Environment and Ecology 40 (2B) : 792—798, April—June 2022
ISSN 0970-0420

Mechanized Weed Management in Cluster Bean (*Cyamopsis tetragonoloba* L.) under Rainfed Conditions

Sushil Kumar, Bikram Singh, Anil Kumar, Ekta Kamboj, Akshit, Sunil

Received 2 March 2022, Accepted 14 April 2022, Published on 8 May 2022

ABSTRACT

A field experiment was carried out at Regional Research Station, Bawal (Rewari), CCS Haryana Agricultural University, Hisar (Haryana) during *kharif* season 2018 to study the effect of mechanized weed management in rainfed cluster bean (*Cyamopsis tetragonoloba* L.). The major weeds reported from the field were *Cyperus rotundus, Digera arvensis, Trianthema portulacastrum* and *Eragrostis* spp. Significant minimum weed count and weed dry weight was recorded from the treatment T_6 where two time mechanized interculture (at 20 and 35 DAS) with power weeder was done under 60 cm row spacing and it was at par with treatment T_5 in which tractor drawn cultivator was instead of power weeder. Maximum weed control efficiency and minimum weed dry index was found in treatment T_6 (94.1% and 3.04 %, respectively) followed by T_5 (90.9 % and 7.49 %, respectively). It was concluded that two time mechanized interculture (at 20 and 35 DAS) with power weeder (T_6) or tractor drawn cultivator (T_5) under row spacing of 60 cm were found superior over recommended manual weeding once either with kasola (T_1) or wheel hand hoe (T_2) performed at 27 DAS under 45 cm row spacing.

Keywords Clusterbean, Mechanized weed control, Power weeder, Tractor drawn cultivator.

INTRODUCTION

Cluster bean (*Cyamopsis tetragonoloba* L.) which is known as guar is drought hardy leguminous cash crop. Its residues are mainly used as a feed for cattle "Gowahaar" (Gow means cow and Ahaar mean feed) from which the name guar originated. It contains 10.8 % of carbohydrates, 23-24 % protein, 1.4 % fat, 1.4 % minerals and vitamins A and C. It is mainly grown on poor and marginal land during *kharif* season. It is a deep rooted nitrogen fixer plant. Tap root system is well developed which makes it to withstand in water scarcity conditions. Incorporation of residue of cluster bean in soil helps in improving fertility and soil physical, chemical and biological properties. It is mainly used as vegetable, fodder for animals,

Sushil Kumar*[1], Bikram Singh[2], Anil Kumar[3], Ekta Kamboj[4], Akshit[5], Sunil[6]

[1,4,5,6]Ph.D Scholar, Department of Agronomy, Department of Agronomy, CCS Haryana Agricultural University, Hisar 125004, Haryana

[2]Principal Scientist, Regional Research Station, CCS Haryana Agricultural University, Hisar 125004, Haryana

[3]Principal Scientist, Bajra Section, Department of Genetics and Plant Breeding
CCS Haryana Agricultural University, Hisar 125004, Haryana, India
Email: puniasushil22@gmail.com
*Corresponding author

green manure and seed. Its seeds contain 28-33 % galactomann (gum) that is found in endosperm of seed. Its gum has commercial importance so makes it one of the important industrial crop of the country. It is mainly used for manufacturing of cardboard, clothes, petroleum, medicinal drugs, food processing, beauty products, combustible products, oil drilling. Thus making it a main foreign exchange earner crop. India produced about 80 % of total global production of cluster bean. Major cluster bean growing countries are India, Australia, USA, Pakistan, South Africa and Brazil. Its cultivation in India is mainly confined to north western states which are Rajasthan, Gujarat, Haryana, Punjab and Madhya Pradesh.

Initial growth of guar is very slow which makes it a poor competitor for weeds. It is grown during rainy season and due to frequent rain flushes weed population increase which compete with crop for nutrient, water, space and cause reduction in yield (Brar 2018). Critical period of weed competition ranges from 20-30 DAS. Crop is infested with both grassy and broad-leaved weeds. Yield reduction ranges from 28-53 % and in severe cases it may goes up to 70-98 % (Saxena *et al*. 2004). Under Haryana conditions only manual weeding is recommended. Manual weeding is expensive and time consuming process so other methods of weed control should be exploited. Among the different weed management methods, mechanical weeding can be used for control of weeds if minimum requirement of row spacing was fulfilled. Mechanical weeding helps to control the weeds in time as well as it is economically viable for farmers. However, Mechanical weed control can be used only during early stages of crop because at later stages potential damage to crop foliage may takes place. Hence, mechanical weeding is a good option over manual weeding. The use of inter row cultivator can reduce the costs for hand weeding in small sized less competitive crops (Peruzzi *et al*. 2007). So to overcome the problem of labor shortage and to avoid economic losses the present investigation was carried out.

