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Growth, Yield and Economics of Rainfed Clusterbean (*Cyamopsis tetragonoloba*) as Influenced by Various Mechanized Weed Management Practices

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ABSTRACT

Background: Clusterbean is one of the most important crop of arid and semi-arid region of India. It is mainly grown for vegetable, manure, fodder and seed purpose. Seeds of clusterbean contain galactomann (stored in endosperm) which has industrial uses, thus making it the major cash earner crop. Various biotic and abiotic stresses affects the crop during its growth stages. Among biotic stresses, weeds are the major one affecting the crop growth and yield. Due to initial slow growth of the clusterbean intense crop-weed competition takes place upto 20-30 DAS and if weeds are not managed properly there will be a severe yield reduction. Under Haryana conditions only manual weeding is recommended which is time consuming and expensive hence there is need to exploit other methods of weed control. Therefore, present study was conducted to study the effect of mechanical methods of weed management on growth, yield and economics of clusterbean.

Methods: A field experiment was conducted during *kharif* season 2018 to study the effect of mechanized weed management practices on growth, yield and economics of clusterbean at Regional Research Station, Bawal (Rewari), CCS Haryana Agricultural University, Hisar. Experiment was performed in randomized block design with ten treatments and three replication.

Result: It was found that among various weed management practices, two mechanized weeding with power weeder at 20 DAS and 35 DAS under 60 cm row spacing resulted in significantly higher plant height, leaf area index, dry matter accumulation, seed yield and its attributes in comparison to other treatments and it was statistically at par with mechanized weeding at 20 DAS and 35 DAS with tractor drawn cultivator. The weeding with tractor drawn cultivator was found to be most economical with maximum net returns (Rs. 36076 ha^{-1}) and B:C (2.37) in comparison to other treatments followed by weeding with power weeder that fetched net return of Rs. 35868 ha^{-1} with B:C of 2.25. Therefore, two times interculture with power weeder or tractor drawn cultivator found beneficial and economical for farmers.

Key words: Cluster bean, Mechanized weeding, Power weeder, Tractor drawn cultivator.

INTRODUCTION

Clusterbean which is locally known as guar, is one of the important drought hardy leguminous cash crop of arid and semi-arid region of Haryana, Punjab, Uttar Pradesh, Rajasthan, Gujarat *etc.* It is mainly grown for vegetable, manure, fodder and seed purpose. But, now a days, it has grown as one of the main industrial crop due to presence of 28-33% galactomann (gum) in seed endosperm. Gum is used for manufacturing of beauty products, petroleum, cardboard, clothes, medicinal drugs, food processing, oil drilling combustible products, *etc*. thus making it a main foreign exchange earner (Brar, 2018). Weeds cause serious problem in legume crops because they are grown on poor and marginal fertility soils. Clusterbean is mainly cultivated in rainy season. Due to initial slow growth of guar, intense crop weed competition occur which adversely affects the growth and yield. Weeds compete with crops for nutrient, water and space and cause reduction in yield. The critical period of weed competition is 20-30 DAS (Patel *et al.,* 2005). Yield reduction due to weeds ranges from 30-98% depending upon the severity of infestation (Sonani *et al.*, 1985). Moreover weed causes hindrance in harvesting operations as well as affects the quality of crop produce. Hand weeding is mainly preferred in clusterbean. But, due to unavailability of labour during peak period and higher wages rate, this method is not economical. It is also time consuming. No herbicides recommendation is available for weed control in guar under Haryana conditions. Mechanical weeding, cut, crush and burry the weeds in the field itself thus add organic

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matter to soil. It also helps to control the weeds within time. Hence, for enhancing the yield of clusterbean weed control is most important. Thus present investigation was carried out to find a suitable method of weed control in clusterbean which can solve the problem of labour and also economically viable for the farmers.

MATERIALS AND METHODS

Experimental site

The experiment was carried out at Regional Research Station, Bawal (Rewari) CCS HAU, Hisar during *kharif* season 2018. It was situated in south western region of Haryana at 28.1° N and 76.5° E.

