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CLUSTERBEAN (GUAR) WEED MANAGEMENT METHODOLOGIES IMPROVES SOCIO ECONOMIC CONDITION OF FARMERS; A REVIEW

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ABSTRACT

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. 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.

Weed infestation is one of the main constraints. On an average 20% crop yield is lost due to pest infestation, out of which 37% reduction caused by weed infestation. 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%. Weed management practices decreased the weed population and dry weight and consequently increased the weed control efficiency over weedy check.

Poor weed management is one of the important factors for low yield of this crop. Slow growth at initial stages of the crop favors recurrent flushes of weeds, which compete with crop for essentials of growth and cause heavy reduction in its seed yield. Critical period for crop-weed competition in cluster bean has been identified as 20 to 30 days after sowing and presence of weeds showed in yield reductions by 47 to

92%. Among different weed management practices, use of herbicides is the only choice under adverse situations. However, herbicides are costly and their availability in desired quality has residual effect. Therefore, integrated approach (chemical and mechanical control) makes weed management more effective and economical. Effective control of weeds through cultural practices. In the long run, pre-mixture of pendimethalin+imazethapyr @ 800 g ha-1 pre-emergence was found more effective for controlling monocot weeds as well as dicot weeds. This might be due to the broad-spectrum control of weeds because of combination of two herbicides with different mode of action and decreasing residual effect of pendimethalin and prolonged residual effect of imazethapyr). Higher weed control efficiency was noted in hand weeding at 20 and 40 days after sowing in cluster bean crop. Due to controlling weeds, higher growth and yield parameters of cluster bean were probable reasons for higher seed yield in intercultering+ hand weeding treatment. The weed management schedule having low weed biomass and higher weed control efficiency would provide favorable situation for maximization of cluster bean yield potential. Among herbicide application of pendimethalin+imazethapyr (pre-mixed) @ 800 g ha-1 pre-emergence followed by hand weeding at 30 days after sowing recorded higher net return and B: C ratio.

Keywords: Digera arvensis; Mollugo nudicaulis; Commelina benghalensis; Dactyloctenium aegyptium; Weed control efficiency (WCE); Oxyflourfen and Imazethapyr

INTRODUCTION

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. 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, and 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.

Jain and Singh (2000) 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.

Major weed flora of cluster bean includes Digera *arvensis* Forsk., Trianthema *Portulaca strum* (L.), *Cleome viscosa* (L.), *Dactylocteniumaegyptium Beauv.*, *Physallis minima* (L.), *Echinochloa colona* (L.) Link, *Cenchrus echinatus* (L.), *Corchorus sp*., *Acrachneracemosa* (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 nir*uri 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. 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. 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. On an average 20% crop yield is lost due to pest infestation, out of which 37% reduction caused by weed infestation (Planning Commission, 2006). 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).

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. 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. Dhaker et al. (2009) conducted a field experiment Weed management in clusterbean, during kharif season. of experimental field was comprised *Cynodon dactylon, Cyperus rotundus, Echinochloa colona, Echinochloacrus-galli* among monocot weeds and *Amaranthus viridis Amaranthus spinosus, Commelina benghalensis, Partheniumhysterophorus* and *Trianthema portulacastrumamong* dicot weeds. Overall, the experiment was dominated by population of dicot weeds over monocots. Punia et al. (2011) 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) reported that, the experimental field was infested with different weed flora like *Amarathus viridis* (5.0%), *Amaranthus spinosus* (6.5%), *Commelina benghalensis* (13.9%), *Parthenium hysterophorus* (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) reported that *Amaranthus viridis*, *Gisekia poiedious*, *Digera arvensis*, *Cenchrus biflorus*, *Eragristis pilosa* and *Eragristis tannela*. These are the major weed flora of experimental field of clusterbean. Yadav et al. (2013) 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 album*, *Eleusine indica*, *Euphorbia hirta* and *Boerhavia diffusa*.

Patil et al. (2014) 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) 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) 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.

Sumanth Kumar (2005) 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 Yadao et al., (2013) reported that the significantly lesser number of total weeds density (9.98 no./m^2) and dry weight (21.80gm^{-2}) at 25 DAS was registered under the pre-emergence application of pendimethalin at 1000 gha^{-1}. Dhaker et al. (2009) revealed that imazethapyr 100 g/ha at 20 DAS + one hand weeding at 35 DAS was significantly superior to rest of the treatments in minimizing weed densities and weed dry matter in

clusterbean Punier et al., (2011) mentioned that PoE (post-emergence) application at 21-28 DAS at 80-100 gha^{-1} of imazethapyr provided season long control (85-95%) of clusterbean weeds. Yadav et al. (2011) 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) 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) found pendimethalin 1.5 kg/ha superior to imazethapyr 90 gha^{-1} 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 gha^{-1} 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 reported by Gupta et al. (2015). Singh et al. (2001) in clusterbean reported that weed management practices decreased the weed population and dry weight over weedy check during Kharif season. Lhungdim et al., (2013b) 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) 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) recorded that in clusterbean. Pendimethalin 750 g/ha followed by imazethapyr 40 g/ha results minimum weed intensity and weed dry matter accumulation. Patel et al. (2014) studied weed management in clusterbean and recorded that the Odyssey 70% WG @ 70 a.i. ha^{-1} with MSO adjuvant @ 2 ml $litre^{-1}$ 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) 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), reported that among herbicides, 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), results revealed that among various weed management practices in clusterbean, two hand weeding 20 and 40 DAS recorded significantly lower weed dry matter during both the years over rest of the treatments except sequential application of pendimethalin + imazethapyr which was statistically at par. Sharma et al., (2017) 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) reported that the minimum weed dry matter of narrow-leaved (129 kg per ha), broad-leaved (106 kg ha^{-1}) and total weed dry weight (235 kg ha^{-1}) was recorded under two hand weeding treatment which was closely followed by sequential application of pre emergence application of pendimethalin 0.75 kg ha^{-1}followed by post emergence

application of imazethapyr 0.075 kg ha^{-1}.