MATERIALS AND METHODS

The experiment was carried out at Regional Research Station, Bawal (Rewari) CCS HAU, Hisar during *kharif* season 2018. The mean weekly minimum and maximum temperature ranged from 20.6^{0}C to 27.6^{0}C and 30^{0}C to 38.6^{0}C, respectively. However, mean weekly morning and evening relative humidity ranged from 71 to 91 % and 39 to 76 %, respectively (Fig. 1). The soil of experimental site was sandy loam in texture with pH 8.3, organic matter (0.29 %), EC (0.26 ds m^{-1} at 25^{0}C), $KMnO_4$ oxidizable N (145 kg ha^{-1}), 0.5 M $NaHCO_3$ extractable P (18 kg ha^{-1}) and 1 N NH_4OAC extractable K (188 kg ha^{-1}). The experiment was laid out in Randomized block Design (RBD) with 10 treatments and 3 replications. The treatment details include; T_1: Interculture with kasola at 27 DAS with row spacing of 45 cm, T_2:

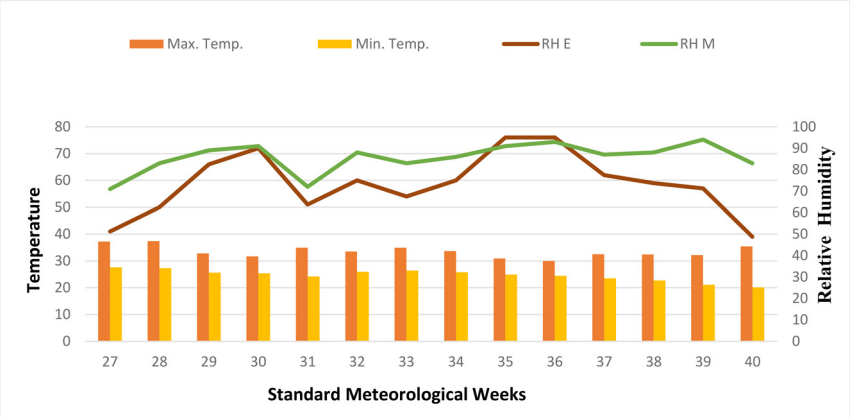


Fig. 1. Meteorological parameters during crop growing season.

Interculture with wheel hand hoe at 27 DAS with row spacing of 45 cm, T_3: Interculture with tractor drawn cultivator at 27 DAS with row spacing of 60 cm, T_4: Interculture with power weeder at 27 DAS with row spacing of 60 cm, T_5: Interculture with tractor drawn cultivator at 20 and 35 DAS with row spacing of 60cm, T_6: Interculture with power weeder at 20 and 35 DAS with row spacing of 60 cm, T_7: Weedy check with 45 cm row spacing, T_8: Weed free with 45 cm row spacing, T_9: Weedy check with 60 cm row spacing and T_{10}: Weed free with 60 cm row spacing. Field preparation was started after the onset of rains in July. Two cross harrowing with disc harrow was done followed by planking. Fertilizers were applied as per recommendation of package of practices of CCS HAU i.e., 20 kg N and 40 kg P_2O_5 ha^{-1} in the field. The fertilizers used were urea and DAP. Full dose of N and P_2O_5 were applied before sowing. Guar variety HG 2-20 was sown on 19 July 2018 in different plots as per treatments. Weeding was done as per treatments. Weed density and dry weight of weeds were taken at 20, 40, 60 and 80 DAS using 1.0 m^2 quadrant placed in three randomly selected spots in each plot. Weed species were counted from these spots and average was taken. After the counting of weeds from quadrant weeds were uprooted and dried in sun after that they were dried in oven at a constant temperature of 65^0C and after complete and proper drying, weight of weeds was measured. Weed data taken was subjected to square root transformation before analysis.