Weather and climatic conditions

Bawal is situated in semi-arid regions of the country with hot and dry summer and severe cold in winter. Almost 80-90% of the total rainfall was received during south-west monsoon from July to September. Weather parameters (weekly) recorded during *kharif* 2018 are presented in Fig 1.

Soils

The soil of experimental field was sandy loam in texture having a pH 8.3, organic matter (0.29%), EC (0.26 ds m^{-1} at 25°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}).

Experiment details

The experimental design used was randomized block design with three replications and a total number of ten treatments. Gross plot size was 8.0 × 5.4 m. Guar variety HG 2-20 was grown. Treatments details were as follow:

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 60 cm.
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.
T_{10}: Weed free with 60 cm row spacing.

Field preparation

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}. 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.

Recording observation and analysis of data

Plant population was recorded plot wise at 20 DAS and at physiological maturity stage. Then it was converted to plant population on hectare basis. Three plants from each plot were tagged for measurement of plant height and the height was measured from base of the plant to growing point at different intervals. Five plants from each plot were taken and their leaf area was measured with leaf area meter. For determination of plant dry matter accumulation three plants from each plot were taken and dried in sun. After sun drying plants were dried in oven at a temperature of 65°C. From three tagged plants number of primary and secondary branches and number of pods were calculated and average of three was taken. A total number of twenty pods were selected from each plot and numbers of seeds were calculated on average basis. Seed sample from each plot was taken randomly and 1000 seed weight was calculated. Biological yield and grain yield were recorded separately. The yield per plot obtained was converted to kg per hectare. Cost of cultivation for each treatment was calculated by using the rates of different agronomic practices and the inputs used in a particular treatment. The data collected was analysed with OP STAT software of CCS HAU, Hisar.

RESULTS AND DISCUSSION

Plant population

Numbers of plant were significantly higher in treatments in which sowing was done under 60 cm row spacing as compared sowing at 45 cm spacing (Table 1). However, among 60 cm row spacing treatments, plant population (ha^{-1}) was at par with each other. Similar trend was observed under treatments in which sowing was under 45 cm row spacing.

Plant height (cm), leaf area index and dry matter accumulation per plant

Data presented in Table 1 and Table 2 revealed that plant height, leaf area index and dry matter accumulation increased successively with advancement of crop growth stages. Maximum increase in plant height and leaf area index was observed between 40 and 60 DAS while dry matter accumulation was maximum between 60 and 80 DAS. Plant height, leaf area index and dry matter accumulation per plant was significantly higher in treatment T_6 at all the stages (except 20 DAS) in which weeding twice at 20 DAS and 35 DAS done with power weeder as compared to other treatments. However, it was statistically at par with treatment T_5 in which weeding was done two times at 20 DAS and 35 DAS with tractor drawn cultivator. Due to interculture, weeds were cut and buried at same place in field. This helped to increase the organic matter in the soil and also improved the soils physical, chemical and biological properties which ultimately provided the better environment for plant growth.

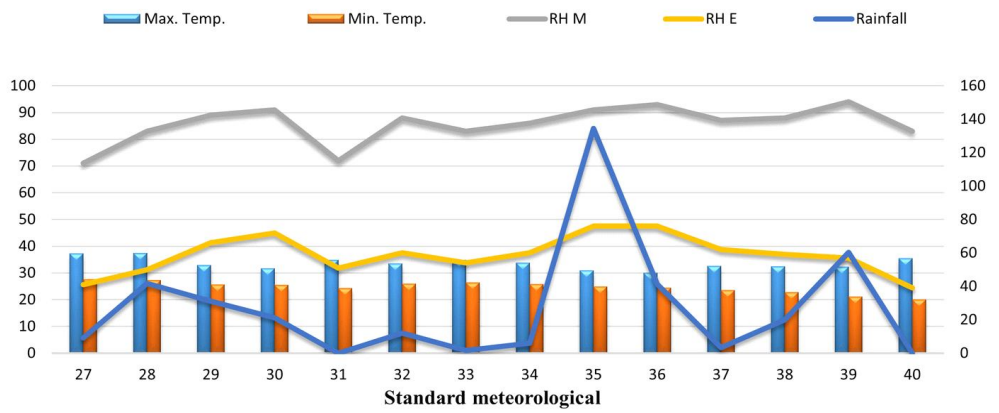
Due to less competition from weeds, efficient utilization of available resources by crop plants had been taken place and finally this resulted into better plant growth. Similar findings were reported by Veeraputhiron (2009) in black gram and green gram and Kurstjens and Perdok (2000) for control of ryegrass and garden cress.

