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Effect of Growth Regulators and Methods of Application on Growth, Fruit and Seed Yield in Paprika Chilli (*Capsicum annuum* L.) cv. Kt-Pl-19

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ABSTRACT Effect of growth regulators *viz.*, NAA (40 ppm), GA_3 (50 ppm), CCC (500 ppm) and 2,4-D (5 ppm) and methods of application on growth, fruit and seed yield in paprika chilli cv. Kt-Pl-19 was studied during *kharif* 2006-07. Among the growth regulators, NAA @ 40 ppm was found most effective for higher plant height at 30, 60and 90 days after transplanting, more number of fruits per plant (25.20), 1000 seed weight (5.92g), fruit yield per hectare (924.8kg), seed yield per plant (12.77 g) and per hectare (371.23 kg).Between the methods of application, application of growth regulators at flower bud initiation stage recorded the highest plant height at 60 and 90 days after transplanting, more number of fruits per plant (22.97), 1000 seed weight (5.81 g), fruit yield per hectare (924.8kg), seed weight per fruit (2.41g), seed yield per plant (12.02 g) and per hectare (353.88 kg). Applications of NAA (40 ppm) or GA_3 (50 ppm) at flower bud initiation stage were most effective for higher fruit and seed yield in paprika chilli.

Key words: Paprika chilli, NAA, GA_3, CCC, 2,4-D, methods of application, seed.

Paprika chilli (*Capsicum annuum* L.) is one of the most valuable commercial annual spice crops grown in India. There is great demand for paprika chilli powder and oleo-resin in western countries. Paprika chilli powder is widely used as food flavourant, red colourant, in medicines and cosmetic preparations [1]. In India its area is increasing every year due to high value in international market. Hence production and supply of quality seeds of paprika chilli has become necessary. Plant growth regulators are known to enhance the source sink relationship and simulate the translocation of photo assimilates thereby helping in better retention of flowers and fruits. They also modify growth, seed yield and improve the seed quality in chilli [2]. Considering all these, an attempt was made to find out the effect of growth regulator and methods of application on growth, fruit and seed yield of paprika chilli during *kharif* 2006-07.

MATERIALS AND METHODS

The field experiment was conducted at Main Agricultural Research Station, University of Agricultural Sciences, Dharwad during the year 2006-07 *kharif* season with three replications in factorial RBD. The variety used for this experiment is Kt-Pl-19. Treatment comprises of four growth regulators like naphthalene acetic acid (NAA @ 40 ppm), gibberllic acid (GA_3 @ 50 ppm), cycocel (CCC @ 500 ppm) and 2, 4-Dichlorophenoxy acetic acid (2, 4-D @ 5 ppm) and two methods of application of growth regulators i.e., seed treatment and foliar application. In case of seed treatment, seeds were soaked in NAA (40 ppm), GA_3 (50 ppm), CCC (500 ppm), 2, 4-D (5 ppm) solutions and water for a period of six hours and immediately after seed treatment, seeds were sown in the nursery seed beds. In case of foliar spraying, separate crop was raised on another block and growth

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regulators were sprayed at flower bud initiation stage. Precaution was taken to prevent drifting of spray solution from one treatment plot to the other by using **V** shaped hood. The healthy and normal seedlings were transplanted at 4-6 true leaf stage in 45 cm apart per hill and 60cm apart in a row. The size of the gross plot was 4.2 x $3.6m^2$ and net plot was 3.0 x $2.7m^2$. Other cultivation operations including plant protection measures were carried out as per recommended package of practices of University of Agricultural Sciences, Dharwad [3]. Five plants from each plot were selected randomly and tagged for recording observations. Observations were recorded on plant height and number of branches at 30, 60 and 90 days after transplanting, number of fruits per plant, fruit yield per plant and per hectare, seed weight per fruit, 1000 seed weight and seed yield per plant and per hectare.