Weed control efficiency was calculated by using the following formula (Kondap and Upadhyay 1985).

$$WCE\ (\%) = \frac{\text{Density of weeds in weedy plot} - \text{Density of weeds in treatment plot}}{\text{Density of weeds in weedy plot}} \times 100$$

Where,

WCE = Weed control efficiency (%)

Weed index (%) was calculated by the formula given by Gill and Kumar (1969).

$$WI\ (\%) = \frac{X-Y}{X} \times 100$$

Where,
WI = Weed Index (%)
X = Yield from weed free plot
Y = Yield from treated plot for which WI was to be worked out

RESULTS AND DISCUSSION

Major weed flora of the research field

The crop field was infested with different types of weeds that were identified and collected and have been listed in Table 1. The major weeds flora included *Cyperus rotundus, Digera arvensis, Trianthema portulacastrum* and *Eragrostis* spp. other weeds were *Dactyloctenium aegyptium, Digitaria sanguinalis, Phyllanthus niruri* and *Cynodon dactylon*.

Weed count, weed dry weight and weed index

Sowing of cluster bean under 60 cm row spacing and two interculture with power weeder (T_6) at 20 DAS and 35 DAS resulted in minimum weed count and dry weight of *Cyperus rotundus, Digera arvensis, Trianthema portulacastrum, Eragrostis* spp. and other weeds i.e., *Dactyloctenium aegyptium, Digitaria san-*

Table 1. Weed flora of the experimental field and their relative density. * Eragrostis spp. emergence was observed at 40 DAS.

Scientific name	Common name	Local name	Family	Average (45 and 60 cm row spacing) relative density of weeds (%)	
				20 DAS	80 DAS
Cyperus rotundus L.	Purple nut sedge	Motha	Cyperaceae	45	42
Digera arvensis L.	False amaranth	Kondra	Amaranthaceae	23	16
Trianthema portulacastrum L.	Horse purslane	Vishakhapara	Aizoaceae	18	15
Eragrostis spp.	Love grass	-	Poaceae	11*	14
Others	-	-	-	12	26

Table 2. Effect of various weed management treatments on *Cyperus rotundus* and *Digera arvensis* at periodical interval in cluster bean. Original data given in parenthesis were subjected to square root √(x+1) transformation before analysis.

Treatments	Weed density (No. m^{-2}) *Cyperus rotundus*				Weed density (No. m^{-2}) *Digera arvensis*			
	20 DAS	40 DAS	60 DAS	80 DAS	20 DAS	40 DAS	60 DAS	80 DAS
T_1 : Sowing at 45 cm row spacing and interculture with kasola at 27 DAS	5.25 (26.6)	4.68 (20.9)	4.77 (21.8)	4.48 (19.0)	3.70 (12.7)	2.88 (7.2)	3.06 (8.3)	2.98 (7.8)
T_2 : Sowing at 45 cm row spacing and interculture with wheel hand hoe at 27 DAS	5.32 (27.3)	4.67 (20.8)	4.76 (21.7)	4.64 (20.5)	3.90 (14.2)	2.79 (6.7)	2.94 (7.6)	2.80 (6.8)
T_3 : Sowing at 60 cm row spacing and interculture with tractor drawn cultivator at 27 DAS	5.38 (27.9)	4.63 (20.5)	4.73 (21.3)	4.62 (20.3)	3.87 (14.0)	2.66 (6.0)	2.62 (5.9)	2.56 (5.5)
T_4 : Sowing at 60 cm row spacing and interculture with power weeder at 27 DAS	5.21 (26.2)	4.42 (18.6)	4.52 (19.5)	4.45 (18.9)	3.82 (13.6)	2.60 (5.8)	2.68 (6.2)	2.55 (5.5)
T_5 : Sowing at 60 cm row spacing and interculture with tractor drawn cultivator at 20 and 35 DAS	1.78 (2.20)	2.58 (5.6)	2.75 (6.5)	2.70 (6.30)	1.79 (2.20)	1.92 (2.7)	1.67 (1.8)	1.56 (1.4)
T_6 : Sowing at 60 cm row spacing and interculture with power weeder at 20 and 35 DAS	1.55 (1.40)	2.59 (5.8)	2.71 (6.3)	2.69 (6.2)	1.57 (1.48)	1.90 (2.6)	1.62 (1.6)	1.59 (1.5)
T_7 : Sowing at 45 cm row spacing (weedy check)	5.31 (27.2)	5.61 (30.5)	5.87 (33.5)	5.96 (34.5)	3.85 (13.8)	4.20 (16.7)	4.38 (18.1)	4.65 (20.6)
T_8 : Sowing at 45 cm row spacing (weed free)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
T_9 : Sowing at 60 cm row spacing (weedy check)	5.29 (26.9)	5.59 (30.3)	5.69 (31.4)	5.93 (34.2)	3.89 (14.1)	4.18 (16.51)	4.50 (19.2)	4.70 (21.1)
T_{10} : Sowing at 60 cm row spacing (weed free)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
SE(m) ±	0.03	0.04	0.03	0.02	0.04	0.04	0.06	0.06
CD at 5%	0.10	0.12	0.09	0.06	0.12	0.12	0.18	0.19

