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Research Article

Effect of Plant Growth Regulators on Growth & Flowering of Seed Guar Cultivars

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ABSTRACT

The seed cluster bean exhibited significant variations in growth and flowering due to spray of growth regulators. The highest plant height was recorded in the HG 365 and among the growth regulators maximum plant height was recorded by the application of triacontanol at 1500 ppm which was on par with 1000 ppm. In case of earliest occurrence of 50% flowering was noticed in variety HG 563 and lowest number of days to 50% flowering was recorded by the application of CCC at 1500 ppm which was on par with CCC 1000 ppm. The highest seed yield per plant was recorded by HG 365, whereas in growth regulators maximum seed yield per plant was recorded by the application of CCC at 1500 ppm which was on par with CCC 1000 ppm.

Keywords: *Seed Cluster, Growth, Flowering, Triacontanol, CCC.*

INTRODUCTION

Plant growth regulators (PGR) are known to improve physiological efficiency including photosynthetic ability of plants and offer a significant role in realizing higher crop yields. The PGR's are also known to enhance the source-sink relationship and stimulate the translocation of photo-assimilates, thereby increasing the productivity. Though, the plant growth regulators have great potential, its application and assessment etc. have to be judiciously planned in terms of optimal concentration, stage of application, species specificity and seasons. In their wide spectrum of effectiveness on every aspect of plant growth, even a modest increase of 10-15 per cent could bring about an increment in the gross annual productivity by 10-15 m tons. The effect of PGRs particular new compounds on cluster bean has not been evaluated and hence the data on this aspect is scarce. Unlike the seeds of other legumes, guar seeds contains sufficient amount of galactomannan gum, which form a viscous gel in cold water. Guar gum has 5-8 times the thickening power of starch. It is used in textile, paper manufacture, stamps, cosmetics, pharmaceuticals, food products, e.g. bakery products, ice cream, stabilizer for cheeses and meat binder. Also it is used recently in oil wells, mining industries, explosives, and other industrial applications.

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Under these conditions, the spray of growth regulating chemicals on growth and flowering influenced and ultimately the seed yield is studied in the present study.

MATERIALS AND METHODS

Seed guar cultivars HG 365 and HG 563 were applied with growth regulating chemicals in a factorial experiment under Mahanandi conditions both during Kharifand Rabi in the year 2015-16. Foliar sprays of chemicals *viz,* cycocel, Mepiquat chloride and triacontenol were given twice at 20 and 40 days after sowing. Each of these chemicals was tried at three different concentrations i.e. 500, 1000 and 1500 ppm. The plants were spaced at 30 cm x 10 cm and applied with a uniform nutrient dose of N at 30 kg ha-1 + P at 40 kg ha-1 + K at 40 kg ha-1 + S at20 kg ha-1.

RESULTS AND DISCUSSION

Plant height (cm)

The plant height differed significantly due to spray of growth regulators during *kharif* and *rabi* seasons at 30, 60 and 90 days after sowing (DAS). The mean plant height (Table 1a, 1b) increased from 23.92 cm and 22.18 cm (30 DAS) to 63.19 cm and 58.58 cm (90 DAS) during *kharif* and *rabi* seasons, respectively. At 90 DAS, the highest plant height (*kharif* 63.99 cm; *rabi* 59.32) was recorded by HG 365. Among the growth regulators, maximum plant height (*kharif* 85.13 cm; *rabi* 78.92 cm) was recorded by the application of triacontanol at 1500 ppm which was on par with 1000 ppm (*kharif* 82.63 cm; *rabi* 76.60 cm). The lowest plant height was observed by the spray of MC 1500 ppm (*kharif* 47.32 cm; *rabi* 43.87 cm) preceded by MC 1000 ppm (*kharif* 50.45 cm; *rabi* 46.77 cm). The control recorded a plant height of 62.85 cm in *kharif* and 58.26 cm in *rabi* at 90 DAS. Whereas CCC 1500 has shown intermediate values for plant height (*kharif* 49.58 cm; *rabi* 45.96 cm).