Yield and its attributes

Treatment T_6 where interculture twice (20 and 35 DAS) was done with power weeder under row spacing of 60 cm recorded significantly superior yield attributes than other weed control treatments *i.e.* T_1, T_2, T_3, T_4 and it was statistically at par with treatment T_5 in which two times interculture with tractor drawn cultivator was done (Table 3). Grain yield, straw yield, biological yield and harvest index was significantly higher in treatment T_6 in comparison to other treatments and it was statistically at par with treatment T_5 (Table 4). The relationship between yield and weed density showed that with an increase in density of weeds, crop yield decreases (Fig 2). Deep mechanized interculture helped in complete removal and incorporation of weeds into the soil as well as loosening of soil which resulted into better aeration and retention of soil moisture for longer time period. The decomposition of removed and buried weeds into the soil with time helped to maintain high soil fertility and simultaneously improved the soil surface structure. Early removal of weeds by mechanical methods reduced the crop weed competition and resulted into higher crop yield. This result is in confirmation with findings of Veeraputhiron (2009) in black gram and green gram and Cavers and Kane (1990) in proso millet.

Economics

Highest net return (Rs. 36076 ha^{-1}) was obtained from treatment T_5 followed by treatment T_6 (Rs. 35868 ha^{-1}). Highest cost was recorded under treatments in which weeding was done manually (Table 4). This may be due to more number of persons required for weeding, higher wages rate and more times as compared to mechanical methods. These results are in line with the findings of Veeraputhiron (2009) in black gram and green gram and Buhler *et al.* (1995) in corn.



*Max. Temp.- Maximum temperature (°C), Min. Temp.- Minimum temperature (°C), RH M- Relative humidity morning (%), RH E-Relative humidity evening (%), Rainfall (mm).

Fig 1: Mean weekly temperature, relative humidity (RH) and total rainfall.

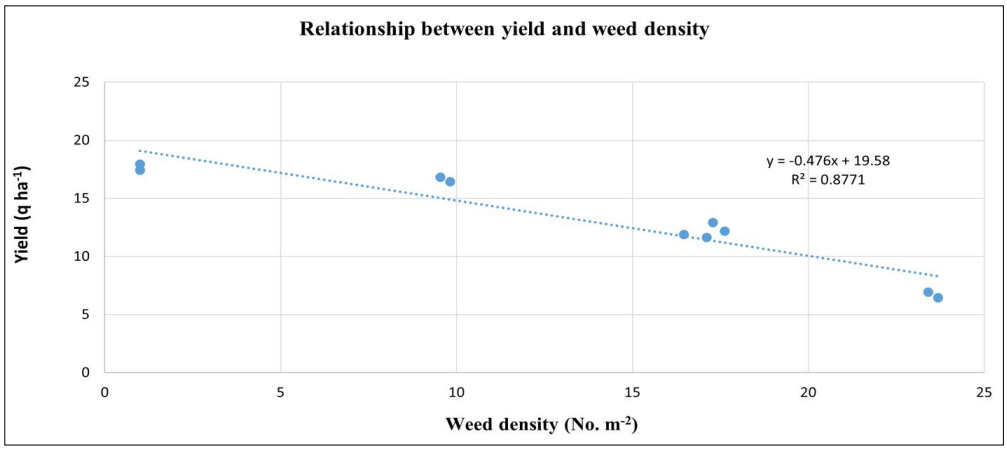


Fig 2: Relationship between crop yield and weed density.

Table 1: Effect of various weed management treatments on plant population and plant height of cluster bean at periodical interval.

