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Effect of Growth Regulators/chemicals on Growth and Yield Parameters of Garland Chrysanthemum (*Chrysanthemum coronarium* L.)

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ABSTRACT

There was an increase in the flower yield per plant by the foliar application of growth regulating chemicals, *viz.* GA, CCC, SA and paclobutrazol, when compared to control. 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 a higher number of flowers per plant, when compared to other concentrations. SA spray at 100 ppm resulted in significant increase in flower 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.

Key words : Garland chrysanthemum, Gibberellic acid, Paclobutrazol and Salicylic acid.

Several positive and precise results were obtained in the past by the growth regulating chemicals on various flowering annuals. 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). The response exhibited by plants to growth regulators vary with the species, varieties and on the concentration of the chemical used. Gibberellic acid at various concentrations depending on species has improved quality of flowers in terms of size. Salicylic acid may help regulate several plant functions, including formation of flowers (Heatholt *et al.,* 2001). Salicylic acid is regarded as a wonder compound. It ameliorates biotic and abiotic stresses. It has a definite role in thermogenesis, flowering and bio-productivity. The chemical is known to inhibit catalase activity preventing the release of reactive oxygen species from hydrogen peroxide, thus ameliorating abiotic stress. The compound is also proved to be a flower inducing hormone in several species (Ansari and Misra, 2007). Growth retarding chemicals, *viz.* Cycocel and paclobutrazol are of appreciable utility in suppressing apical dominance and promoting lateral buds to produce shoots thus increasing productivity.

MATERIAL AND METHODS

The treatments included three chemicals, *viz.* gibberellic acid-3 (GA), salicylic acid (SA), cycocel (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 (SA 50) 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 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

Plant height

Significant differences existed in the plant height due to growth regulators/chemicals during both the seasons (Table 1). At 65 DAT during *kharif*, maximum plant height (134.48 cm) was recorded by the spray of GA at 150 ppm. It was on par with GA at 100 ppm (129.11 cm) whereas the plant height was minimum (85.15 cm) with the spray of paclobutrazol at 80 ppm and it was at par with the same chemical spray at 60 ppm (90.94

cm). At 85 DAT during *rabi*, maximum plant height (140.27 cm) was recorded by the spray of GA at 150 ppm and it was significantly superior to GA at 100 ppm (134.66 cm) whereas the plant height was minimum (88.81 cm) with the spray of paclobutrazol at 80 ppm. The plant height was significantly lesser (94.86 cm) when the same chemical at 60 ppm concentration was sprayed.

Number of leaves per plant

There were significant differences with respect to number of leaves per plant due to spray of growth regulators/chemicals during both the seasons (Table 1). At 65 DAT during *kharif*, maximum number of leaves (191.14) was recorded by the spray of CCC at 4000 ppm. It was at par with the number of leaves (189.10) with the spray of SA at 150 ppm but significantly superior to the spray of CCC at 3000 ppm (177.38) whereas the number of leaves was minimum (107.95) with the spray of GA at 50 ppm. At 85 DAT during *rabi*, maximum number of leaves (200.69) was recorded by the spray of CCC at 4000 ppm. It was at par with the spray of SA at 150 ppm (198.55) but significantly superior to the spray of CCC at 3000 ppm (186.24) whereas the number of leaves was minimum (113.35) with the spray of GA at 50 ppm.

Leaf area per plant

Leaf area per plant varied significantly due to spray of growth regulators/chemicals during both the seasons (Table 1). At 65 DAT during *kharif*, maximum leaf area (1132.5 cm^2) was recorded by the spray of GA at 100 ppm. It was at par with the leaf area (1098.3 cm^2) with the spray of GA at 150 ppm whereas the leaf area was minimum (753.4 cm^2) with control. At 85 DAT during *rabi*, maximum leaf area (1150.3 cm^2) was recorded by the spray of GA at 100 ppm. It was at par with the leaf area (1115.6 cm^2) with the spray of GA at 150 ppm whereas the leaf area was minimum (735.5 cm^2) with control.