guinalis, Phyllanthus niruri and *Cynodon dactylon* as shown in Tables 2 - 5 which was statistically at par with interculture twice with tractor drawn cultivator (T_5) at 20 DAS and 35 DAS under row spacing of 60

Table 3. Effect of various weed management treatments on *Trianthema portulacastrum* and *Eragrostis* spp. at periodical interval in cluster bean. Original data given in parenthesis were subjected to square root √(x+1) transformation before analysis.

Treatments	Weed density (No. m^{-2}) *Trianthema portulacastrum*				Weed density (No. m^{-2}) *Eragrostis* spp.		
	20 DAS	40 DAS	60 DAS	80 DAS	40 DAS	60 DAS	80 DAS
T_1 : Sowing at 45 cm row spacing and interculture with kasola at 27 DAS	3.43 (10.8)	2.50 (5.2)	2.74 (6.5)	2.94 (7.7)	2.32 (4.4)	2.52 (5.3)	2.73 (6.4)
T_2 : Sowing at 45 cm row spacing and interculture with wheel hand hoe at 27 DAS	3.46 (11.0)	2.48 (5.1)	2.88 (7.2)	3.04 (8.3)	2.37 (4.6)	2.59 (5.7)	2.75 (6.5)
T_3 : Sowing at 60 cm row spacing and interculture with tractor drawn cultivator at 27 DAS	3.46 (10.9)	2.37 (4.6)	2.55 (5.5)	2.73 (6.5)	2.42 (4.8)	2.57 (5.6)	2.77 (6.7)
T_4 : Sowing at 60 cm row spacing and interculture with power weeder at 27 DAS	3.50 (11.2)	2.31 (4.3)	2.50 (5.3)	2.74 (2.8)	2.37 (4.6)	2.52 (5.3)	2.77 (6.7)
T_5 : Sowing at 60 cm row spacing and interculture with tractor drawn cultivator at 20 and 35 DAS	1.76 (2.10)	1.78 (2.1)	1.90 (2.6)	1.94 (2.7)	1.65 (1.7)	1.80 (2.2)	1.89 (2.6)
T_6 : Sowing at 60 cm row spacing and interculture with power weeder at 20 and 35 DAS	1.60 (1.58)	1.75 (2.0)	1.91 (2.7)	1.91 (2.6)	1.69 (1.9)	1.75 (2.0)	1.83 (2.6)
T_7 : Sowing at 45 cm row spacing (weedy check)	3.49 (11.1)	3.80 (13.4)	4.03 (15.3)	4.22 (16.8)	3.40 (10.6)	3.65 (12.3)	4.03 (15.3)
T_8 : Sowing at 45 cm row spacing (weed free)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
T_9 : Sowing at 60 cm row spacing (weedy check)	3.46 (10.9)	3.83 (13.6)	4.08 (15.6)	4.29 (17.4)	3.44 (10.8)	3.70 (12.9)	4.05 (15.4)

Table 3. Continued.

Treatments	Weed density (No. m^{-2}) *Trianthema portulacastrum*				Weed density (No. m^{-2}) *Eragrostis* spp.		
	20 DAS	40 DAS	60 DAS	80 DAS	40 DAS	60 DAS	80 DAS
T_{10} : Sowing at 60 cm row spacing (weed free)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)	1 (0)
SE(m) ±	0.03	0.01	0.03	0.03	0.03	0.04	0.02
CD at 5%	0.11	0.03	0.10	0.11	0.09	0.12	0.08

