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Research Article

YIELD AND QUALITY PARAMETERS OF GARLAND CHRYSANTHEMUM (CHRYSANTHEMUM CORONARIUM L.) AS INFLUENCED BY GROWTH REGULATORS/CHEMICALS

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ABSTRACT
The results on weight of flowers per plot showed that the maximum yield enhancing ability was shown by GA at 100 ppm. There was no addition in the yield of garland chrysanthemum by increasing the concentration of GA beyond 100 ppm. Foliar spray of cycocel at 3000 ppm recorded maximum number of flowers per plant, when compared to other concentrations. But their average weight being relatively lesser, they were making a gross weight of flowers per ha only next to gibberellic acid at 100 ppm. SA spray at 100 ppm resulted in significant increase in flower and seed yield when compared to other concentrations. Paclobutrazol at 40 ppm recorded a higher number of flowers per plant compared to other higher concentrations of 60 and 80 ppm. Flower quality in terms of average flower weight, flower diameter and seed quality in terms of test weight were also at maximum by the application of GA at 100 ppm.

Key Words: *Flower Yield, Garland Chrysanthemum, Growth Regulators and Quality*

INTRODUCTION
Garland chrysanthemum, botanically known as *Chrysanthemum coronarium* L., is an annual under the chrysanthemum group of flowers. It is different from plurannual or florist chrysanthemum in many aspects. The crop is relatively short durated and less photosensitive; thus capable of coming up throughout the year. It is hardier, vigorous and grows taller. Its flowers are in various shades of yellow, white, having single or double forms (Desai, 1962). They are hermaphrodite. The plant is self-fertile and seed propagated. In India, the crop is cultivated in localized spots and is becoming popular recently. However, there is no information about the use of growth regulators/chemicals on the yield and quality parameters of this crop. Growth regulators have been found useful in overcoming the factors limiting the yield and quality of flowering annuals like marigold, China aster, daisy (Patil, 1998). Several positive and precise results were obtained in the past by the growth regulating chemicals on various flowering annuals. The response exhibited by plants to growth regulators vary with the species, varieties and on the concentration of the chemical used.

MATERIALS AND METHODS
The treatments included three chemicals, *viz.* gibberellic acid-3 (GA), salicylic acid (SA), gibberllic (CCC) and paclobutrazol and each at three different concentrations. Thus, there were thirteen treatments including water spray as control. They were: 1. Gibberellic acid-3 at 50 ppm (GA 50) 2. Gibberellic acid-3 at 100 ppm (GA 100) 3. Gibberellic acid-3 at 150 ppm (GA 150) 4. Salicylic acid at 50 ppm 5. Salicylic acid at 100 ppm (SA 100) 6. Salicylic acid at 100 ppm (SA 150) 7. Cycocel at 2000 ppm (CCC 2000) 8. Cycocel at 3000 ppm (CCC 3000) 9. Cycocel at 4000 ppm (CCC 4000) 10. Paclobutrazol at 40 ppm 11. Paclobutrazol at 60 ppm 12. Paclobutrazol at 80 ppm 13. Water spray (Control).
The experiment was laid out in randomized block design with three replications. The layout plan is given in figure no. 4. The gross plot size was 3.0 m x 2.1 m and the net plot size was 2.7 m x 1.8 m. The spacing adopted was 30 cm x 30 cm. The treatments were imposed in the form of foliar sprays with a spray fluid volume of 250 ml on 30th DAT.

RESULTS AND DISCUSSION

Number of Flowers per Plant

Flower yield per plot exhibited significant differences due to spray of growth regulators/chemicals during both the seasons. In *kharif*, spray of CCC at 3000 ppm recorded the highest number of flowers per plot (1710.7) which was significantly superior to spray of GA at 100 ppm (1684.3) whereas, a minimum of 1217.8 flowers per plot was recorded by control. In *rabi*, spray of CCC at 3000 ppm was the most productive with 2243.5 flowers per plot significantly superior to the spray of GA at 100 ppm (2202.7 flowers per plot).

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Flower Yield per Plot

There were significant differences with respect to weight of flowers per plot among the different treatments during both the seasons. During *kharif*, spray of GA at 100 ppm recorded the highest weight of flowers per plot (3.01 kg) which was significantly superior to spray of GA at 150 ppm (2.78 kg) whereas, a minimum of 1.24 kg flowers per plot was recorded by control. In *rabi*, spray of GA at 100 ppm was the most productive with 4.56 kg flowers per plot significantly superior to GA at 150 ppm (5.71 kg flowers per plot) while minimum weight of flowers (1.80 kg) was recorded by control.