The height of plant was found to increase throughout the growth period in both the varieties and under the influence of all the growth regulators studied in the present investigation at various concentrations. The foliar spray of growth regulators in early stages (20 and 40 DAS) significantly influenced the plant height and resulted in either increase or decrease in plant height depending on the chemical used in the spray. Significant increase in plant height was observed when the plants were sprayed with tricantanol from 500 ppm to 1000 ppm whereas further increase in concentration of triacontenol did not show significant increase in plant height. Foliar spray of CCC and mepiquat chloride was found to decrease plant height with every increase in the concentration from 500 ppm to 1500 ppm when compared to control.

An increase in the plant height due to application of tricontanol could be attributed to an increase in the meristematic activity of apical tissues. Tricontanol was also said to increase photosynthetic activity and improve the efficiency of translocation and utilization of photosynthates causing rapid cell elongation and cell division at growing region of the plant leading to stimulation of growth, besides increasing the uptake of nutrients (Dicks, 1980). Similar beneficial effect of growth promoters on plant height was also reported by Dashora and Jain (1994) in soybean and Neelam et al. (1995) in lentil.

The lower plant height in CCC (cycocel) and mepiquatchloride applied plants may be due to retardation of transverse cell multiplication particulary in combium, which was the zone of meristimatic activity at the base of the internode as repored by Arunakumar and Uppar (2007). The results of the present study are in agreement with the findings of Grossman (1990) who opined that the cycocel is an antigibberellin dwarfing agent, leading to a deficiency of gibberellin in the plant and reduced the growth. Mepiquat chloride also was found to show antigibberellin like activity leading to reduced plant height as observed in case of some pulses (Jeyakumar & Thangaraj, 1996).

Leaf area per plant (cm^2)

The leaf area per plant differed significantly due to spray of growth regulators during both *kharif* and *rabi* seasons at various growth

stages and interactions. The mean leaf area (Table 2a, 2b) was found to increase from 178.73 cm^2 and 159.07 cm^2 (30 DAS) to 305.63 cm^2 and 272.01 cm^2 (90 DAS) during *kharif* and *rabi* seasons respectively. At 90 DAS, the highest leaf area (*kharif* 307.47 cm^2; *rabi 273.65* cm^2) was recorded by HG 365. Among the growth regulators, maximum leaf area (*kharif* 375.80 cm^2; *rabi 334.46* cm^2) was recorded by the application of CCC at 1500 ppm which was on par with 1000 ppm (*kharif* 369.93 cm^2; *rabi 329.23* cm^2). The lowest leaf area was observed by the spray of MC 500 ppm (*kharif* 263.94 cm^2; *rabi 234.90* cm^2) preceded by MC 1000 ppm (*kharif* 281.97 cm^2; *rabi 250.95* cm^2). Tricontanol concentrations recorded leaf area values in medium range, out of which, the maximum was at 1500 ppm (*kharif* 303.59; *rabi* 270.19) which was on par with 1000 ppm (*kharif* 298.45 cm^2; *rabi* 265.62 cm^2) during both the seasons. The control recorded a leaf area of 261.49 cm^2 in *kharif* and 232.72 cm^2 in *rabi*at 90 DAS.

Days to first flowering

The days to first flowering (Table 3) differed significantly due to spray of growth regulators during *kharif* and *rabi* seasons. The lowest number of days to first flowering (*kharif* 21.80; *rabi* 20.06) was recorded by the var. HG 563. Among the growth regulators, earliest days to first flowering (*kharif* 20.28; *rabi* 18.66) was recorded by the application of CCC at 1500 ppm which was on par with CCC 1000 ppm (*kharif* 20.90; *rabi* 19.23). The highest number of days to first flowering was observed by the spray of MC 1500 ppm (*kharif* 26.24; *rabi* 24.14) which was on par with MC 1000 ppm (*kharif* 25.63; *rabi* 23.58). Application of TRIA 1500 ppm resulted in the attainment of first flowering at 23.29 days in *kharif* 21.43 days in *rabi*. The control recorded 24.04 days to first flowering in *kharif* and 22.12 days in *rabi*.