Singh et al., (2001) 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) 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 weeding's 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) studied weed management in clusterbean and recorded that the Odyssey 70% WG @ 70 a.i. ha^{-1} with MSO adjuvant @ 2 ml $litre^{-1}$ 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) in a study conducted in clusterbean reported that, imazethapyr 60 g at 20 DAS showed highest values weed control efficiency (90.1, 88.9 % at 30, 60 DAS and at harvest, respectively) and minimum weed index (4.7). Saras et al. (2016), observed that in clusterbean maximum weed control efficiency was recorded with the intercultering followed by hand weeding at 20 and 40 days after sowing. Kumara et al. (2017), results revealed that among various weed management practices in clusterbean, two hand weeding 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.

Sumanth Kumar (2005) 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) studied bio efficacy 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 up to 7 DAT, but it diminished within three weeks without any yield reduction. Manhas and Sidhu (2014) 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) 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 were 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.

Sharma et al. (2001) 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) 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) 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) 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) observed that maximum seed yield and yield attributes recorded under weed-free check were at par with trifluralin 0.50 kg ha^{-1} + intercultering (IC) at 30 DAS, pendimethalin 0.50 kg ha^{-1} + IC and oxadiazon 0.25 kg ha^{-1} + IC and oxadiazon 0.50 kg ha^{-1} were significantly superior to rest of the treatments. Singh et al. (2008) 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) imazethapyr 100 g ha^{-1} 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^{-1}) was obtained under two hand weedings which was at par with imazethapyr 100 g ha^{-1} at 20 DAS+ one hand weeding at 35 DAS (1580 kg ha^{-1}). Punia et al. (2011). Maximum seed yield (1424 kg ha^{-1}) of clusterbean was obtained with imazethapyr at 100 g/ha PE which was at par with weed free check. Yadav et al. (2011) reported that the Highest grain yield was obtained with weed free check (1840 kg/ha) followed by two hand weedings (1720 kg ha^{-1}) and imazethapyr 100 g ha^{-1} + hand weeding 40 DAS (1711 kg/ha) and it was significantly higher than all other treatments. Singh et al. (2013) reported that the application of imazethapyr + imazamox at 40 g ha^{-1} and imazethapyr alone at 40 g ha^{-1} significantly increased the yield attributes and seed yield and net return of clusterbean compared to weedy. Patil et al. (2014) studied weed management in clusterbean and recorded that the pod yield was significantly higher in Odyssey 70% WG @ 70 a.i. ha^{-1} with MSO adjuvant @ 2 ml $litre^{-1}$. Godara and Singh (2015) in a study conducted in clusterbean reported that, imazethapyr60 g at 20 DAS showed highest values of yield attributes, seed yield (11.65 q ha^{-1}), haulm yield (31.12q ha^{-1}). Sharma et al. (2017) reported that combined application of imazethapyr + imazamox @ 40 g a.i. ha^{-1} (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. Shaner and Hornford (2005) reported that imazamox and imazethapyr applied early POE, did not have residual activity. Manhas and Sidhu (2014) 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.

The higher benefits obtained under these treatments were also due to comparatively less cost of herbicides than hand weeding as well as higher seed and stover yield of cluster bean (Reager *et al*., 2003b)

Poor weed management is one of the important factors for low yield of this crop. Slow growth at initial

stages of the crop favors recurrent flushes of weeds, which compete with crop for essentials of growth and cause heavy reduction in its seed yield. Critical period for crop-weed competition in cluster bean has been identified as 20 to 30 days after sowing and presence of weeds showed in yield reductions by 47 to 92% (Punia *et al*., 2011). Among different weed management practices, use of herbicides is the only choice under adverse situations. However, herbicides are costly and their availability in desired quality has residual effect. Therefore, integrated approach (chemical and mechanical control) makes weed management more effective and economical. Effective control of weeds through cultural practices was also reported by Yadav et al. (2011). In the long run, pre-mixture of pendimethalin+imazethapyr @ 800 g ha^{-1} pre-emergence was found more effective for controlling monocot weeds as well as dicot weeds. This might be due to the broad spectrum control of weeds because of combination of two herbicides with different mode of action and decreasing residual effect of pendimethalin and prolonged residual effect of imazethapyr (Soltani *et al*., 2012 and Jha and Soni, 2013). Yadav et al. (2011) also reported higher weed control efficiency in hand weeding at 20 and 40 days after sowing in cluster bean crop. Due to controlling weeds, higher growth and yield parameters of cluster bean were probable reasons for higher seed yield in intercultering+ hand weeding treatment (Yadav et al. (2011); Soltani et al., 2012 and Bhadoria and Jain, 2005. The weed management schedule having low weed biomass and higher weed control efficiency would provide favorable situation for maximization of cluster bean yield potential (Yadav *et al*., 2011 and Jha and Soni, 2013). Among herbicide application of pendimethalin+imazethapyr (pre-mixed) @ 800 g ha^{-1} pre-emergence followed by hand weeding at 30 days after sowing recorded higher net return and B:C ratio (Jha and Soni, 2013).

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