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Darbar Singh
Research Scholar, Department of Floriculture and Landscape Architecture, Pt. Kishori Lal Shukla College of Horticulture and Research Station, Rajnandgaon, IGKV, Raipur Chhattisgarh, India

Toran Lal Sahu
Assistant Professor, Department of Floriculture and Landscape Architecture, Pt. Kishori Lal Shukla College of Horticulture and Research Station, Rajnandgaon, IGKV, Raipur Chhattisgarh, India

Neelima Netam
Assistant Professor, Department of Floriculture and Landscape Architecture, Pt. Kishori Lal Shukla College of Horticulture and Research Station, Rajnandgaon, IGKV, Raipur Chhattisgarh, India

Dikeshwar Nishad
Assistant Professor, Department of Agricultural Statistics and Social Science L. Pt. Shiv Kumar Shastri College of Agriculture and Research Station, Rajnandgaon, IGKV, Raipur Chhattisgarh, India

Bhuneshwar Banjare
Research Scholar, Department of Floriculture and Landscape Architecture, Pt. Kishori Lal Shukla College of Horticulture and Research Station, Rajnandgaon, IGKV, Raipur Chhattisgarh, India

Corresponding Author:
Darbar Singh
Research Scholar, Department of Floriculture and Landscape Architecture, Pt. Kishori Lal Shukla College of Horticulture and Research Station, Rajnandgaon, IGKV, Raipur Chhattisgarh, India

Effect of plant growth regulators on growth and flowering of China aster (*Callistephus chinensis* L.) cv. Phule Ganesh pink

Darbar Singh, Toran Lal Sahu, Neelima Netam, Dikeshwar Nishad and Bhuneshwar Banjare

Abstract
The present investigation entitled "Effect of plant growth regulators on growth and flowering of China aster (*Callistephus chinensis* L.) cv. Phule ganesh pink'' was carried out during the year 2020-21 at Department of Floriculture and Landscape Architecture, Pt. Kishori Lal Shukla College of Horticulture and Research Station, Rajnandgaon. The growth regulators used were Gibberellic acid (150, 250, 350, 450 ppm), Naphthalene acetic acid (50, 100, 150, 200 ppm) and Salicylic acid (50, 100, 150, 200 ppm). The result obtained that the Minimum number of days to first flower bud initiation (64.87 days) and days to opening of flower from bud appearance (8.07 days) were noted in GA_3 150 ppm and days to 50% flowering (82.47 days) was recorded in GA_3 250 ppm and longest blooming period (68.80 days) was noted in GA_3 150 ppm. Highest individual flower weight (3.90 g), Flower yield plant^{-1} (161.21 g), and highest yield of flower per hectare (164.21 q.) were noted under GA_3 150 ppm. Maximum flower diameter (7.25 cm), stalk length (15.15 cm) was noted in GA_3 250 ppm. In research, control was reported minimum for every trait from different concentrated PGRs taken in the investigation.

Keywords: China aster, GA_3, NAA, SA, growth and flowering parameters

Introduction
China aster (*Callistephus chinensis* L.) is to be considered as one of the important commercial flower crops belonging to the family Asteraceae and Chromosome No. 2n = 18. It originated in China and spread to Europe and other nations between 1731 and 1732 AD. The name Callistephus comes from two Greek words: Kalistos, which means "most lovely," and Stephus, which refers to the flower's crown. In reality, in the 18th century, a missionary brought China aster from China to France (Desai 1967) [2]. It is a self-pollinated crop and natural out crossing is approximately 10 per cent as reported by Fleming *et al,* (1937) [3]. Aster plants are erect bearing alternate, broadly ovate or triangular-ovate, irregularly toothed leaves. Blooms contain two kinds of florets, ray-florets and disc florets. Plants require gibberellic acid (GA_3) throughout their lives. Seed germination, leaf expansion, stem elongation, flower and trichome initiation, source-sink relationships flower, fruit, and seed development are all regulated by this protein synthesis which is well-recognized for flower induction in many herbaceous flower crops.