Days to 50% flowering

The days to 50% flowering (Table 4) differed significantly due to spray of growth regulators during *kharif* and *rabi* seasons. The earliest occurrence of 50% flowering (*kharif* 24.65; *rabi* 22.68) was observed in the var. HG 563. Among the growth regulators, the lowest number of days to 50% flowering (*kharif* 23.09; *rabi* 21.24) was recorded by the application of CCC at 1500 ppm which was on par with CCC 1000 ppm (*kharif* 23.71; *rabi* 21.81). The highest delay to 50% flowering was noticed by the spray of MC 1500 ppm (*kharif* 29.02; *rabi* 26.70) which was on par with MC 1000 ppm (*kharif* 28.41; *rabi* 26.14). Foliar spray of TRIA 1500 ppm resulted in intermediary values for days to 50% flowering during both the seasons (*kharif* 24.39; *rabi* 22.44). The control recorded 26.97 days to 50% flowering in *kharif* and 24.81 days in *rabi*.

Seed yield per plant (g)

The seed yield per plant (Table 5) differed significantly due to spray of growth regulators during *kharif* and *rabi* seasons. The highest seed yield per plant (*kharif* 16.88 g; *rabi* 16.04 g) was recorded by HG 365. Among the growth regulators, maximum seed yield per plant (*kharif* 18.33 g; *rabi* 17.42 g) was recorded by the application of CCC at 1500 ppm which was on par with CCC 1000 ppm (*kharif* 18.05 g; *rabi* 17.15 g) (Fig. 12). The lowest seed yield per plant was observed by the spray of MC 500 ppm (*kharif* 14.58 g; *rabi* 13.85 g) which was on par with MC 1000 ppm (*kharif* 14.93 g; *rabi* 14.18 g). TRIA 1500 ppm produced moderate quantities of seed per plant during both *kharif* (16.94 g) and *rabi* (16.10 g). The control recorded a seed yield per plant of 13.70 g in *kharif* and 13.01 g in *rabi*.

Crop yield depend not only on the accumulation of photosynthates during the crop growth and development, but also on its partitioning into the desired storage organs. These in turn, are influenced by the efficiency of metabolic processes within the plant. The growth retardants are capable of redistribution of dry matter in the plant thereby bringing about improvement in yield (Chetti, 1991; Chandrababu et al., 1995). The pod yield in cluster bean depends on the accumulation of photo assimilates and partitioning in different plant parts. The yield in cluster bean was found to be strongly influenced by the

application of different growth regulators and thus indicating the importance of these compounds in increasing the yield potential through their effect on various morpho-physiological and biochemical traits.

Similar opinion was expressed by Prabhavathi (2005) who reported that the application of lihocin (1000 ppm) resulted in significantly higher pod yield followed by miraculan @ 1000 ppm and mepiquat chloride @ 1000 ppm as compared to control in cluster bean. The increased yield was attributed to higher dry matter production and its accumulation in reproductive parts, higher AGR, CGR and enhanced chlorophyll and nitrate reductase activity.

Table 1 a. Plant height (cm) as influenced by growth regulators in cluster bean varieties during *kharif* 2015-16

Growth regulators (ppm) (B)	Variety (A)								
	30 DAS			60 DAS			90 DAS		
	HG 365	HG 563	***Mean***	HG 365	HG 563	***Mean***	HG 365	HG 563	Mean
CCC 500	24.00	23.40	**23.70**	51.12	49.84	**50.48**	63.39	61.80	**62.60**
CCC 1000	21.12	20.59	**20.86**	44.99	43.86	**44.42**	55.78	54.39	**55.08**
CCC 1500	19.01	18.53	**18.77**	40.49	39.47	**39.98**	50.20	48.95	**49.58**
MC 500	22.00	21.45	**21.73**	46.87	45.70	**46.28**	58.11	56.66	**57.39**
MC 1000	19.34	18.86	**19.10**	41.20	40.17	**40.69**	51.09	49.81	**50.45**
MC 1500	18.14	17.69	**17.92**	38.65	37.68	**38.16**	47.92	46.72	**47.32**
TRIA 500	30.24	29.48	**29.86**	64.41	62.80	**63.61**	79.87	77.87	**78.87**
TRIA 1000	31.68	30.89	**31.28**	67.48	65.79	**66.63**	83.67	81.58	**82.63**
TRIA 1500	32.64	31.82	**32.23**	69.52	67.79	**68.65**	86.21	84.05	**85.13**
Control	24.10	23.49	**23.79**	51.32	50.04	**50.68**	63.64	62.05	**62.85**
Mean	**24.23**	**23.62**	**23.92**	**51.60**	**50.31**	**50.96**	**63.99**	**62.39**	**63.19**
Factor	***S Em±***	***CD***		***S Em±***	***CD***		***S Em±***	***CD***	
Variety (A)	*0.071*	*0.21*		*0.152*	*0.44*		*0.189*	*0.55*	
Growth regulators (B)	*0.357*	*1.03*		*0.761*	*2.20*		*0.944*	*2.73*	
Interaction (A x B)	-	*NS*		-	*NS*		*1.076*	*3.11*	

