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Growth Indices Influenced by Plant Growth Regulators in Seed Cluster Bean

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ABSTRACT

The seed cluster bean exhibited significant variations in growth indices like absolute growth rate, crop growth rate and relative growth rate. The highest absolute growth rate, crop growth rate and relative growth rate was recorded by HG 365. Among the growth regulators, maximum absolute growth rate, crop growth rate and relative growth rate was recorded by the application of CCC at 1500 ppm which was on par with CCC 1000 ppm even seed yield per plot, fresh weight and dry weight followed same trend both in cultivar and growth regulator.

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 (Undersander *et al.*, 2006). Under these conditions, the spray of growth regulating chemicals on partitioning of dry weight among different parts 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 Kharif and 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 at 20 kg ha-1.

Results and Discussion

Dry weight of whole plant (g)

The dry weight of whole plant (Table 1a and 1b) differed significantly due to spray of growth regulators during *kharif* and *rabi* seasons at 30, 60, and 90 DAS. At 90 DAS, the highest dry weight of whole plant (*kharif* 31.48 g; *rabi* 28.29 g) was recorded by HG 365. Among the growth regulators, maximum dry weight of whole plant (*kharif* 36.41 g; *rabi* 34.10 g) was recorded by the application of CCC at 1500 ppm which was on par with CCC 1000 ppm (*kharif* 35.98 g; *rabi* 33.70 g). The lowest dry weight of whole plant was observed by the spray of MC 500 ppm (*kharif* 26.88 g; *rabi* 25.18 g) preceded by MC 1000 ppm (*kharif* 26.89 g; *rabi* 25.65 g). Whole plant dry weight was moderate due to the spray of TRIA 1500 ppm (*kharif* 29.42 g; *rabi* 27.56 g). The control recorded a dry weight of whole plant of 21.17 g in *kharif* and 19.83 g in *rabi* at 90 DAS.

It is inferred from the results on fresh and dry weights of all plant parts as well as whole plant that since the weights were taken at 90 DAS, the difference between fresh weight and dry weight was less in magnitude. Foliar spray of CCC was found to be the most powerful in the enhancement of fresh and dry weights of different plant parts in both the cultivars of cluster bean and exhibited maximum assimilation at 1500 ppm strength as compared to lower strengths. However, it was not significantly superior to the spray of same chemical at 1000 ppm strength. The difference between 1000 and 1500 ppm was tested non-significant in case of all the three chemicals with respect to majority of the weight observations.

The greatest influence of CCC was followed by traicontenol; but even the highest concentration of traicontenol (1500 ppm) could not show the values on par with the lowest concentration of CCC with respect of weights of different plant parts at both fresh and dry states. However, traicontanol along with mepiquat chloride, though brought about significant increase in the fresh and dry weights of plants over control, they were apparently less effective as compared to CCC at varied concentrations. However, triacontenol was significantly different from mepiquat chloride at respective concentrations regarding their influence on fresh and dry weights of various plant parts. Such differences may be attributed to the corresponding differences in leaf area and spad values. The chemical sprays those exhibited higher leaf areas with thicker chlorophyll contents also recorded higher quantities of dry matter assimilation.

The beneficial effect of tricontanol could be due to its cytokinin like activity which could therefore increase the assimilation of photosynthetic carbon products in the plant parts (Kumar and Kaushik, 2014).