Flower Yield per Ha

The flower yield per ha exhibited significant differences among the various growth regulator/chemical sprays during both the seasons. During *kharif*, GA at 100 ppm recorded the highest weight of flowers per ha (6.21 t) which was significantly superior to spray of GA at 150 ppm (5.71 t) whereas, a minimum flower yield of 2.57 t ha^{-1} was recorded by control. In *rabi*, spray of GA at 100 ppm was the most productive with 7.51 t ha^{-1} flower yield which was significantly superior to GA at 150 ppm (6.88 t ha^{-1}) while minimum weight of flowers (2.96 t ha^{-1}) was recorded by control.

Seed Yield per Flower

The seed yield per flower exhibited significant differences among the different growth regulator/chemical treatments during both the seasons. The maximum seed yield per flower (219 mg and 251.8 mg) was recorded by the spray of GA 100 ppm. It was on par with GA at 150 ppm which recorded seed yield per flower as 212.4 mg and 244.2 mg as well as SA at 100 ppm with 211.9 mg and 243.7 mg, respectively during *kharif* and *rabi* seasons.

Seed Yield per Plant

The seed yield per plant differed significantly among the different growth regulator treatments during both the seasons. The maximum seed yield per plant (2.88 g and 3.31 g) was recorded by the spray of GA 100 ppm which was on par with GA at 150 ppm (2.79 g and 3.21 g) as well as SA at 100 ppm (2.79 g and 3.21 g) during *kharif* and *rabi* seasons.

Seed Yield per Plot

There were significant differences with respect to seed yield per plot among the different treatments during both the seasons. The maximum seed yield per plot (201.70 g and 231.95 g) was recorded by the spray of GA 100 ppm which was on par with GA at 150 ppm (195.60 g and 224.94 g) as well as SA at 100 ppm (195.20 g and 214.13 g) during *kharif* and *rabi* seasons.

Flower Diameter

The flower diameter exhibited significant differences among the various growth regulator/ chemical sprays during both the seasons. During *kharif*, spray of GA at 100 ppm recorded the highest size of flowers having a diameter of 5.51 cm which was significantly superior to spray of GA at 150 ppm (5.34

cm) whereas; a minimum flower diameter of 2.84 cm was recorded by control. In *rabi*, spray of GA at 100 ppm had the largest flowers with 6.17 cm flower diameter which was significantly superior to GA at 150 ppm (5.98 cm) while minimum diameter of flowers (3.18 cm) was recorded by control.

Table1: Flower yield parameters as influenced by planting geometry in garland chrysanthemum during kharif and rabi.

Treatment	Number of Flowers /Plant			Number of Flowers per Plot			Flower Yield Per Plot (kg)			Flower Yield per Hectare (tonnes)		
	Kharif	*Rabi*	Mean	*Kharif*	*Rabi*	Mean	*Kharif*	*Rabi*	Mean	*Kharif*	*Rabi*	Mean
GA50	35.09	45.89	**40.49**	1684.3	2202.7	**1943.5**	3.01	4.56	**3.79**	6.21	7.51	**6.86**
GA100	32.63	42.07	**37.35**	1566.2	2019.4	**1792.8**	2.78	4.18	**3.48**	5.71	6.88	**6.30**
GA150	28.59	35.81	**32.20**	1372.3	1718.9	**1545.6**	1.88	2.78	**2.33**	3.86	4.57	**4.22**
SA50	33.7	43.17	**38.44**	1617.6	2072.1	**1844.9**	2.92	4.42	**3.67**	6.01	7.26	**6.64**
SA100	33.46	43.36	**38.41**	1606.1	2081.3	**1843.7**	2.69	4.07	**3.38**	5.56	6.69	**6.13**
SA150	30.98	39.52	**35.25**	1487.0	1897.0	**1692.0**	1.88	2.8	**2.34**	3.89	4.61	**4.25**
CCC2000	35.64	46.74	**41.19**	1710.7	2243.5	**1977.1**	2.57	3.88	**3.23**	5.31	6.38	**5.85**
CCC3000	33.18	42.93	**38.06**	1592.6	2060.6	**1826.6**	2.2	3.28	**2.74**	4.52	5.4	**4.96**
CCC4000	31.63	40.53	**36.08**	1518.2	1945.4	**1731.8**	1.98	2.94	**2.46**	4.07	4.83	**4.45**
Paclobutrazol40	30.18	38.28	**34.23**	1448.6	1837.4	**1643.0**	1.79	2.64	**2.22**	3.67	4.34	**4.01**
Paclobutrazol60	29.8	37.69	**33.75**	1430.4	1809.1	**1619.8**	1.74	2.56	**2.15**	3.57	4.21	**3.89**
Paclobutrazol80	25.37	30.83	**28.10**	1217.8	1479.8	**1348.8**	1.24	1.8	**1.52**	2.57	2.96	**2.77**
Control	**31.68**	**40.56**	**36.12**	**1520.5**	**1946.7**	**1733.6**	**2.25**	**3.36**	**2.81**	**4.63**	**5.54**	**5.09**
Mean	0.14	0.21	0.18	6.69	10.3	8.50	0.03	0.04	0.04	0.06	0.07	0.07
S Em	0.41	0.63	0.52	19.54	30.06	24.80	0.08	0.12	0.10	0.16	0.20	0.18
CD at 5%	35.09	45.89	40.49	1684.3	2202.7	1943.5	3.01	4.56	3.79	6.21	7.51	6.86