NAA (Naphthalene acetic acid) are Auxin-like synthetic plant growth regulators. NAA stimulates cell division, cell elongation, shoot elongation, photosynthesis, RNA synthesis, membrane permeability and water uptake, which are all involved in many physiological processes such as preventing pre-harvest flower induction, fruit set, delayed senescence and bud sprouting, as well as increasing leaf chlorophyll content and yield.

The role of salicylic acid (SA), a naturally occurring phenolic secondary metabolite, in essential activities like as ethylene production, stomata conductance, respiration, senescence and the activation of defence mechanisms against diverse pathogens, has been extensively described. Salicylic acid treatment of different species resulted in a significant increase in blooming components and the number of flowering parts in plants. (Zeb *et al,* 2017) [14].

Materials and Methods
The present investigation was carried out during Rabi season of the year 2020-21 at the Horticultural Research cum Institutional Farm, Pt. K.L.S. College of Horticulture and Research Station, Pendri, Rajnandgaon, I.G.K.V. Raipur, Chhattisgarh.

The reason is located at about 21.10^0 N latitude and 81.03^0 E longitudes with an average altitude of 307 m above the mean sea level. A field experiment was laid out in Randomized Block Design (RBD) with thirteen treatments and replicated three *viz.*, Control (T_1), GA_3 150 ppm (T_2), GA_3 250 ppm (T_3), GA_3 350 ppm (T_4), GA_3 450 ppm (T_5), NAA 50 ppm (T_6), NAA 100 ppm (T_7), NAA 150 ppm (T_8), NAA 200 ppm (T_9), SA 50 ppm (T_{10}), SA 100 ppm (T_{11}), SA 150 ppm (T_{12}), SA 200 ppm (T_{13}). The seedlings were well prepared seed bed in open condition of 1×1 m size in row 10 cm a part and at a depth of 1 cm on 1st October 2020 in Pt. K.L.S. Collage of Horticulture and Research Station Rajnandgaon. The experimental plot on seedling transplanting dated 10th November, 2020 at the spacing of row x plant, 30 cm x 30 cm. The three growth regulators like GA_3, NAA, and SA were taken. The plant growth regulators of the respective concentration were foliar spraying twice at 20 DAT with the help of hand sprayer.
Observations on flowering parameters *viz*., Days to first flower bud initiation, Days to opening of flower from bud emergence, Days to 50% flowering, Blooming periods (days), Number of flower plant^{-1}, Individual flower weight (gm), Flower yield per plant (gm), Flower yield per plot (kg), Flower yield per hectare (q), also quality parameters *viz*., Flower diameter, Stalk length, Vase life of cut flowers.