Number of branches per plant

Number of branches per plant differed significantly due to spray of growth regulators/ chemicals during both the seasons (Table 2). At 65 DAT during *kharif*, maximum number of branches (36.97) was recorded by the spray of CCC at 4000 ppm. It was at par with the number of branches (36.58) with the spray of SA at 150 ppm but significantly superior to the spray of CCC at 3000 ppm (34.31) whereas the number of branches (20.88) was minimum with the spray of GA at 50 ppm. At 85 DAT during *rabi*, maximum number of branches (40.29) was recorded by the spray of CCC at 4000 ppm. It was at par with the spray of SA at 150 ppm (39.86) but significantly superior to the spray of CCC at 3000 ppm (37.39) whereas the number of branches (22.76) was minimum with the spray of GA at 50 ppm.

Plant spread

The effect of planting geometry on mean plant spread was found significant due to spray of growth regulators/chemicals during both the seasons (Table 2). At 65 DAT during *kharif*, maximum mean plant spread (25.31 cm) was recorded by the spray of CCC at 4000 ppm. It was at par with the plant spread (25.04 cm) with the spray of SA at 150 ppm whereas the plant spread was minimum (14.30 cm) with GA 50. At 85 DAT during *rabi*, maximum plant spread (27.03 cm) was recorded by the spray of CCC at 4000 ppm. It was at par with the spray of SA at 150 ppm (26.75 cm) but significantly superior to the spray of CCC at 3000 ppm (25.09 cm) whereas the number of branches was minimum (17.30) with control plots.

Above ground dry matter per plant

The total dry matter accumulation per plant significantly differed among various treatments during both the seasons (Table 2). Mean total dry matter increased from 6.73 g $plant^{-1}$ at 25 DAT to 17.43 g $plant^{-1}$ at 65 DAT during *kharif*, whereas during *rabi* it increased from 5.16 g $plant^{-1}$ at 25 DAT to 18.93 g $plant^{-1}$ at 85 DAT. At 65 DAT during *kharif*, maximum dry matter (21.30 g $plant^{-1}$) was recorded by the spray of GA at 100 ppm which was on par with GA at 150 ppm (20.56 g $plant^{-1}$), while the minimum total dry matter per plant was recorded by control plots (12.57 g $plant^{-1}$) which was significantly inferior to the spray of paclobutrazol at 80 ppm (15.08 g $plant^{-1}$). During *rabi*, maximum total dry matter per plant (23.05 g $plant^{-1}$) was recorded by GA at 100 ppm at 85 DAT which was on par with GA 150 ppm (22.25 g $plant^{-1}$), while the minimum total dry matter per plant was

Table 1. Plant height, number of leaves and leaf area per plant as influenced by growth regulators/ chemicals in garland chrysanthemum during *kharif* and *rabi.*

Treatment	Plant height (cm)		Number of leaves per plant		Leaf area (cm^2) per plant	
	Kharif 65 DAT	*Rabi* 85 DAT	*Kharif* 65 DAT	*Rabi* 85 DAT	*Kharif* 65 DAT	*Rabi* 85 DAT
GA50	115.50	120.47	107.95	113.35	1046.2	1062.7
GA100	129.11	134.66	128.14	134.55	1132.5	1150.3
GA150	134.48	140.27	124.88	131.12	1098.3	1115.6
SA50	106.74	111.33	146.79	154.13	833.5	846.6
SA100	113.01	117.87	170.44	178.97	974.3	989.6
SA150	118.30	123.39	189.10	198.55	935.8	950.5
CCC2000	105.06	109.57	148.12	155.52	971.8	987.0
CCC3000	93.13	97.13	177.38	186.24	1007.5	1023.3
CCC4000	89.52	93.37	191.14	200.69	1024.8	1041.0
Paclobutrazol40	98.78	103.03	166.27	174.59	956.3	971.3
Paclobutrazol60	90.94	94.86	165.65	173.93	892.3	906.3
Paclobutrazol80	85.15	88.81	152.21	159.82	875.2	889.0
Control	103.54	108.00	122.33	128.44	753.4	735.5
Mean	106.40	110.98	153.11	160.76	961.7	974.5
S Em	2.57	1.92	2.28	2.96	16.0	12.6
CD at 5%	7.50	5.59	6.66	8.65	46.9	36.9

Table 2. Number of branches per plant, plant spread and above ground dry matter per plant as influenced by growth regulators/chemicals in garland chrysanthemum during *kharif* and *rabi.*