Thousand Seed Weight

The differences recorded in thousand seed weights among the different treatments with growth regulators/chemicals were found significant during both the seasons. The maximum thousand seed weight (1.37 g and 1.58 g) was recorded by the spray of GA 100 ppm which was on par with GA at 150 ppm (1.34 g and 1.53 g) as well as SA at 100 ppm (1.34 g and 1.53 g) during *kharif* and *rabi* seasons.

There was an increase in the flower yield as well as seed yield per plant by the foliar application of growth regulating chemicals, *viz.* GA, CCC, SA and paclobutrazol, when compared to control. The result on weight of flowers per plot showed that the maximum yield enhancing ability was shown by GA at 100 ppm. There was no addition in the yield of garland chrysanthemum by increasing the concentration of GA beyond 100 ppm. Chakradhar and Khiratkar (2003) reported an increase in flower yield per plant by the

application of GA on rose plants, which was attributed to better translocation of assimilates to the site of bud development, leading to maximum number of buds converting into flower buds. In the presents study, GA at 100 ppm had not shown maximum number of flowers per plant but due to the maximum mean weight of flowers (Table 1), it recorded maximum yield in terms of weight of flowers per ha. An increase in the concentration of CCC had increased the number of flowers per plant. Foliar spray of cycocel at 3000 ppm recorded a higher number of flowers per plant, when compared to other concentrations. But their average weight being relatively lesser, they were making a gross weight of flowers per ha only next to gibberellic acid at 100 ppm. Both increase and decrease in the concentration had not resulted in increase in either number of flowers per plant or mean flower weight. The increase in number of flowers per plant with the application of CCC was attributed to increased mobilization of bio-mass to flowers from sources in China aster (Joshi and Reddy, 2006). Enhancement of flower production in daisy due to the application of CCC was attributed to the retardation of vegetative growth (Patil, 1998). SA spray at 100 ppm resulted in significant increase in flower and seed yield when compared to other concentrations. Though there was a slight increase in yield with SA at 150 ppm, it was not statistically significant. Foliar spray of SA increased the number of flowers per plant in chrysanthemum (Padmapriya and Chezhiyan, 2002a) and China aster (Ramesh, 1999).

Table 2: Seed yield parameters as influenced by planting geometry in garland chrysanthemum during kharif and rabi.

	Seed yield per flower (mg)			**Seed yield per plant (g)**			**Seed yield per plot (g)**		
Treatment	***Kharif***	***Rabi***	**Mean**	***Kharif***	***Rabi***	**Mean**	***Kharif***	***Rabi***	**Mean**
GA50	202.3	232.7	**217.5**	2.66	3.06	**2.86**	186.33	214.28	**200.31**
GA100	219.0	251.8	**235.4**	2.88	3.31	**3.10**	201.70	231.95	**216.83**
GA150	212.4	244.2	**228.3**	2.79	3.21	**3.00**	195.60	224.94	**210.27**
SA50	157.0	180.6	**168.8**	2.07	2.38	**2.23**	144.62	166.31	**155.47**
SA100	211.9	243.7	**227.8**	2.79	3.21	**3.00**	195.20	224.48	**209.84**
SA150	202.2	232.5	**217.3**	2.66	3.06	**2.86**	186.20	214.13	**200.17**
CCC2000	154.1	177.2	**165.7**	2.03	2.33	**2.18**	141.95	163.24	**152.60**
CCC3000	188.3	216.6	**202.4**	2.48	2.85	**2.67**	173.44	199.46	**186.45**
CCC4000	170.3	195.8	**183.0**	2.24	2.58	**2.41**	156.83	180.35	**168.59**
Paclobutrazol40	158.9	182.7	**170.8**	2.09	2.40	**2.25**	146.33	168.28	**157.31**
Paclobutrazol60	148.2	170.5	**159.4**	1.95	2.24	**2.10**	136.54	157.02	**146.78**
Paclobutrazol80	145.4	167.2	**156.3**	1.91	2.20	**2.06**	133.93	154.02	**143.98**
Control	112.9	129.9	**121.4**	1.49	1.71	**1.60**	104.00	119.60	**111.80**
Mean	**175.6**	**202.0**	**188.8**	**2.31**	**2.66**	**2.49**	**161.74**	**186.01**	**173.88**
S Em	4.11	6.13	5.12	0.05	0.08	0.07	3.79	3.32	3.56
CD at 5%	12.00	13.06	12.53	0.16	0.24	0.20	11.05	9.82	10.44