Treatments	Plant population (000 ha^{-1})		Plant height (cm)				
	20 DAS	At harvest	20 DAS	40 DAS	60 DAS	80 DAS	At harvest
T_1: Sowing at 45 cm row spacing and interculture with *kasola* at 27 DAS	147.8	147.5	9.9	24.7	55.9	74.8	82.2
T_2: Sowing at 45 cm row spacing and interculture with wheel hand hoe at 27 DAS	147.6	147.4	9.8	23.6	55.3	76.0	84.1
T_3: Sowing at 60 cm row spacing and interculture with tractor drawn cultivator at 27 DAS	165.7	165.3	10.9	26.0	55.5	78.1	83.2
T_4: Sowing at 60 cm row spacing and interculture with power weeder at 27 DAS	165.8	165.3	10.3	26.1	56.2	78.8	84.3
T_5: Sowing at 60 cm row spacing and interculture with tractor drawn cultivator at 20 and 35 DAS	165.8	165.5	10.4	27.7	56.9	81.2	86.6
T_6: Sowing at 60 cm row spacing and interculture with power weeder at 20 and 35 DAS	165.6	165.4	10.3	28.3	57.4	82.3	87.6
T_7: Sowing at 45 cm row spacing (weedy check)	147.6	147.3	9.8	18.6	44.9	65.1	72.0
T_8: Sowing at 45 cm row spacing (weed free)	148.0	147.7	11.3	30.3	58.9	78.1	87.2
T_9: Sowing at 60 cm row spacing (weedy check)	165.1	164.5	10.1	18.9	46.3	66.7	76.6
T_{10}: Sowing at 60 cm row spacing (weed free)	165.6	165.4	11.2	32.8	61.3	83.3	91.2
SE(m) ±	3.16	2.01	0.52	0.36	0.51	0.41	0.79
C.D. at 5%	10.01	6.72	NS	1.08	1.55	1.24	2.35

Table 2: Effect of various weed management treatments on leaf area index and dry matter accumulation (g plant^{-1}) of cluster bean.

Treatments	Leaf area index			Dry matter accumulation (g plant^{-1})					
	20 DAS	40 DAS	60 DAS	80 DAS	20 DAS	40 DAS	60 DAS	80 DAS	At harvest
T_1: Sowing at 45 cm row spacing and interculture with *kasola* at 27 DAS	0.22	0.30	1.58	1.40	0.39	3.62	10.06	20.23	25.93
T_2: Sowing at 45 cm row spacing and interculture with wheel hand hoe at 27 DAS	0.21	0.28	1.54	1.37	0.48	3.94	11.29	21.39	26.82
T_3: Sowing at 60 cm row spacing and interculture with tractor drawn cultivator at 27 DAS	0.22	0.29	1.50	1.35	0.38	4.13	13.33	22.77	28.02
T_4: Sowing at 60 cm row spacing and interculture with power weeder at 27 DAS	0.20	0.31	1.60	1.41	0.43	4.33	13.79	22.83	28.39
T_5: Sowing at 60 cm row spacing and interculture with tractor drawn cultivator at 20 and 35 DAS	0.22	0.38	1.72	1.63	0.41	4.43	14.28	23.45	30.97
T_6: Sowing at 60 cm row spacing and interculture with power weeder at 20 and 35 DAS	0.20	0.43	1.79	1.69	0.44	4.59	14.42	23.72	31.21
T_7: Sowing at 45 cm row spacing (weedy check)	0.22	0.32	1.08	0.93	0.38	2.42	6.13	13.68	17.42
T_8: Sowing at 45 cm row spacing (weed free)	0.22	0.50	1.85	1.76	0.43	4.21	12.96	22.84	32.58
T_9: Sowing at 60 cm row spacing (weedy check)	0.24	0.33	1.16	0.97	0.44	2.00	6.67	14.59	19.95
T_{10}: Sowing at 60 cm row spacing (weed free)	0.22	0.56	1.94	1.81	0.43	5.11	15.13	25.09	34.58
SE(m) ±	0.03	0.01	0.01	0.01	0.02	0.21	0.48	0.42	0.58
C.D. at 5%	NS	0.04	0.06	0.05	NS	0.63	1.45	1.27	1.74

Table 3: Effect of various weed management treatments on yield attributes of cluster bean.