RESULTS AND DISCUSSION

Application of growth regulators either as a seed treatment or as a foliar treatment was found to significantly increase the plant height at all stages of crop growth except at 30 DAT over control (Table 1). Among the growth regulators, NAA @ 40 ppm recorded significantly the highest plant height (57.02cm) at 90DAT and was on par with the 50 ppm GA_3 (56.68cm) as against CCC (52.45cm) and other treatments at the end of 90 DAT. More plant height with NAA and GA_3 may be due to rapid cell division and cell elongation in the growing portions of the plant or stimulation of growth besides increasing uptake of nutrients [4]. The stimulatory actions of auxins not only soften the cell wall of the stem but also increase their plasticity and stimulate plant growth in tomato [5]. Similar beneficial effect of growth regulators on plant height was reported in chilli [7] and bottle gourd [8].

A significant difference in number of branches per plant was noticed among the growth regulator treatments over application methods (Table 2). Significantly higher number of branches (24.33) was recorded with CCC @ 500 ppm followed by 40 ppm NAA (23.00) and 2,4-D 5 ppm (22.83) over water treatment. The more number of branches may be due to the inhibitory effect of CCC that has induced less growth of main axis and accelerated its horizontal growth by forming the highest number of lateral shoots per plant. It might be further due to blocking of the plant system which provided active gibberellins to the growth mechanism and reduced the apical dominance in the plants, thereby increased dry matter due to the increased carbohydrate accumulation resulting from a more efficient photosynthetic activity brought about by the anatomical modifications [9, 10].

Present study indicated significant variations due to growth regulators for number of fruits per plant, 1000 seed weight, fruit yield per plant and fruit yield per hectare (Table 3 & 4). Yield components were consistently more in all the growth regulator treatments compared to water spray i.e. 40 ppm NAA (25.20, 5.90g, 33.29g and 924.8 kg/ha, respectively) followed by 50 ppm GA_3 (22.80, 5.78g, 32.98g and 916.3 kg/ha, respectively) as against water spray (19.80, 5.32g, 31.06g and 862.70 kg/ha, respectively). From the results of this study, it is observed that significant increase in number of fruits per plant, 1000 seed weight, fruit yield per plant and fruit yield per hectare noticed in NAA and GA_3 growth regulator spray may be related to the increased flowering period and reduced flower and fruit drop due to the promotery effect of growth regulators. Similarly, increase in fruit yield components with application of growth regulators was observed in chilli [2]. The growth regulators like NAA and GA_3 are known to involve in inhibition of cellulose and pectinase activities and abscissin production which might have reduced the premature flower drop apart from involved in ovary development during seed filling process in chilli [6].

Application of NAA (40 ppm) recorded significantly maximum seed weight per fruit (2.53g), seed yield per plant (12.77g) and seed yield per hectare (371.23kg) followed by 50 ppm GA_3 (Table 5),whereas all these yield components were minimum in control (water treatment) (1.98g,10.25g and 310.5kg/ha, respectively). Increase in seed yield per hectare with NAA and GA_3 growth regulators may be attributed to the better plant growth and canopy area which might have resulted in more number of fruits per plant and fruit yield per hectare ultimately increased

Table 1. Effect of growth regulators and methods of application on plant height at different growth stages in paprika chilli cv. Kt-Pl-19

Growth regulators (G)	Plant height (cm)								
	30 DAT			60 DAT			90 DAT		
	M_1	M_2	Mean	M_1	M_2	Mean	M_1	M_2	Mean
G_0–Water spray (control)	11.86	11.80	**11.83**	27.17	27.50	**27.33**	52.20	54.73	**53.47**
G_1–NAA @ 40 ppm	13.19	12.77	**12.98**	30.77	33.50	**32.13**	55.07	58.97	**57.02**
G_2–GA_3 @ 50 ppm	13.26	12.60	**12.93**	30.00	31.60	**30.80**	54.43	58.00	**56.22**
G_3–CCC @ 500 ppm	12.67	12.80	**12.73**	26.17	26.83	**26.50**	51.17	53.73	**52.45**
G_4–2,4-D @ 5 ppm	12.20	12.13	**12.17**	28.33	30.50	**29.42**	52.30	57.07	**54.68**
Mean	13.20	12.42	12.80	28.49	29.99	29.24	53.03	56.55	54.77
For comparing the means of	SEm±	CD at 5%		SE m±	CD at 5%		SE m±	CD at 5%	
Growth regulators (G)	0.58	NS		0.78	2.32		1.48	4.39	
Methods of application (M)	0.36	NS		0.49	1.47		0.94	2.79	
Interactions (G x M)	0.82	NS		1.10	NS		2.10	NS	