Result and Discussion

Flowering parameters

The data presented in table 1 revealed that, at 90 DAT, significantly earliest first flower bud initiation (64.87 days) was observed with spraying of GA_3 @150 ppm was found to be statistically at par with the treatments SA 100 ppm (73.27 days). However, late days to first flower bud initiation was noted under control (79.93 days). The foliar application of gibberellic acid might have stimulated and enhanced the vegetative growth by increasing photosynthesis and respiration with enhanced carbon-Di-oxide fixation in the treated plants which would have associated with an early flowering. Further, gibberellin is quite effective in reducing the juvenile period of the plants. At the termination of juvenile phase, the shoot apical meristem might have converted into the flower primordia instead of producing leaves. The results obtained in the present investigation are in close agreement with the findings of Nandre *et al*. (2009) [7] and Sharma and Joshi (2015) [9] in China aster and Vijayakumar *et al.* (2017b) [13] in China aster. Minimum days to opening of flower from bud emergence (8.07 days) was observed with spraying of GA_3 @150 ppm was found to be statistically at par with the GA_3 @350 ppm (9.47 days), However, longest days to opening of flower from bud emergence was noted under control (11.13 days). The plants were treated with gibberellic acid which might be due to fact that, gibberellin is a component of florigen which is required for formation of flowers in the plant system. The enhanced vegetative parameters by gibberellic acid application might have a positive bearing on earlier flowering. These results are very close with the findings of Ghadge *et al.* (2010) [5] in gaillardia and Vijayakumar *et al.* (2017b) [13] in China aster. Earliest days to 50% flowering (82.47 days) was observed with spraying of GA_3 @ 250 ppm followed by NAA 50 ppm (82.53 days), However, late days to 50% flowering was noted under control (88.00 days). longest blooming periods (68.80 days) was observed with spraying of GA_3 @150 ppm was found to be statistically at par with the SA 100 ppm (63.60 days). However, lowest blooming periods was noted under control (55.47 days). Longest duration of flowering noticed with gibberellic acid which could be due to an enhanced production of flowering shoots. Both long photoperiod and gibberellic acid had an additive effect on flowering period due to their early induce of flowering. These results are in close agreement with the findings of Gautam *et al.* (2006) [4] and Shinde *et al.* (2010) [10] in chrysanthemum, Sharma and Joshi (2015) [9], Vijayakumar *et al.* (2017b) [13] in China aster. Maximum number of flower per plant (41.20) was observed with spraying of GA_3 @150 ppm followed by GA_3 @350 ppm (38.13). However, minimum number of flower per plant was noted under control (20.33). Highest individual flower weight (3.90 gm) was observed with spraying of GA_3 @150 ppm was found to be statistically at par with the NAA 150 ppm (3.65 gm). However, lowest individual flower weight was noted under control (2.99 gm). It may be attributed to the fact that gibberellic acid enhanced the efficacy of plants in terms of photosynthetic activity, uptake of nutrients and their translocation as well as better partitioning of assimilates into reproductive parts. The results obtained during this investigation are closely in agreement with the findings of Sharma and Joshi (2015) [9] in China aster, Vijayakumar *et al.* (2017a) [12] and Sindhuja *et al*. (2018) [11] in China aster. Maximum flower yield per plant (161.21 gm) was observed with spraying of GA_3 @150 ppm was found to be statistically at par with the GA_3 @350 ppm (140.25 gm). However, minimum flower yield per plant was noted under control (62.99 gm). Greater dry matter accumulation which is certainly suggestive to better photosynthetic activity, other metabolic activities and uptake of nutrients from soil. There for, the growth promoting substances might have positive influence on the yield of flowers. The present results are in conformity of Reddy (1983) [8] in China aster. Highest flower yield per plot (5.64 kg) was observed with spraying of GA_3 @150 ppm followed by GA_3 @350 ppm (4.91 kg). However, lowest flower yield per plot was noted under control (2.20 kg). Maximum flower yield per ha (164.28 q) was observed with spraying of GA_3 @150 ppm was found to be statistically at par with the GA_3 @350 ppm (142.93 q). However, minimum flower yield per ha was noted under control (64.20 q). Greater dry matter accumulation is certainly suggestive of better photosynthetic activity, other metabolic activities and uptake of nutrients from soil. Therefore, the growth promoting substances might have a positive influence on the yield of flowers. The present results are in conformity with Reddy (1983) [8] in Aster.

Quality Parameters

The data presented in table 1 revealed that, the treatment Significantly the maximum flower diameter (7.25 cm) was observed with spraying of GA_3 @250 ppm was found to be statistically at par with the treatments GA_3 @350 ppm (6.78 cm). However, minimum flower diameter was noted under control (9.69 cm). The highest flower diameter in China aster was noticed with the plants treatment with gibberellic acid. This could be due to active cell elongation in the flower caused increase in length of petals and pedicels or may be owing to division of photosynthates towards flower as a consequence of which there is intensification of sink in China aster. The findings are in line with the results obtained by Gupta *et al.* (2015) [6] and Sharma and Joshi (2015) [9] in

China aster, Vijayakumar *et al.* (2017a) [12] and Sindhuja *et al.* (2018) [11] in China aster. Highest stalk length (15.15 cm) was observed with spraying of GA_3 @250 ppm was found to be statistically at par with the NAA 100 ppm (11.99 cm). However, lowest stalk length was noted under control (8.09 cm). An increase in stalk length might be result of the translocation of photosynthesis to the flower as a consequence of intensification of the sink and also due to increased cell division and elongation. This may be due to the maximum stalk having high accumulation of carbohydrates. A similar result was obtained by Aklade *et al.* (2010) [1] in Chrysanthemum. Maximum day's vase life of cut flower (10.20 days) was observed with spraying of GA_3 @250 ppm followed by SA150 ppm (9.27 days). However, minimum day's vase life of cut flower was noted under control (7.33 days).