Table.1a Dry weight (g) of whole plant 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	10.51	9.17	9.84	25.08	19.64	22.36	33.96	29.54	31.75
CCC 1000	11.42	9.96	10.69	26.91	21.07	23.99	38.49	33.47	35.98
CCC 1500	11.14	10.12	10.63	26.82	21.36	24.09	38.94	33.87	36.41
MC 500	9.17	8.01	8.59	19.39	15.20	17.29	28.75	25.01	26.88
MC 1000	8.38	8.20	8.29	18.66	15.41	17.03	28.29	25.48	26.89
MC 1500	8.43	8.24	8.33	18.74	15.47	17.10	28.43	25.60	27.02
TRIA 500	9.64	8.41	9.02	21.19	16.59	18.89	31.25	27.17	29.21
TRIA 1000	10.44	9.11	9.77	22.39	17.54	19.96	30.56	26.58	28.57
TRIA 1500	10.62	10.32	10.47	22.94	17.96	20.45	31.47	27.37	29.42
Control	8.65	7.55	8.10	17.88	14.00	15.94	22.64	19.69	21.17
Mean	**9.84**	**8.91**	**9.37**	**22.00**	**17.42**	**19.71**	**31.48**	**27.38**	**29.43**
Factor	***S Em±***	***CD***		***S Em±***	***CD***		***S Em±***	***CD***	
Variety (A)	*0.014*	*0.04*		*0.040*	*0.11*		*0.060*	*0.17*	
Growth regulators (B)	*0.069*	*0.20*		*0.199*	*0.57*		*0.299*	*0.87*	
Interaction (A x B)	-	*NS*		-	*NS*		*0.341*	*0.99*	

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

Table.1b Dry weight (g) of whole plant 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	9.22	8.24	8.73	23.79	20.46	22.13	30.52	28.95	29.74
CCC 1000	10.02	8.95	9.49	25.53	21.96	23.75	34.59	32.81	33.70
CCC 1500	10.18	9.08	9.63	25.87	22.25	24.06	35.00	33.19	34.10
MC 500	8.05	7.19	7.62	18.40	15.83	17.11	25.84	24.51	25.18
MC 1000	8.24	7.36	7.80	18.66	16.05	17.35	26.33	24.97	25.65
MC 1500	8.28	7.40	7.84	18.73	16.11	17.42	26.45	25.09	25.77
TRIA 500	8.46	7.55	8.00	20.10	17.29	18.69	28.08	26.63	27.36
TRIA 1000	9.17	8.18	8.67	21.25	18.27	19.76	27.47	26.05	26.76
TRIA 1500	9.33	10.31	9.82	21.77	18.71	20.24	28.29	26.82	27.56
Control	7.59	6.77	7.18	16.97	14.59	15.78	20.35	19.30	19.83
Mean	**8.85**	**8.10**	**8.48**	**21.11**	**18.15**	**19.63**	**28.29**	**26.83**	**27.56**
Factor	***S Em±***	***CD***		***S Em±***	***CD***		***S Em±***	***CD***	
Variety (A)	*0.012*	*0.04*		*0.039*	*0.11*		*0.056*	*0.16*	
Growth regulators (B)	*0.062*	*0.18*		*0.193*	*0.56*		*0.279*	*0.81*	
Interaction (A x B)	-	*NS*		*0.220*	*0.64*		*0.319*	*0.92*	

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

Table.2a Absolute growth rate (centi gram day^{-1}) as influenced by growth regulators in cluster bean varieties during *kharif* 2015-16

Growth regulators (ppm) (B)	Variety (A)					
	30-60 DAS			60-90 DAS		
	HG 365	HG 563	***Mean***	HG 365	HG 563	***Mean***
CCC 500	48.56	34.90	**41.73**	29.61	32.99	**31.30**
CCC 1000	51.64	37.05	**44.35**	38.60	41.32	**39.96**
CCC 1500	52.26	37.48	**44.87**	38.91	41.70	**40.31**
MC 500	34.07	23.95	**29.01**	31.19	32.71	**31.95**
MC 1000	34.25	24.04	**29.15**	32.10	33.57	**32.84**
MC 1500	34.35	24.10	**29.23**	32.31	33.78	**33.04**
TRIA 500	38.51	27.30	**32.91**	33.52	35.25	**34.39**
TRIA 1000	39.85	28.09	**33.97**	27.23	30.14	**28.69**
TRIA 1500	41.04	25.48	**33.26**	28.45	31.36	**29.90**
Control	30.78	21.52	**26.15**	15.87	18.97	**17.42**
Mean	**40.53**	**28.39**	**34.46**	**30.78**	**33.18**	**31.98**
Factor	***S Em±***	***CD***		***S Em±***	***CD***	
Variety (A)	*0.091*	*0.26*		*0.085*	*0.25*	
Growth regulators (B)	*0.454*	*1.31*		*0.426*	*1.23*	
Interaction (A x B)	-	*NS*		*0.486*	*1.41*	