M_1–Seed soaking for six hour; M_2–Foliar spray at flower bud initiation stage = Methods of application

NS–Non significant; DAT–Days after transplanting

Table 2. Effect of growth regulators and methods of application on number of branches per plant at different growth stages in paprika chilli cv. Kt-Pl-19

Growth regulators (G)	No. of branches/plant								
	30 DAT			60 DAT			90 DAT		
	M_1	M_2	Mean	M_1	M_2	Mean	M_1	M_2	Mean
G_0–Water spray(control)	5.00	5.00	**5.00**	11.33	11.00	**11.17**	19.33	19.67	**19.50**
G_1–NAA @ 40 ppm	6.33	5.33	**5.83**	12.33	13.33	**12.83**	22.00	24.00	**23.00**
G_2–GA_3 @ 50 ppm	6.00	5.67	**5.83**	11.33	12.00	**11.67**	21.00	23.00	**22.00**
G_3–CCC @ 500 ppm	7.00	5.66	**6.33**	12.67	15.33	**14.00**	22.67	26.00	**24.33**
G_4–2,4-D @ 5 ppm	6.33	5.33	**5.83**	11.67	13.33	**12.50**	21.67	24.00	**22.83**
Mean	6.13	5.40	5.77	11.86	13.00	12.43	21.33	23.33	22.33
For comparing the means of	SEm±	CD at 5%		SE m±	CD at 5%		SE m±	CD at 5%	
Growth regulators (G)	0.35	NS		0.50	1.49		0.68	2.02	
Methods of application (M)	0.22.	0.66		0.32	0.95		0.43	1.27	
Interactions (G x M)	0.50	NS		0.71	NS		0.96	NS	

M_1–Seed soaking for six hour; M_2–Foliar spray at flower bud initiation stage = Methods of application

NS–Non significant; DAT–Days after transplanting

Table 3. Effect of growth regulators and methods of application on fruit yield per plant (g) and fruit yield per hectare (kg) in paprika chilli cv. Kt-Pl-19

Growth regulators (G)	Fruit yield per plant (g)			Fruit yield per hectare (kg)		
	M_1	M_2	Mean	M_1	M_2	Mean
G_0–Water spray(control)	31.12	31.01	**31.06**	864.1	861.4	**862.7**
G_1–NAA @ 40 ppm	32.84	33.74	**33.29**	912.2	937.3	**924.8**
G_2–GA_3 @ 50 ppm	31.77	34.20	**32.98**	882.6	950.1	**916.3**
G_3–CCC @ 500 ppm	30.74	31.94	**31.35**	856.9	899.1	**878.0**
G_4–2,4-D @ 5 ppm	31.74	33.77	**32.75**	881.6	938.0	**909.8**
Mean	31.64	32.94	32.29	879.5	917.2	898.3
For comparing the means of	SEm±		CD at 5%	SEm±		CD at 5%
Growth regulators (G)	0.56		1.67	15.10		44.84
Methods of application (M)	0.36		1.06	9.55		28.36
Interactions (G x M)	0.79		NS	21.35		NS

M_1–Seed soaking for six hour; M_2–Foliar spray at flower bud initiation stage = Methods of application