CD: CD at 5% level of significance DAS: Days after sowing CCC: Cycocel MC: Mepiquat chloride TRIA: Triacontanol

Table 1 b. Plant height (cm) as influenced by growth regulators in cluster bean varieties during *rabi* 2015-16

Growth regulators (ppm) (B)	Variety (A)								
	30 DAS			60 DAS			90 DAS		
	HG 365	HG 563	***Mean***	HG 365	HG 563	***Mean***	HG 365	HG 563	Mean
CCC 500	22.25	21.69	**21.97**	47.39	46.21	**46.80**	58.77	57.30	**58.03**
CCC 1000	19.58	19.09	**19.34**	41.71	40.66	**41.18**	51.71	50.42	**51.07**
CCC 1500	17.62	17.18	**17.40**	37.53	36.60	**37.07**	46.54	45.38	**45.96**
MC 500	20.40	19.89	**20.14**	43.45	42.36	**42.91**	53.88	52.53	**53.20**
MC 1000	17.93	17.49	**17.71**	38.20	37.24	**37.72**	47.37	46.18	**46.77**
MC 1500	16.82	16.40	**16.61**	35.83	34.93	**35.38**	44.43	43.32	**43.87**
TRIA 500	28.04	27.33	**27.68**	59.71	58.22	**58.97**	74.05	72.19	**73.12**
TRIA 1000	29.37	28.64	**29.00**	62.56	60.99	**61.78**	77.57	75.63	**76.60**
TRIA 1500	30.26	29.50	**29.88**	64.45	62.84	**63.65**	79.92	77.92	**78.92**
Control	22.34	21.78	**22.06**	47.58	46.39	**46.99**	59.00	57.53	**58.26**
Mean	**22.46**	**21.90**	**22.18**	**47.84**	**46.65**	**47.24**	**59.32**	**57.84**	**58.58**
Factor	***S Em±***	***CD***		***S Em±***	***CD***		***S Em±***	***CD***	
Variety (A)	*0.066*	*0.19*		*0.141*	*0.41*		*0.175*	*0.51*	
Growth regulators (B)	*0.331*	*0.96*		*0.706*	*2.04*		*0.875*	*2.53*	
Interaction (A x B)	-	*NS*		-	*NS*		-	*NS*	

CD: CD at 5% level of significance DAS: Days after sowing CCC: Cycocel MC: Mepiquat chloride TRIA: Triacontanol

Table 2 a. Leaf area (cm^2) per plantas influenced by growth regulators in cluster bean varieties during *kharif* 2015-16

Growth regulators (ppm) (B)	Variety (A)								
	30 DAS			60 DAS			90 DAS		
	HG 365	HG 563	***Mean***	HG 365	HG 563	***Mean***	HG 365	HG 563	Mean
CCC 500	191.52	189.22	**190.37**	344.74	340.60	**342.67**	327.50	323.57	**325.53**
CCC 1000	217.64	215.02	**216.33**	391.75	387.04	**389.39**	372.16	367.69	**369.93**
CCC 1500	221.09	218.44	**219.76**	397.96	393.19	**395.58**	378.07	373.53	**375.80**
MC 500	155.28	153.42	**154.35**	279.50	276.15	**277.83**	265.53	262.34	**263.94**
MC 1000	165.89	163.90	**164.89**	298.60	295.02	**296.81**	283.67	280.26	**281.97**
MC 1500	173.33	171.25	**172.29**	311.99	308.25	**310.12**	296.39	292.83	**294.61**
TRIA 500	165.31	163.33	**164.32**	297.56	293.99	**295.78**	282.68	279.29	**280.99**
TRIA 1000	175.58	173.48	**174.53**	316.05	312.26	**314.15**	300.25	296.65	**298.45**
TRIA 1500	178.61	176.46	**177.54**	321.49	317.64	**319.57**	305.42	301.75	**303.59**
Control	153.84	151.99	**152.92**	276.91	273.59	**275.25**	263.07	259.91	**261.49**
Mean	**179.81**	**177.65**	**178.73**	**323.66**	**319.77**	**321.71**	**307.47**	**303.78**	**305.63**
Factor	***S Em±***	***CD***		***S Em±***	***CD***		***S Em±***	***CD***	
Variety (A)	*0.313*	*0.90*		*0.563*	*1.63*		*0.535*	*1.55*	
Growth regulators (B)	*1.564*	*4.52*		*2.815*	*8.14*		*2.675*	*7.74*	
Interaction (A x B)	-	*NS*		*3.209*	*9.28*		*3.049*	*8.82*	