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

Table.2b Absolute growth rate (centi gram day^{-1}) as influenced by growth regulators in cluster bean varieties during *rabi* 2015-2016

Growth regulators (ppm) (B)	Variety (A)					
	30-60 DAS			60-90 DAS		
	HG 365	HG 563	***Mean***	HG 365	HG 563	***Mean***
CCC 500	48.57	40.75	**44.66**	22.42	28.29	**25.36**
CCC 1000	51.69	43.36	**47.53**	30.20	36.16	**33.18**
CCC 1500	52.32	43.88	**48.10**	30.43	36.48	**33.45**
MC 500	34.49	28.79	**31.64**	24.80	28.94	**26.87**
MC 1000	34.72	28.97	**31.84**	25.57	29.74	**27.66**
MC 1500	34.82	29.05	**31.93**	25.75	29.93	**27.84**
TRIA 500	38.81	32.46	**35.64**	26.59	31.14	**28.87**
TRIA 1000	40.28	33.65	**36.97**	20.73	25.93	**23.33**
TRIA 1500	41.46	28.01	**34.74**	21.74	27.03	**24.38**
Control	31.27	26.07	**28.67**	11.27	15.70	**13.48**
Mean	**40.84**	**33.50**	**37.17**	**23.95**	**28.93**	**26.44**
Factor	***S Em±***	***CD***		***S Em±***	***CD***	
Variety (A)	*0.094*	*0.27*		*0.075*	*0.22*	
Growth regulators (B)	*0.471*	*1.36*		*0.377*	*1.09*	
Interaction (A x B)	-	*NS*		*0.429*	*1.24*	

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

Table.3a Crop growth rate(g dm^{-2} day^{-1}) as influenced by growth regulators in cluster bean varieties during *kharif* 2015-*16*

Growth regulators (ppm) (B)	Variety (A)					
	30-60 DAS			60-90 DAS		
	HG 365	HG 563	***Mean***	HG 365	HG 563	***Mean***
CCC 500	16.19	11.63	**13.91**	9.87	11.00	**10.43**
CCC 1000	17.21	12.35	**14.78**	12.87	13.77	**13.32**
CCC 1500	17.42	12.49	**14.96**	12.97	13.90	**13.44**
MC 500	11.36	7.98	**9.67**	10.40	10.90	**10.65**
MC 1000	11.42	8.01	**9.72**	10.70	11.19	**10.95**
MC 1500	11.45	8.03	**9.74**	10.77	11.26	**11.01**
TRIA 500	12.84	9.10	**10.97**	11.17	11.75	**11.46**
TRIA 1000	13.28	9.36	**11.32**	9.08	10.05	**9.56**
TRIA 1500	13.68	8.49	**11.09**	9.48	10.45	**9.97**
Control	10.26	7.17	**8.72**	5.29	6.32	**5.81**
Mean	**13.51**	**9.46**	**11.49**	**10.26**	**11.06**	**10.66**
Factor	***S Em±***	***CD***		***S Em±***	***CD***	
Variety (A)	*0.030*	*0.09*		*0.028*	*0.08*	
Growth regulators (B)	*0.151*	*0.44*		*0.142*	*0.41*	
Interaction (A x B)	-	*NS*		*0.162*	*0.47*	

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

Table.3b Crop growth rate(g dm^{-2} day^{-1}) as influenced by growth regulators in cluster bean varieties during *rabi* 2015-16