Table 1: Effect of plant growth regulators on flowering, quality parameters and Benefit cost ratio of China aster

Treatment	Treatment Combinations	Days to first flower bud initiation	Days to opening of flower from bud emergence	Days to 50% flowering	Blooming periods (days)	Number of flower $plant^{-1}$	Individual flower weight (gm)	Flower yield $plant^{-1}$ (gm)	Flower yield $plot^{-1}$ (kg)	Flower yield $hectare^{-1}$ (q)	Flower diameter	Stalk length	Vase life of cut flower	Benefit Cost Ratio
T_1	Control	79.93	11.13	88	55.47	20.33	2.99	62.99	2.2	64.2	5.05	8.09	7.33	1:1.58
T_2	GA_3 150	64.87	8.07	83.07	68.8	41.2	3.9	161.21	5.64	164.28	6.32	14.55	9.2	1:3.82
T_3	GA_3 250	67.33	9.67	82.47	67.73	33.47	3.51	116.64	4.08	118.87	7.25	15.15	10.2	1:2.83
T_4	GA_3 350	67.47	9.47	83.27	66.87	38.13	3.68	140.25	4.91	142.93	6.78	11.23	9.13	1:3.25
T_5	GA_3 450	68.47	9.87	83.47	65.53	30.27	3.17	96.88	3.39	98.73	6.61	10.53	8.93	1:2.19
T_6	NAA 50	67.2	10.13	82.53	60.33	32.33	3.25	106.65	3.73	108.69	5.81	8.62	8.2	1:2.67
T_7	NAA 100	73.27	11.07	82.67	62.47	36.07	3.61	129.91	4.55	132.39	6.18	11.99	8.07	1:3.23
T_8	NAA 150	71.6	10.87	82.73	61.07	34.33	3.65	125.27	4.38	127.66	6.05	10.24	7.87	1:3.09
T_9	NAA 200	69.73	10.73	83.67	59.13	29.67	3.11	93.53	3.27	95.32	5.77	8.2	7.73	1:2.30
T_{10}	SA 50	67.4	9.93	83.6	57.4	27.4	3.31	90.29	3.16	92.02	5.89	10.7	8.4	1:2.26
T_{11}	SA 100	68.53	10.47	84.13	63.6	35.53	3.81	136.07	4.76	138.66	6.21	11.21	9.07	1:3.41
T_{12}	SA 150	69.5	10.8	83.87	58.67	31.73	3.2	101.51	3.55	103.59	6.09	10.87	9.27	1:2.53
T_{13}	SA 200	69.53	10.93	83.4	56.27	26.6	3.15	84.15	2.95	85.75	5.82	8.58	8.6	1:2.09
	SEm±	2.47	0.31	2.46	2.01	2.28	0.18	7.25	0.33	7.71	0.27	1.29	0.22	
	C.D. at 5%	7.29	0.92	NS	5.93	NS	0.53	21.42	NS	22.77	0.8	3.8	NS	
	C.V.	6.14	5.26	5.1	5.63	12.29	9.18	11.3	14.52	11.78	7.65	20.71	4.34	

Conclusion

Based on the findings of the present experiment results it is concluded that the treatment T_2 (GA_3 @150 ppm) were performed better for days to first flower bud initiation, blooming period, days to opening of flower from bud emergence, and individual flower weight, flower yield per plant (g), Flower yield per hectare (q), Cost of cultivation and treatment T_3 (GA_3 @250 ppm) flower diameter (cm), stalk length (cm). In research, among the all treatment T_1 (control) was found most inferior for the use of different concentrations of plants growth regulators in China aster.

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