragonoloba* (L.) Taub.] as influenced by weed management. Annals of Agri Bio Research 2014;19(1):70-73.
71. Yadav Ramawatan, Bhullar S, Makhan. Bioefficacy of pre and post emergence herbicides of soybean. (25th Asian-Pacific Weed Science Society Conference on "Weed Science for Sustainable Agriculture, Environment and Biodiversity", Hyderabad, India 2015,212p.
72. Yadav RK, Mundra SL. Weed management and sulphur nutrition in clusterbean for higher productivity and profitability. Journal of Pharmacognosy and Phytochemistry 2017;6(3):06-08.
73. Yadav RS. Effects of weed removal in cluster bean (Cyamopsis tetragonoloba) under different rainfall situations in an arid region. J. Agron. Crop Science 1998;181:209-214.
74. Yadav VK, Yadav BD, Joshi UN. Effect of weed control and fertilizer application on seed and grain yield of cluster bean under rainfed conditions. Forage Res 1993;19:341-342.