Growth regulators (ppm) (B)	Variety (A)					
	30-60 DAS			60-90 DAS		
	HG 365	HG 563	***Mean***	HG 365	HG 563	***Mean***
CCC 500	16.19	13.58	**14.89**	7.47	9.43	**8.45**
CCC 1000	17.23	14.45	**15.84**	10.07	12.05	**11.06**
CCC 1500	17.44	14.63	**16.03**	10.14	12.16	**11.15**
MC 500	11.50	9.60	**10.55**	8.27	9.65	**8.96**
MC 1000	11.57	9.66	**10.61**	8.52	9.91	**9.22**
MC 1500	11.61	9.68	**10.64**	8.58	9.98	**9.28**
TRIA 500	12.94	10.82	**11.88**	8.86	10.38	**9.62**
TRIA 1000	13.43	11.22	**12.32**	6.91	8.64	**7.78**
TRIA 1500	13.82	9.34	**11.58**	7.25	9.01	**8.13**
Control	10.42	8.69	**9.56**	3.76	5.23	**4.49**
Mean	**13.61**	**11.17**	**12.39**	**7.98**	**9.64**	**8.81**
Factor	***S Em±***	***CD***		***S Em±***	***CD***	
Variety (A)	*0.031*	*0.09*		*0.025*	*0.07*	
Growth regulators (B)	*0.157*	*0.45*		*0.126*	*0.36*	
Interaction (A x B)	-	*NS*		*0.143*	*0.41*	

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

Table.4a Relative growth rate (mg g^{-1} day^{-1}) as influenced by growth regulators in cluster bean varieties during *kharif* 2015-16

Growth regulators (ppm) (B)	Variety (A)					
	30-60 DAS			60-90 DAS		
	HG 365	HG 563	***Mean***	HG 365	HG 563	***Mean***
CCC 500	30.39	26.80	**28.60**	10.32	13.94	**12.13**
CCC 1000	30.02	26.43	**28.23**	12.19	15.81	**14.00**
CCC 1500	29.96	26.37	**28.16**	12.14	15.76	**13.95**
MC 500	26.19	22.60	**24.40**	13.42	17.04	**15.23**
MC 1000	25.87	22.28	**24.07**	13.58	17.21	**15.39**
MC 1500	25.83	22.24	**24.04**	13.62	17.24	**15.43**
TRIA 500	27.59	24.00	**25.80**	13.24	16.86	**15.05**
TRIA 1000	26.61	23.02	**24.82**	10.58	14.20	**12.39**
TRIA 1500	26.85	19.24	**23.05**	10.77	14.39	**12.58**
Control	25.25	21.66	**23.46**	8.02	11.64	**9.83**
Mean	**27.46**	**23.47**	**25.46**	**11.79**	**15.41**	**13.60**
Factor	***S Em±***	***CD***		***S Em±***	***CD***	
Variety (A)	*0.028*	*0.08*		*0.025*	*0.07*	
Growth regulators (B)	*0.141*	*0.41*		*0.123*	*0.35*	
Interaction (A x B)	-	*NS*		*0.140*	*0.40*	

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

Table.4b Relative growth rate (mg g^{-1} day^{-1}) as influenced by growth regulators in cluster bean varieties during *rabi* 2015-16

Growth regulators (ppm) (B)	Variety (A)					
	30-60 DAS			60-90 DAS		
	HG 365	HG 563	***Mean***	HG 365	HG 563	***Mean***
CCC 500	32.97	31.78	**32.37**	8.49	11.84	**10.16**
CCC 1000	32.60	31.41	**32.01**	10.36	13.71	**12.04**
CCC 1500	32.53	31.34	**31.94**	10.31	13.66	**11.99**
MC 500	28.77	27.58	**28.17**	11.59	14.94	**13.27**
MC 1000	28.44	27.25	**27.85**	11.75	15.11	**13.43**
MC 1500	28.41	27.22	**27.82**	11.79	15.14	**13.46**
TRIA 500	30.17	28.98	**29.58**	11.41	14.76	**13.08**
TRIA 1000	29.19	28.00	**28.60**	8.75	12.11	**10.43**
TRIA 1500	29.43	20.67	**25.05**	8.94	12.29	**10.61**
Control	27.83	26.64	**27.24**	6.19	9.54	**7.87**
Mean	**30.03**	**28.09**	**29.06**	**9.96**	**13.31**	**11.63**
Factor	***S Em±***	***CD***		***S Em±***	***CD***	
Variety (A)	*0.032*	*0.09*		*0.025*	*0.07*	
Growth regulators (B)	*0.160*	*0.46*		*0.123*	*0.35*	
Interaction (A x B)	-	*NS*		*0.140*	*0.40*	

