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Influence of growth retardants on growth and flowering of Crossandra (*Crossandra infundibuliformis*) under potted conditions

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Abstract
The present research was carried out in crossandra at ICAR-DFR, Regional Station, Vemagiri, Kadiyam mandal. The experiment was carried out during 2021-22 (September-May). The experiment was laid out in Completely Randomised Design (CRD) with ten treatments of plant growth retardants *viz.*, cycocel (500, 1000 1500 ppm), paclobutrazol (500, 1000, 1500 ppm) and maleic hydrazide (200, 600, 1000 ppm). The treatments were replicated thrice. The application of growth retardants led to significant differences in the various growth and flowering parameter among the treatments. Among the growth parameters, at 120 DAT, the maximum suppression in the plant height was observed with the application of paclobutrazol at 1500 ppm (37.92 cm) that was on par with the application of paclobutrazol at 1000 ppm (39.53 cm). The maximum plant height was recorded with control plants (56.46 cm). The foliar application of maleic hydrazide at 600 ppm recorded the maximum plant spread (57.14 cm), number of branches per plant (10.36) and leaf area (1714.42 cm^2) as compared to other treatments. The chlorophyll content was recorded maximum with the spray application of paclobutrazol at 1500 ppm (190.08 SPAD units) as compared to control plants (160.18 SPAD units). Among the flowering attributes, the spray application of maleic hydrazide @ 600 ppm recorded the minimum number of days for first spike emergence (45.63 days), maximum number of spikes per plant (13.96), spike length (12.59 cm), flower yield per plant (43.09 g) 100 florets weight (5.18 g) and shelf life of florets (4.15 days) as compared to other treatments. From the results it can be concluded that foliar application of maleic hydrazide @ 600 ppm was proved to be superior in terms of growth and flowering parameters as compared to other plant growth retardants used in the study.

Keywords: Paclobutrazol, maleic hydrazide, Cycocel, Crossandra, growth and flowering parameters

Introduction
Ornamental flowering plants are highly valued for their attractive look and appearance. One such ornamental flowering plant is crossandra that produces bright orange and yellow coloured flowers. Crossandra is a member of the family Acanthaceae and the genus Crossandra consists of about 50 species. The species *C. infundibuliformis* is cultivated for commercial flower production. Crossandra, also known as "fire cracker plant" because the seed pods that are usually formed after flowering tend to explode under high humid conditions. Crossandra plants are generally hardy in nature and can be cultivated as loose flowers or potted plants. It is having commercial importance as potted plants in Denmark, Sweden and Hungary. (Bharathi *et al*., 2018) [1]. It has got considerable importance in comparison to other flower crops due to perennial nature, flowering throughout the year, consumption of minimum amount of fertilizers and higher profitability. There is an adequate scope to enhance the production of crossandra by adopting proper crop management practices. One such approach is application of plant growth retardants. The growth retardants act by blocking the biosynthesis of gibberellins, thereby restricting the activity of cell expansion that results in plants which are compact with dark green foliage. Synthetic plant growth retardants are becoming more popular in commercial floriculture for their ability in manipulating the growth and development of ornamental crops with a view to develop compact growth habitat by retarding the excessive vegetative growth without having any detrimental effect to the yield of crop, resulting in early and quality blooming.

Materials and Methods
The present research work was carried out at ICAR-DFR, Regional center, Vemagiri, East

Godavari District. This location comes under the Agro-climatic zone no:10 (Godavari zone) with tropical savanna climate. The average annual rainfall is 1017.67 mm. The mean temperature ranges from a maximum of 51°C to a minimum of 16°C. The experiment was carried out in a Completely Randomised Design with 10 treatments that were replicated thrice. The treatments are three concentrations of Cycocel (500, 1000 and 1500 ppm), paclobutrazol (500, 1000 and 1500 ppm) and maleic hydrazide (200, 600 and 1000 ppm). One month old rooted cuttings of *cv.* Local Orange were transplanted into pots of 6 inches size. Cultural and management practices were attended timely. Spray application of growth retardants was done 45 DAT and 60 DAT. Maleic hydrazide and cycocel were applied through foliar spray, whereas, paclobutrazol was applied through soil drenching followed by foliar application. The data was subjected to statistical analysis and tabulated hereunder.

Results and Discussion

The results of the research and the relevant discussions were summarized under following heads:

Growth parameters

The data pertaining to the plant height, plant spread, leaf length, leaf width, number of branches per plant, chlorophyll content and leaf area was shown in the Table 1. From the table, it can be concluded that the maximum reduction of 32.83% in the height of the plant was observed in the treatment T_7 (37.92 cm) which was on par with T_6 (39.53 cm) when compared to control. All the growth retardants recorded a suppression in the height of the plants as compared to control and it was more pronounced in the paclobutrazol treatments. this might be due to the anti-gibberellin nature that retards the activity of cell elongation, thereby resulting in plants with shortened internodes. Similar results were reported by Karlovic *et al.* (2004) [6] and Dorajeerao *et al.* (2012) [3] in chrysanthemum.