Treatment	Number of branches per plant		Plant spread		Above ground dry matter per plant	
	Kharif 65 DAT	*Rabi* 85 DAT	*Kharif* 65 DAT	*Rabi* 85 DAT	*Kharif* 65 DAT	*Rabi* 85 DAT
GA50	20.88	22.76	14.30	15.27	19.04	20.61
GA100	24.79	27.01	16.97	18.12	21.30	23.05
GA150	24.16	26.32	16.54	17.66	20.56	22.25
SA50	28.40	30.94	19.44	20.76	16.94	18.33
SA100	32.97	35.93	22.57	24.11	18.83	20.46
SA150	36.58	39.86	25.04	26.75	18.34	19.90
CCC2000	28.65	31.22	19.62	20.95	17.07	18.48
CCC3000	34.31	37.39	23.49	25.09	17.37	18.88
CCC4000	36.97	40.29	25.31	27.03	16.92	18.36
Paclobutrazol40	29.38	32.02	20.12	21.48	16.90	18.32
Paclobutrazol60	32.04	34.92	21.94	23.43	15.68	16.99
Paclobutrazol80	33.62	36.64	23.02	24.58	15.08	16.35
Control	23.66	25.79	16.20	17.30	12.57	14.08
Mean	29.73	32.39	20.35	21.73	17.43	18.93
S Em	0.29	0.24	0.73	0.61	0.41	0.49
CD at 5%	0.84	0.69	2.14	1.77	1.21	1.42

Table 3. Number flowers per plant and flower yield per hectare as influenced by growth regulators/ chemicals in garland chrysanthemum during *kharif* and *rabi.*

Treatment	Number of flowers per plant		Flower yield per ha	
	Kharif 65 DAT	*Rabi* 85 DAT	*Kharif* 65 DAT	*Rabi* 85 DAT
GA50	31.56	40.41	5.27	6.34
GA100	35.09	45.89	6.21	7.51
GA150	32.63	42.07	5.71	6.88
SA50	28.59	35.81	3.86	4.57
SA100	33.70	43.17	6.01	7.26
SA150	33.46	43.36	5.56	6.69
CCC2000	30.98	39.52	3.89	4.61
CCC3000	35.64	46.74	5.31	6.38
CCC4000	33.18	42.93	4.52	5.40
Paclobutrazol40	31.63	40.53	4.07	4.83
Paclobutrazol60	30.18	38.28	3.67	4.34
Paclobutrazol80	29.80	37.69	3.57	4.21
Control	25.37	30.83	2.57	2.96
Mean	31.68	40.56	4.63	5.54
S Em	0.14	0.21	0.06	0.07
CD at 5%	0.41	0.63	0.16	0.20

recorded by control plots (14.08 g plant^{-1}) which was significantly inferior to the spray of paclobutrazol at 80 ppm (16.35 g plant^{-1}).

Number of flowers per plant

The number of flowers per plant exhibited significant differences among the different treatments by growth regulators/chemicals during both the seasons (Table 3). In *kharif,* spray of CCC at 3000 ppm recorded the highest number of flowers per plant (35.64) which was significantly superior to GA at 100 ppm (35.09) whereas, a minimum of 29.80 flowers per plant was recorded by paclobutrazol at 80 ppm. In *rabi,* treatment with CCC at 3000 ppm resulted in the maximum number of flowers per plant (46.74 flowers per plant) significantly superior to the treatment with GA at 100 ppm (45.89 flowers per plant).

Flower yield per ha

The flower yield per ha exhibited significant differences among the various growth regulator/ chemical sprays during both the seasons (Table 3). 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 in 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 per ha (2.96 t ha^{-1}) was recorded by control.

In the present study, there was an increase in the flower yield per plant by the foliar application of growth regulating chemicals, *viz.* GA, CCC, SA and paclobutrazol, when compared to control. There was no addition in the yield of garland chrysanthemum by increasing the concentration of GA beyond 100 ppm. Rakesh *et al.* (2005) attributed the increase in yield due to the application of GA which increased in plant height and number of branches per plant compared to control plots. 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 it recorded maximum yield in terms of weight of flowers per ha perhaps due to the maximum mean weight of flowers.

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 they were making a gross weight of flowers per ha only next to gibberellic acid at 100 ppm. 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 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). The flower inducing effect of SA by exogenous application was demonstrated in Oncidium, Impatiens and *Spirodela punctata* (Raskin, 1992).

It is interesting to note that the number of flowers per plant decreased both by decreasing the concentration of SA and increasing the concentration of paclobutrazol sprays. 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.

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