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

Table.5 Dry pod yield per plot (kg) 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	4.81	3.89	**4.35**	4.07	3.30	**3.68**
CCC 1000	5.65	4.57	**5.11**	4.78	3.87	**4.32**
CCC 1500	5.82	4.71	**5.27**	4.93	3.99	**4.46**
MC 500	3.69	2.98	**3.33**	3.12	2.52	**2.82**
MC 1000	3.86	3.13	**3.49**	3.27	2.65	**2.96**
MC 1500	3.90	3.15	**3.53**	3.30	2.67	**2.98**
TRIA 500	4.04	3.27	**3.66**	3.42	2.77	**3.10**
TRIA 1000	4.81	3.89	**4.35**	4.07	3.30	**3.68**
TRIA 1500	4.97	4.02	**4.50**	4.21	3.41	**3.81**
Control	3.34	2.55	**2.95**	2.83	2.16	**2.49**
Mean	**4.49**	**3.62**	**4.05**	**3.80**	**3.06**	**3.43**
Factor	***S Em±***	***CD***		***S Em±***	***CD***	
Variety (A)	*0.010*	*0.03*		*0.009*	*0.03*	
Growth regulators (B)	*0.052*	*0.15*		*0.044*	*0.13*	
Interaction (A x B)	*0.059*	*0.17*		*0.050*	*0.14*	

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

Poor translocation of photo-assimilates to the growing reproductive parts was found to be the major constraint in cluster bean. This constraint can be overcome by applying synthetic plant growth regulators which improve the canopy structure and increase the productivity through the manipulation of source-sink relationship (Sahu *et al.,* 1993).

Thus the present study it was noticed that the dry matter accumulation in the different parts increased from 30 to 90 DAS due to the spray of all the growth regulators over control. This could be due to better translocation of stored photo-assimilates towards the development of various organs, the higher leaf dry weight with the application of mepiquat chloride could be attributed to it is beneficial effect on leaf development (Prabhavathi, 2005).

Similarly, application of CCC lead to increased leaf dry weight which was also observed in greengram (Shah and Prathapsenan, 1991). Wasnik and Bagga (1996) reported that the application of mepiquat chloride increased the leaf dry weight in chickpea over control. The stem dry weight and pod dry weight along with leaf dry weight were increased significantly due to application of mepiquat chloride (1000 ppm) at all the stages studied (Prabhavathi, 2005).

Dry matter accumulation, particularly in reproductive parts is an important yield contributing character. However, a productive vegetative phase is essential for the development of reproductive organs. Although, the dry matter production in general is an indication of the efficiency of any treatment, the pattern in which it is distributed in different plant parts would give a better understanding about the effect of such treatment.

In the present study, CCC maintained higher dry weight of reproductive parts. Among the growth regulators this might be probably due to better source sink relationship. Maintained by the external application of CCC such a better source sink relationship might have be due to increased translocation of assimilates from leaf and stem to the reproductive parts. Similar effects were found in mungbean and chickpea due to application of CCC (Singh *et al.,* 1993 and Brar *et al.,* 1993). The application of cycocel was found to increase the RuBP carboxylase enzyme activity, net photosynthesis and drymatter partitioning in to pods in groundnut Dashora and Jain (1994), while the combination of triacontanol with other chemicals (paras or planofix) increased the dry matter accumulation in whole plants of mustard (Ghosh *et al.,* 1991). These findings are in conformity with the results obtained in the present study.