Treatments	No. of primary branches plant^{-1}	No. of secondary branches plant^{-1}	No. of pods plant^{-1}	No. of seeds pod^{-1}	1000 grains weight (g)
T_1: Sowing at 45 cm row spacing and inter-culture with *kasola* at 25-30 DAS	3.88	5.29	49.4	5.8	33.2
T_2: Sowing at 45 cm row spacing and inter-culture with wheel hand hoe at 25-30 DAS	3.37	4.55	48.5	5.4	33.0
T_3: Sowing at 60 cm row spacing and inter-culture with tractor drawn cultivator at 25-30 DAS	3.66	5.32	50.7	5.3	32.2
T_4: Sowing at 60 cm row spacing and inter-culture with power weeder at 25-30 DAS	3.21	4.18	51.6	5.7	32.9
T_5: Sowing at 60 cm row spacing and inter-culture with tractor drawn cultivator at 20 and 35 DAS	4.10	6.13	56.2	6.2	34.1
T_6: Sowing at 60 cm row spacing and inter-culture with power weeder at 20 and 35 DAS	3.99	6.21	57.2	6.5	34.5
T_7: Sowing at 45 cm row spacing (weedy check)	1.69	3.10	33.8	4.3	21.7
T_8: Sowing at 45 cm row spacing (weed free)	4.21	6.43	57.3	6.6	35.8
T_9: Sowing at 60 cm row spacing (weedy check)	1.37	3.08	33.8	4.9	21.0
T_{10}: Sowing at 60 cm row spacing (weed free)	4.32	6.88	59.0	6.8	35.4
SE(m) ±	0.24	0.34	0.40	0.19	0.27
C.D. at 5%	0.74	1.03	1.22	0.56	0.80

Table 4: Effect of various weed management treatments on yield and economics of cluster bean.

Treatments	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})	Biological yield (q ha^{-1})	Harvest index (%)	Cost of cultivation (Rs. ha^{-1})	Gross returns (Rs. ha^{-1})	Net returns (Rs. ha^{-1})	B:C
T_1: Sowing at 45 cm row spacing and inter-culture with *kasola* at 25-30 DAS	12.92	35.3	48.2	26.8	34419	49664	15245	1.44
T_2: Sowing at 45 cm row spacing and inter-culture with wheel hand hoe at 25-30 DAS	12.19	35.8	48.1	25.5	27230	46893	19663	1.72
T_3: Sowing at 60 cm row spacing and inter-culture with tractor drawn cultivator at 25-30 DAS	11.63	35.1	46.8	24.9	24624	44831	20207	1.82
T_4: Sowing at 60 cm row spacing and inter-culture with power weeder at 25-30 DAS	11.89	34.0	45.9	25.9	25382	45693	20311	1.80
T_5: Sowing at 60 cm row spacing and inter-culture with tractor drawn cultivator at 20 and 35 DAS	16.43	44.1	60.5	27.1	26214	62996	36076	2.37
T_6: Sowing at 60 cm row spacing and inter-culture with power weeder at 20 and 35 DAS	16.82	44.3	61.2	27.5	28581	64449	35868	2.25
T_7: Sowing at 45 cm row spacing (weedy check)	6.92	24.8	31.7	21.8	22970	26844	3878	1.16
T_8: Sowing at 45 cm row spacing (weed free)	17.94	44.6	62.5	28.7	57312	68608	11296	1.21
T_9: Sowing at 60 cm row spacing (weedy check)	6.44	23.4	29.9	21.6	23032	24998	1966	1.06
T_{10}: Sowing at 60 cm row spacing (weed free)	17.43	44.0	61.5	28.3	57378	66691	9313	1.16
SE(m) ±	1.06	2.12	2.05	0.29	-	-	-	-
C.D. at 5%	2.92	5.87	6.29	0.87	-	-	-	-

CONCLUSION

Based on the experiment it can be concluded that mechanical weeding with power weeder or tractor drawn cultivator helps to gain better growth and higher yield of clusterbean. It saves the labour cost and provide economic benefit to the farmers.

Conflict of interest

All authors declare that they have no conflicts of interest.

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