CD: CD at 5% level of significance DAS: Days after sowing CCC: Cycocel MC: Mepiquat chloride TRIA: Triacontanol

Table 2 b. Leaf area (cm^2) per plant as influenced by growth regulators in cluster bean varieties during *rabi* 2015-16

Growth regulators (B)	Variety (A)								
	30 DAS			60 DAS			90 DAS		
	HG 365	HG 563	***Mean***	HG 365	HG 563	***Mean***	HG 365	HG 563	Mean
CCC 500	170.45	168.41	*169.43*	306.82	303.13	*304.97*	291.47	287.98	**289.73**
CCC 1000	193.70	191.37	*192.53*	348.65	344.47	*346.56*	331.22	327.25	**329.23**
CCC 1500	196.77	194.41	*195.59*	354.19	349.94	*352.06*	336.48	332.44	**334.46**
MC 500	138.20	136.54	*137.37*	248.76	245.77	*247.27*	236.32	233.48	**234.90**
MC 1000	147.64	145.87	*146.75*	265.75	262.56	*264.16*	252.46	249.44	**250.95**
MC 1500	154.26	152.41	*153.34*	277.67	274.34	*276.01*	263.79	260.62	**262.21**
TRIA 500	147.13	145.36	*146.24*	264.83	261.65	*263.24*	251.59	248.57	**250.08**
TRIA 1000	156.27	154.39	*155.33*	281.29	277.91	*279.60*	267.22	264.01	**265.62**
TRIA 1500	158.96	157.05	*158.01*	286.13	282.70	*284.41*	271.82	268.56	**270.19**
Control	136.92	135.27	*136.10*	246.45	243.49	244.97	234.13	231.32	**232.72**
Mean	**160.03**	**158.11**	**159.07**	**288.05**	**284.60**	**286.33**	**273.65**	**270.37**	**272.01**
Factor	***S Em±***	***CD at 5%***		***S Em±***	***CD at 5%***		***S Em±***	***CD at 5%***	
Variety (A)	*0.290*	*0.84*		*0.632*	*1.83*		*0.784*	*2.27*	
Growth regulators (B)	*1.450*	*4.19*		*3.161*	*9.14*		*3.920*	*11.34*	
Interaction (A x B)	*1.653*	-		*NS*	*10.42*		*4.468*	*12.92*	

CD: CD at 5% level of significance DAS: Days after sowing CCC: Cycocel MC: Mepiquat chloride TRIA: Triacontanol

Table 3. Days to first flowering as influenced by growth regulators in cluster bean varieties during *kharif* and *rabi* 2015-16

Growth regulators (ppm) (B)	Variety (A)					
	Kharif			Rabi		
	HG 365	HG 563	***Mean***	HG 365	HG 563	***Mean***
CCC 500	22.54	20.74	**21.64**	20.74	19.08	**19.91**
CCC 1000	21.77	20.03	**20.90**	20.03	18.43	**19.23**
CCC 1500	21.13	19.44	**20.28**	19.44	17.88	**18.66**
MC 500	26.43	23.79	**25.11**	24.32	21.89	**23.10**
MC 1000	26.98	24.28	**25.63**	24.82	22.34	**23.58**
MC 1500	27.62	24.86	**26.24**	25.41	22.87	**24.14**
TRIA 500	25.45	21.63	**23.54**	23.41	19.90	**21.66**
TRIA 1000	26.01	20.77	**23.39**	23.93	19.10	**21.52**
TRIA 1500	26.65	19.93	**23.29**	24.52	18.34	**21.43**
Control	25.55	22.53	**24.04**	23.51	20.73	**22.12**
Mean	**25.01**	**21.80**	**23.41**	**23.01**	**20.06**	**21.53**
Factor	***S Em±***	***CD***		***S Em±***	***CD***	
Variety (A)	*0.026*	*0.08*		*0.024*	*0.07*	
Growth regulators (B)	*0.132*	*0.38*		*0.122*	*0.35*	
Interaction (A x B)	-	*NS*		-	*NS*	