The maximum readings of plant spread (57.14 cm), number of branches per plant (10.36) and leaf area (1714.42 cm^2) was recorded in the treatment maleic hydrazide @ 600ppm (T_9) and the minimum values were observed with the paclobutrazol treatments. It might be due to the inhibitory effect of maleic hydrazide on the activity of apical meristematic cells that have led to the growth and development of lateral buds into new shoots, thereby increasing the number of branches per plant and plant spread. The application of growth retardants has led to a decline in the size of the leaf. The increase in the fresh weight and dry weight of the plants has led to an increase in the root shoot ratio as compared to control. Corroboratory results were reported by Sujatha *et al.* (2002) [10] in gerbera.

An increase in the content of chlorophyll was observed with the application of paclobutrazol and the highest readings were recorded in the treatment T_7 (190.08 SPAD units). It might be due to an increase in the number of chloroplasts per unit leaf area as there is reduction in the leaf area. The results were found to be in line with those of Carvalho *et al.* (2018) [2] in potted rose, Kudmate *et al.* (2016) [7] in pot chrysanthemum.

Flowering parameters

Significant differences were noticed in the yield attributes of crossandra with the application of growth retardants. The minimum number of days taken for first spike emergence (45.63 days), the maximum number of spikes per plant (13.96) and spike length (12.59 cm) were recorded in the treatment T_9 (maleic hydrazide @ 600) ppm. Sayed and Muthuswamy (1974) [8] also opined that an increase in the flower number was observed in crossandra plants that were sprayed with maleic hydrazide. The positive impact of maleic hydrazide on the flowering parameters might be due to the suppression of apical dominance that has led to an increase in the number of branches to develop, resulting in more number of spikes per plant, and the proper source-sink relation has led to the flow of photosynthates to the reproductive organs. It has resulted in increased spike length. Corroboratory results were reported by Sheetalben *et al.* (2015) [9] in heliconia, and Gopichand *et al.* (2014) [4] in marigold.

Table 1: Influence of growth retardants on various growth parameters of crossandra

Treatments	Plant height (cm)	Plant spread (cm)	Number of branches	Chlorophyll content (SPAD units)	Leaf area (cm^2)
T_1 Control (water spray)	56.46	49.15	6.57	160.18	1271.78
T_2 Cycocel @ 500 ppm	49.68	47.09	7.06	185.03	1341.08
T_3 Cycocel @ 1000 ppm	43.65	51.26	7.15	173.21	1428.15
T_4 Cycocel @ 1500 ppm	40.15	54.38	7.60	178.39	1445.67
T_5 Paclobutrazol @ 500 ppm	42.19	47.64	6.83	185.46	1306.52
T_6 Paclobutrazol @ 1000 ppm	39.53	45.17	5.70	188.33	1270.68
T_7 Paclobutrazol @ 1500 ppm	37.92	43.81	5.60	190.08	1209.53
T_8 Maleic hydrazide @ 200 ppm	48.41	51.58	7.87	169.98	1493.65
T_9 Maleic hydrazide @ 600 ppm	45.94	57.14	10.36	168.25	1714.42
T_{10} Maleic hydrazide @ 1000 ppm	42.26	52.30	9.26	164.96	1524.17
Mean	44.62	49.95	7.40	176.39	1400.6
CD at 5%	2.77	2.28	0.29	13.94	62.31
S.Em ±	0.93	0.76	0.09	4.69	20.97

Table 2: Influence of growth retardants on various flowering parameters of crossandra

Treatments	Days to first spike emergence (days)	No. of spikes per plant	Spike length (cm)	Flower yield per plant	100 flower weight (g)	Shelf life (days)
T_1 Control (water spray)	55.28	8.54	11.51	24.98	4.02	3.12
T_2 Cycocel @ 500 ppm	51.28	8.72	11.29	26.24	4.19	2.91
T_3 Cycocel @ 1000 ppm	49.65	8.85	11.95	30.93	4.37	2.96
T_4 Cycocel @ 1500 ppm	52.36	9.12	12.03	35.54	4.46	2.87
T_5 Paclobutrazol @ 500 ppm	49.87	8.65	10.37	22.57	3.81	2.43
T_6 Paclobutrazol @ 1000 ppm	47.81	8.14	10.12	19.05	3.59	2.18
T_7 Paclobutrazol @ 1500 ppm	46.17	7.25	9.96	15.47	3.17	2.11
T_8 Maleic hydrazide @ 200 ppm	50.34	10.59	12.41	39.76	4.98	3.89
T_9 Maleic hydrazide @ 600 ppm	45.63	13.96	12.59	43.09	5.18	4.15
T_{10} Maleic hydrazide @ 1000 ppm	49.45	11.13	12.43	38.62	5.09	3.96
Mean	49.78	9.50	11.47	29.63	4.29	3.05
CD at 5%	0.79	0.44	0.90	1.40	0.19	0.14
S.Em ±	2.65	0.15	0.30	0.47	0.06	0.04

Conclusion

From the results obtained, it can be concluded that foliar application of maleic hydrazide @ 600 ppm recorded the maximum number of branches, plant spread and leaf area that has led to the highest flower yield per plant.

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