NS–Non significant; DAT–Days after transplanting

Table 4. Effect of growth regulators and methods of application on number of fruits per plants and 1000 seed weight (g) in paprika chilli cv. Kt-Pl-19

Growth regulators (G)	No. of fruit per plant			1000 seed weight (g)		
	M_1	M_2	Mean	M_1	M_2	Mean
G_0–Water spray(control)	19.47	20.13	**19.80**	5.31	5.32	**5.32**
G_1–NAA @ 40 ppm	23.97	26.43	**25.20**	5.76	6.08	**5.92**
G_2–GA_3 @ 50 ppm	22.57	23.03	**22.80**	5.63	5.94	**5.78**
G_3–CCC @ 500 ppm	19.33	22.03	**20.68**	5.32	5.78	**5.55**
G_4–2,4-D @ 5 ppm	22.17	23.20	**22.68**	5.45	5.94	**5.70**
For comparing the means of	SEm±		CD at 5%	SEm±		CD at 5%
Growth regulators (G)	0.55		1.65	0.10		0.30
Methods of application (M)	0.35		1.04	0.06		0.19
Interactions (G ´ M)	0.78		NS	0.14		0.42

M_1–Seed soaking for six hour; M_2–Foliar spray at flower bud initiation stage = Methods of application

NS–Non significant; DAT–Days after transplanting

seed weight per fruit, seed yield per plant and seed yield per hectare as evident from the results of the study. Further, the significant increase in seed yield may also be attributed to the higher chlorophyll content, photosynthetic activity, increased assimilation and accumulation of photosynthates from source to sink (seeds) due to application of growth regulators unlike water treatment (control) seeds as similar promotory and significant effects of NAA and GA_3 in enhancing seed yield per unit area was also reported in chilli [11].

Foliar application of growth regulators at flower bud initiation stage (M_2) recorded more number of fruits per plant (22.97), fruit yield per plant (32.94g) and per hectare (917.2 kg/ha), seed weight per fruit (2.41 g), seed yield per plant (12.02 g) and per hectare (353.88 kg/ha) as compared to seed soaking for 6 hours (41.70%, 21.50, 31.64g, 879.5 kg, 2.10 g, 11.12 g and 320.66 kg, respectively). Exogenous supply of growth regulators at critical stages of flowering and fertilization, ovary formation, fruit and seed development period etc. may enhance source to sink relationship, accumulation of photosynthates and efficient utilization of food reserves for the development of fruit and seed [12]. Similar increase in fruit and seed yield due to foliar application of growth regulators are also confirmed in chilli [2 & 6].

Interaction effects of growth regulators and methods of application on seed yield per plant and per hectare were significant. The highest seed yield per plant (13.36 g) and per hectare (394.14 kg) were recorded with 40 ppm NAA sprayed at flower bud initiation stage and which was at par with 50 ppm GA_3 sprayed at flower bud initiation stage. These results are in conformity with findings of Singh *et.al.* in chilli [13].

Thus, it can be concluded that NAA at 40 ppm or GA_3 at 50 ppm sprayed at flower bud initiation stage was considered as better for higher seed yield and quality in paprika chilli cv. Kt-Pl-19.

Table 5. Effect of growth regulators and methods of application on seed weight per fruit (g), seed yield per plant (g) and seed yield per hectare in paprika chilli cv. Kt-Pl-19