CD: CD at 5% level of significance CCC: Cycocel MC: Mepiquat chloride TRIA: Triacontanol

Table 4. Days to 50% flowering as influenced by growth regulators in cluster bean varieties during *kharif* and *rabi* 2015-16

Growth regulators (ppm) (B)	Variety (A)					
	Kharif			Rabi		
	HG 365	HG 563	***Mean***	HG 365	HG 563	***Mean***
CCC 500	25.47	23.43	**24.45**	23.43	21.56	**22.49**
CCC 1000	24.70	22.72	**23.71**	22.72	20.90	**21.81**
CCC 1500	24.05	22.13	**23.09**	22.13	20.36	**21.24**
MC 500	29.36	26.42	**27.89**	27.01	24.31	**25.66**
MC 1000	29.90	26.91	**28.41**	27.51	24.76	**26.14**
MC 1500	30.55	27.49	**29.02**	28.10	25.29	**26.70**
TRIA 500	27.62	24.86	**26.24**	25.41	22.87	**24.14**
TRIA 1000	26.65	23.98	**25.31**	24.52	22.06	**23.29**
TRIA 1500	25.67	23.10	**24.39**	23.62	21.26	**22.44**
Control	28.48	25.46	**26.97**	26.20	23.42	**24.81**
Mean	**27.24**	**24.65**	**25.95**	**25.06**	**22.68**	**23.87**
Factor	***S Em±***	***CD***		***S Em±***	***CD***	
Variety (A)	*0.028*	*0.08*		*0.025*	*0.07*	
Growth regulators (B)	*0.138*	*0.40*		*0.127*	*0.37*	
Interaction (A x B)	*0.157*	*0.46*		-	*NS*	

CD: CD at 5% level of significance CCC: Cycocel MC: Mepiquat chloride TRIA: Triacontanol

Table 5. Seed yield per plant (g) as influenced by growth regulators in cluster bean varieties during *kharif* and *rabi* 2015-16

Growth regulators (B)	Variety (A)					
	Kharif			*Rabi*		
	HG 365	HG 563	***Mean***	HG 365	HG 563	***Mean***
CCC 500	17.55	15.78	**16.67**	16.67	14.99	*15.83*
CCC 1000	19.01	17.10	**18.05**	18.06	16.24	*17.15*
CCC 1500	19.30	17.36	**18.33**	18.34	16.49	*17.42*
MC 500	15.35	13.81	**14.58**	14.59	13.12	*13.85*
MC 1000	15.72	14.14	**14.93**	14.93	13.43	*14.18*
MC 1500	15.79	14.20	**15.00**	15.00	13.49	*14.25*
TRIA 500	16.09	14.47	**15.28**	15.28	13.74	*14.51*
TRIA 1000	17.55	15.78	**16.67**	16.67	14.99	*15.83*
TRIA 1500	17.84	16.05	**16.94**	16.95	15.24	*16.10*
Control	14.62	12.78	**13.70**	13.89	12.14	13.01
Mean	**16.88**	**15.15**	**16.01**	**16.04**	**14.39**	**15.21**
Factor	***S Em±***	***CD***		***S Em±***	***CD***	
Variety (A)	***0.02***	***0.06***		***0.02***	***0.06***	
Growth regulators (B)	***0.10***	***0.30***		***0.10***	***0.28***	
Interaction (A x B)	***0.12***	***0.34***		***0.11***	***0.32***	

CD: CD at 5% level of significance CCC: Cycocel MC: Mepiquat chloride TRIA: Triacontanol

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