cm. The density and dry weight of weeds was significantly higher in weedy check treatment (T_7 and T_9) as compared to other weed control treatments. Lowest weed index (3.04 %) was reported from treatment T_6 followed by T_5 (Fig. 2). Minimum weed count, dry weight of weeds and weed index was recorded from power weeder as compared to tractor drawn cultivator due to proper crushing and complete removal of weeds between rows. Breakage of soil structure helps to uproot the weeds and death of weeds takes place because of removal of soil around roots. Due to lesser number of weeds, minimum yield loss was recorded from treatment in which mechanized interculture was done. Interculture improve soil aeration, add organic matter by burring the weeds within the field, increase water holding capacity due to which better utilization of available resources takes place and it ultimately helped to improve the yield of crop. Similar findings were reported by Veeraputhiron (2009) in black gram and green gram, Kurstjens and Perdok (2000) for control of ryegrass and garden cress, Buhler *et al.* (1995), Steinmann (2002) in spring wheat-oilseed rape rotation and Cavers and Kane (1990) in proso millet.

Effect on weed control efficiency (%)

Weed control efficiency was highest in treatment T_6

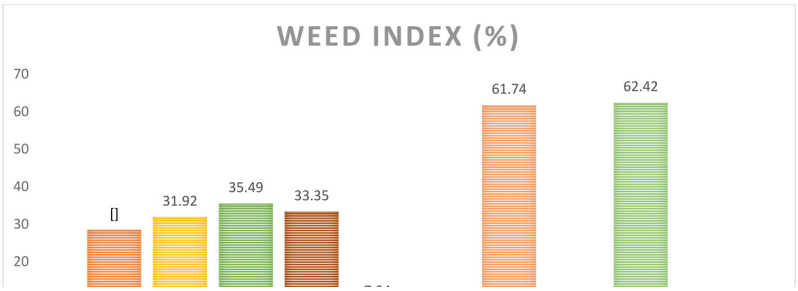
Table 4. Effect of various weed management treatments on remaining weed species i.e., *Dactyloctenium aegyptium*, *Digitaria sanguinalis*, *Phyllanthus niruri* and *Cynodon dactylon* at periodical interval in cluster bean. Original data given in parenthesis were subjected to square root $\sqrt{(x+1)}$ transformation before analysis.

Treatments	Weed density (No. m^{-2})			
	20 DAS	40 DAS	60 DAS	80 DAS
T_1 : Sowing at 45 cm row spacing and interculture with kasola at 27 DAS	2.77 (6.7)	3.37 (10.3)	3.87 (14)	4.16 (16.3)
T_2 : Sowing at 45 cm row spacing and interculture with wheel hand hoe at 27 DAS	2.82 (7.0)	3.41 (10.7)	3.99 (15)	4.39 (18.3)
T_3 : Sowing at 60 cm row spacing and interculture with tractor drawn cultivator at 27 DAS	2.94 (7.7)	3.69 (12.7)	4.04 (15.3)	4.43 (18.7)
T_4 : Sowing at 60 cm row spacing and interculture with power weeder at 27 DAS	2.94 (7.7)	3.50 (11.3)	3.87 (14)	3.96 (14.7)
T_5 : Sowing at 60 cm row spacing and interculture with tractor drawn cultivator at 20 and 35 DAS	1.45 (1.1)	1.52 (1.3)	1.62 (1.66)	1.73 (2)
T_6 : Sowing at 60 cm row spacing and interculture with power weeder at 20 and 35 DAS	1.41 (1.0)	1.41 (1.0)	1.41 (1)	1.52 (1.3)
T_7 : Sowing at 45 cm row spacing (weedy check)	2.94 (7.7)	3.78 (13.3)	4.20 (16.6)	4.55 (19.8)
T_8 : Sowing at 45 cm row spacing (weed free)	1 (0)	1 (0)	1 (0)	1 (0)
T_9 : Sowing at 60 cm row spacing (weedy check)	2.97 (7.7)	3.87 (14.0)	4.36 (18)	4.72 (21.3)
T_{10} : Sowing at 60 cm row spacing (weed free)	1 (0)	1 (0)	1 (0)	1 (0)
SE(m) ±	0.05	0.06	0.07	0.05
CD at 5%	0.16	0.19	0.21	0.15

Table 5. Effect of various weed management treatments on weed dry weight, weed control efficiency and weed index of cluster bean. Original data given in parenthesis were subjected to square root $\sqrt{(x+1)}$ transformation before analysis.