Absolute growth rate (centi gram day^{-1})

The Absolute growth rate (Table 2a, 2b) differed significantly due to spray of growth regulators during *kharif* and *rabi* seasons at various growth stages. At 30-60 DAS, the highest absolute growth rate (*kharif* 40.53; *rabi* 40.84) was recorded by HG 365. Among the growth regulators, maximum absolute growth rate (*kharif* 44.87; *rabi* 48.10) was recorded by the application of CCC at 1500 ppm which was on par with CCC 1000 ppm (*kharif* 44.35; *rabi* 47.53). The lowest absolute growth rate was observed by the spray of MC 500 ppm (*kharif* 29.01; *rabi* 31.64) preceded by MC 1000 ppm (*kharif* 29.15; *rabi* 31.84) whereas, TRIA 1500 ppm resulted in intermediate values of AGR (*kharif* 33.26 g, *rabi* 34.74 g). The control recorded an absolute growth rate of 26.15 in *kharif* and 28.67 in *rabi* at 30-60 DAS.

Crop growth rate (g dm^{-2} day^{-1})

The crop growth rate (Table 3a, 3b) differed significantly due to spray of growth regulators during *kharif* and *rabi* seasons at various growth stages. At 30-60 DAS, the highest crop growth rate (*kharif* 13.51; *rabi* 13.61) was recorded by HG 563. Among the growth regulators, maximum crop growth rate (*kharif* 14.96; *rabi* 16.03) was recorded by the application of CCC at 1500 ppm which was on par with CCC 1000 ppm (*kharif* 14.78; *rabi* 15.84). The lowest crop growth rate was observed by the spray of MC 500 ppm (*kharif* 9.67; *rabi* 10.55) preceded by MC 1000 ppm (*kharif* 9.72; *rabi* 10.61). CGR was moderate due to the spray of TRIA 1500 (*kharif* 11.09; *rabi* 11.58 g). The control recorded a crop growth rate of 8.72 in *kharif* and 9.56 in *rabi* at 30-60 DAS.

Relative growth rate (mg g^{-1} day^{-1})

The Relative growth rate (Table 4a, 4b) differed significantly due to spray of growth regulators during *kharif* and *rabi* seasons at various growth stages. At 30-60 DAS, the highest relative growth rate (*kharif* 27.46; *rabi* 30.03) was recorded by HG 365. Among the growth regulators, maximum relative growth rate (*kharif* 28.60; *rabi* 32.37) was recorded by the application of CCC at 500 ppm which was on par with CCC 1000 ppm (*kharif* 28.23; *rabi* 32.01). The lowest relative growth rate was observed by the spray of TRIA 1500 ppm (*kharif* 23.05; *rabi* 25.05) preceded by TRIA 1000 ppm (*kharif*: 24.82; *rabi* 28.60), whereas the RGR due to MC 1500 ppm was in intermediate range (*kharif* 24.04; *rabi* 27.82). The control recorded a relative growth rate of 23.46 in *kharif* and 27.24 in *rabi* at 30-60 DAS.

Dry pod yield per plot (kg)

The pod yield per plot (Table 5) differed significantly due to spray of growth regulators during *kharif* and *rabi* seasons. The highest pod yield per plot (*kharif* 4.49 kg; *rabi* 3.80 kg) was recorded by HG 365. Among the growth regulators, maximum pod yield per plot (*kharif* 5.27 kg; *rabi* 4.46 kg) was recorded by the application of CCC at 1500 ppm which was on par with CCC 1000 ppm (*kharif* 5.11 kg; *rabi* 4.32 kg). The lowest pod yield per plot was observed by the spray of MC 500 ppm (*kharif* 3.33 kg; *rabi* 2.82 kg) which was on par with MC 1000 ppm (*kharif* 3.49 kg; *rabi* 2.96 kg). Foliar application of TRIA 1500 ppm recorded a medium pod yield per plot during both the seasons (*kharif 4*.50 kg, *rabi* 3.81 kg). The control recorded a pod yield per plot of 2.95 kg in *kharif* and 2.49 kg in *rabi*.

The pod yield is the most essential parameter contributing to the seed yield because the only difference lies in pericarps encircling the seeds. The effect of growth regulators was found significant on the pod yield per plant and per plot in both the varieties. As it was observed in case of growth, flowering and quality parameters, the pod yield was found to be highest in case of spray of CCC at 1500 ppm being significantly superior to the same chemical at 1000 ppm.

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