Growth regulators (G)	Seed wt./fruit(g)			Seed yield/plant(g)			Seed yield/ha(kg)		
	M_1	M_2	Mean	M_1	M_2	Mean	M_1	M_2	Mean
G_0–Water spray(control)	2.01	1.94	**1.98**	10.08	10.43	**10.25**	299.90	321.15	**310.53**
G_1–NAA @ 40 ppm	2.26	2.80	**2.53**	12.19	13.36	**12.77**	348.33	394.12	**371.23**
G_2–GA_3 @ 50 ppm	2.07	2.54	**2.31**	12.13	12.57	**12.35**	341.11	364.86	**352.98**
G_3–CCC @ 500 ppm	2.00	2.53	**2.27**	10.21	11.41	**10.81**	303.33	333.01	**318.17**
G_4–2,4-D @ 5 ppm	2.14	2.40	**2.28**	11.01	12.35	**11.68**	310.65	356.25	**333.45**
Mean	2.10	2.41	2.26	11.12	12.02	11.58	320.66	353.88	337.27
For comparing the means of	SEm±	CD at 5%		SEm±	CD at 5%		SEm±	CD_at 5%	
Growth regulators (G)	0.11	0.32		0.47	1.39		10.85	32.26	
Methods of application (M)	0.07	0.21		0.30	0.88		6.86	20.38	
Interactions (G x M)	0.15	NS		0.66	1.95		15.34	45.56	

M_1–Seed soaking for six hour; M_2–Foliar spray at flower bud initiation stage = Methods of application
NS–Non significant; DAT–Days after transplanting

REFERENCES

1. RAJINDER SINGH & J. S. HINDAL (2001). Combining ability studies in chilli (*Capsicum annum* L.) for oleoresin and related traits. *Veg. Sci.*, **28** (2): 117-120.

2. BIRADAR, B.R. (1999). Investigations of seed technology aspects in chilli *(Capsicum annuum* L.). *Ph.* D. *Thesis,* Uni. Agric. Sci., Dharwad (India).

3. ANONYMOUS (2002). *Improved cultivation practices of horticulture crops (Kannada).* University of Agricultural Sciences, Dharwad, pp. 177-183.

4. PANDITA, M.L., S.C. PANDEY, J.L. MANGAL & G.P. SINGH (1980). Effect of various concentrations of planoflx as foliar spray on plant growth and fruit yield of chillies. *Haryana J. Hortic. Science,* **9** : 170-174.

5. MEHROTRA, O.N., R.C. GARG & IQBAL SINGH (1970). Growth, fruiting and quality of tomato (*Lycopersicon esculentum* Mill.) as influenced by growth regulators. *Progr. Hortic.*, **2:** 57-64.

6. REVANAPPA (1993). Response of green chilli *(Capsicum annuum* L.) genotypes to nitrogen levels, plant density and growth regulators. *Ph.D. Thesis,* Uni. Agric. Sci., Dharwad (India).

7. GOLLAGI, S.G.(1999). Influence of growth regulators and nutrients for increasing productivity potential and quality in chilli *(Capsicum annuum* L.). *M.Sc.(Agri.) Thesis,* Uni. Agric. Sci., Dharwad (India).

8. INGLE, V.G., B.J. JADHAO & P.S. JOSHI (2000). Effect of plant growth regulators on growth, sex ratio and yield of bottle gourd. *J. Soils Crops,* **10**(4): 101-104.

9. SALEH, M.M. &, K.S. ABDUL (1980). Effect of gibberellic acid and CCC, on growth of tomato plants. *Mesopotamia J. Agric.,* **15**(1): 137-166.

10. YADAV, R.B.R. & P.R. SREENATH (1975). Influence of some growth regulators on growth, flowering and yield of cowpea. *Ind. J. Pl. Physiol.*, **18**: 136-139.

11. SINGH, D.K. & G. LAL (1995). Effect of plant growth regulators on the fruit set, yield and quality of chilli *(Capsicum annuum* L.) cultivars. *Adva. Hortic. Forest.,* **4:** 133-141.

12. MEHTA, A.K., R.P. SINGH & G. LAL (1989). Effect of concentration and methods of application of 2,4-D phenoxy acetic acid on yield, fruit quality and seed quality of tomato (*Lycopersicon esculentum* Mill). *Veg. Sci.,* **16**(1): 1-8.

13. SINGH, D.K., GULSHAN LAL & R.P. SINGH (1990). Effect of synthetic auxins on the performance of chilli *(Capsicum annuum* L.). cultivars under tarai conditions of UP during winter season. *Prog. Hortic.,* **22:** 191-197.