Treatments	Weed dry weight (gm^{-2})				Weed control efficiency (%)			
	20 DAS	40 DAS	60 DAS	80 DAS	20 DAS	40 DAS	60 DAS	80 DAS
T_1 : Sowing at 45 cm row spacing and interculture with kasola at 27 DAS	2.33 (4.45)	3.39 (10.6)	4.66 (22.5)	5..80 (35.8)	16.05	66.00	63.77	61.49
T_2 : Sowing at 45 cm row spacing and interculture with wheel hand hoe at 27 DAS	2.48 (5.17)	3.50 (10.92)	4.96 (24.0)	6.04 (37.3)	2.45	63.59	61.35	59.86
T_3 : Sowing at 60 cm row spacing and interculture with tractor drawn cultivator at 27 DAS	2.42 (4.86)	3.72 (12.9)	5.25 (26.6)	6.39 (39.9)	18.32	59.79	58.39	57.86
T_4 : Sowing at 60 cm row spacing and interculture with power weeder at 27 DAS	2.20 (3.85)	3.57 (11.6)	5.14 (25.4)	6.44 (40.5)	35.35	63.30	60.29	57.14
T_5 : Sowing at 60 cm row spacing and interculture with tractor drawn cultivator at 20 and 35 DAS	1.16 (0.54)	1.92 (2.7)	2.90 (7.4)	4.07 (15.6)	90.92	91.50	88.34	83.51
T_6 : Sowing at 60 cm row spacing and interculture with power weeder at 20 and 35 DAS	1.39 (0.36)	1.54 (1.3)	2.69 (6.2)	3.73 (12.9)	94.11	95.60	90.29	86.35
T_7 : Sowing at 45 cm row spacing (weedy check)	2.51 (5.30)	5.68 (31.3)	7.95 (62.2)	9.69 (93.0)	0.00	0.00	0.00	0.00
T_8 : Sowing at 45 cm row spacing (weed free)	1.0 (0)	1.0 (0)	1.0 (0)	1.0 (0)	100.00	100.00	100.00	100.00
T_9 : Sowing at 60 cm row spacing (weedy check)	2.64 (5.95)	5.70 (31.4)	8.06 (64.0)	9.78 (94.7)	0.00	0.00	0.00	0.00
T_{10} : Sowing at 60 cm row spacing (weed free)	1.0 (0)	1.0 (0)	1.0 (0)	1.0 (0)	100.00	100.00	100.00	100.00
SE(m) ±	0.07	0.03	0.02	0.02	-	-	-	-
CD at 5%	0.19	0.10	0.07	0.06	-	-	-	-

(95.6 %) in which 60 cm row spacing was maintained and weeding was done twice at 20 DAS and 35 DAS with power weeder followed by treatment T_5 (91.5 %) in which weeding two times with tractor drawn cultivator was done, at all crop growth stages except at 20 DAS as shown in Table 5. Weed control efficiency



T_1: Interculture with kasola at 27 DAS with row spacing of 45 cm
T_2: Interculture with wheel hand hoe at 27 DAS with row spacing of 45 cm
T_3: Interculture with tractor drawn cultivator at 27 DAS with row spacing of 60 cm
T_4: Interculture with power weeder at 27 DAS with row spacing of 60 cm
T_5: Interculture with tractor drawn cultivator at 20 and 35 DAS with row spacing of 60cm
T_6: Interculture with power weeder at 20 and 35 DAS with row spacing of 60 cm
T_7: Weedy check with 45 cm row spacing
T_8: Weed free with 45 cm row spacing
T_9: Weedy check with 60 cm row spacing T10: Weed free with 60 cm row spacing

Fig. 2. Weed index as influenced by different weed management treatments.

was lower in the treatment in which weeding was done only one time i.e., T_1, T_2, T_3 and T_4. Crushing and burial of weeds by interculture helped in better control of weeds and resulted in highest weed control efficiency. Similar findings were reported by Veeraputhiron (2009) in black gram and green gram.

CONCLUSION

It can be concluded from the experiment that mechanical interculture is a good option for management of weeds in clusterbean. Interculture twice with power weeder or tractor drawn cultivator at 20 and 35 DAS under 60 cm row spacing resulted in minimum weed count, weed dry weight and weed index and highest weed control efficiency. Hence, Power weeder or tractor drawn cultivator can be used for effective control of weeds in clusterbean. This can solve the problem of labor shortage during peak period and it is also a better option for future if any situation like COVID -19 occurs.

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