Paclobutrazol at 40 ppm recorded a higher number of flowers per plant compared to other higher concentrations of 60 and 80 ppm. Increase in concentration of paclobutrazol spray reduced the number of flowers per plant in China aster as reported by Mishra and Mishra (2006), who attributed that it was the increased number of branches that led to the improvement in the number of flowers per plant due to paclobutrazol spray at optimum concentration. Swaminathan *et al.*, (1999) observed that paclobutrazol at

higher doss resulted in lower flower production, whereas at lower doses, significantly increased flower yield in jasmine. Lower doses of paclobutrazol were thought to be enough in annual flowering plants like marigold for inhibition of gibberellin bio-synthesis and retardation of vegetative growth thereby redirecting the metabolites towards reproductive development. Flower quality in terms of average flower weight, flower diameter and seed quality in terms of test weight were also at maximum by the application of GA at 100 ppm. Not only yield, but the quality parameters also did not show any increase by a higher concentration of GA more than 100 ppm. Thus it can be assumed that the optimum concentration of GA for application through foliar spray is 100 ppm on garland chrysanthemum. Increase in weight of flower in treated plants may be attributed to the fact that GA promoted the efficacy of plants in terms of photosynthetic activity, enhanced the uptake of nutrients and their translocation, better partitioning of assimilates into reproductive parts. These results are in agreement with those reported by Rakesh *et al.*, (2005), Deotale *et al.*, (1995) and Dutta *et al.*, (1993) in chrysanthemum. Increase in cell size due to GA might had increased the diameter of flower as stated by Madhumita and Paswan (1998).

Table 3: Flower and seed quality parameters as influenced by planting geometry in garland chrysanthemum during kharif and rabi.

	Flower diameter (cm)		**Hundred flower weight (g)**		**Thousand seed weight (g)**	
Treatment	***Kharif***	***Rabi***	***Kharif***	***Rabi***	***Kharif***	***Rabi***
GA50	5.09	5.70	169.46	198.32	1.27	1.46
GA100	5.51	6.17	180.42	220.00	1.37	1.58
GA150	5.34	5.98	177.25	206.85	1.34	1.53
SA50	3.95	4.42	136.70	161.61	0.98	1.13
SA100	5.33	5.97	178.83	200.49	1.34	1.53
SA150	5.09	5.70	167.78	195.46	1.27	1.46
CCC2000	3.88	4.34	126.72	147.43	0.97	1.11
CCC3000	4.74	5.31	150.52	172.84	1.18	1.36
CCC4000	4.28	4.80	137.87	159.02	1.07	1.23
Paclobutrazol40	4.00	4.48	130.11	151.04	1.00	1.14
Paclobutrazol60	3.73	4.18	123.35	143.56	0.93	1.07
Paclobutrazol80	3.66	4.10	121.39	141.37	0.91	1.05
Control	2.84	3.18	102.16	121.44	0.71	0.81
Mean	**4.42**	**4.95**	**146.35**	**170.73**	**1.10**	**1.27**
S Em	0.02	0.02	1.30	1.53	0.01	0.02
CD at 5%	0.05	0.06	3.79	4.45	0.03	0.05

SA at 100 ppm significantly increased the flower diameter compared to lower level but further increase in the concentration did not show significant improvement in the diameter. In case of CCC, the concentration of 3000 ppm resulted in a higher mean flower weight but increased concentration resulted in a significant decrease in the mean flower weight. The other growth retarding chemical paclobutrazol also showed a decrease in flower weight due to increase in the concentration from 40 to 80 ppm. Thus in the present study, the optimum concentrations found were 100 ppm both for GA and SA, 3000 ppm for CCC and 40 ppm for paclobutrazol. Though the number of flowers was higher with the foliar application of CCC and palobutrazol, the gross weight of flowers per unit area was recorded at lower levels compared

to GA and SA. Flower diameter and thousand seed weight also followed the similar trends of being significantly higher at 100 ppm in case of GA and SA, 3000 ppm and 40 ppm in case of CCC and paclobutrazol, respectively.

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