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Effect of growth regulators on vegetative parameters of China Aster (*Callistephus chinensis* L. Nees) cv. Kamini

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Abstract
The present investigation entitled "Effect of growth regulators on vegetative parameters of china aster (*Callistephus chinensis* L. Nees) cv. Kamini" was carried out in Randomized Block Design (RBD) during the year 2020-21. Among the vegetative characters, the treatment with GA_3 at 200 ppm recorded maximum values for plant height (15.71, 30.61 and 47.03 cm at 30, 60 and 90 DAT, respectively), leaf area (49.13, 84.03 and 114.17 cm^2 at 30, 60 and 90 DAT, respectively), number of branches (5.83, 9.27 and 12.74 at 30, 60 and 90 DAT, respectively), chlorophyll content (47.13, 56.72 and 68.50 SPAD at 30, 60 and 90 DAT, respectively), fresh and dry weight of the plant (113.32 g and 51.45 g, respectively) over other treatments. Alar at 1500 ppm application resulted in minimum plant height (10.49, 21.09 and 32.96 cm at 30, 60 and 90 DAT, respectively). Alar at 500 ppm application recorded minimum values for leaf area (34.53, 63.53 and 79.17 cm^2 at 30, 60 and 90 DAT, respectively) and chlorophyll content (35.50, 44.19 and 50.08 SPAD at 30, 60 and 90 DAT, respectively). Therefore, foliar application of GA_3 200 ppm at 30 and 45 DAT was found to be best in order to get maximum vegetative yield of china aster cv. Kamini.

Keywords: China aster, Growth regulators, GA_3, Alar, BA

Introduction
China aster (*Callistephus chinensis* L. Nees) is one of the most popular cut flowers as well as loose flower grown throughout the world. China aster is native to China and belongs to family 'Asteraceae'. The behaviour of this plant is reported as a diploid (2n=18). The genus C*allistephus* derived from two Greek words 'Kalistos' means most beautiful, and 'stephos' means a crown, referring to the flower. Cassini described the china aster as *Callistephus hortensis*. It was first named by Linnaeus as *Aster chinensis*, and Nees subsequently changed name to C*allistephus chinensis*. Among the annual flower's china aster ranks next to chrysanthemum and marigold. China aster is a free blooming, half hardy and easy growing winter annual.

The commercial importance of china aster is increasing day by day in India especially in Karnataka, Tamil Nadu, West Bengal and Maharashtra. China aster has good vase life and used in flower arrangements vases, bouquets and for interior decoration etc. and loose flowers are widely used for making garland, for worship and also used in social functions. They are highly suitable in garland landscape due to their different plant height and are grown in different features like flower beds, borders and potted plants.

Increased flower production, quality of flower and perfection in the form of plant are the important objectives to be reckoned in commercial flower production. Though the quality of cut flowers is primarily a varietal trait, it is greatly influenced by climatic, geographical and nutritional factors. By manipulating the physiological process of plant, the requirement of fertilizers can be reduced.

Plant growth regulators are cheap and play a significant role in modifying growth, development and flowering in plant system. The plant growth regulators vary with the plant species, variety, concentration used, frequency of application, appropriate time of application and other various factors affect the uptake and translocation of chemicals in plant system. Hence, an attempt was made to study the effect of growth regulators on vegetative parameters of china aster and to appraise the role of growth promotors and retardants on china aster crop.

Materials and Methods
The present investigation on "Effect of growth regulators on vegetative parameters of china aster (*Callistephus chinensis* L. Nees) cv. Kamini" was conducted at Jambuvadi farm, College

of Horticulture, Junagadh Agricultural University, Junagadh during the year 2020-2021. The experiment was laid out in randomized block design (RBD), with three replications during winter, 2020. The details of treatments are presented in the Table 1.

Table 1: Details of Growth regulators used in the study

Sr. No.	Growth regulators	Concentration
T_1	GA_3	100 ppm
T_2	GA_3	150 ppm
T_3	GA_3	200 ppm
T_4	Alar	500 ppm
T_5	Alar	1000 ppm
T_6	Alar	1500 ppm
T_7	BA	25 ppm
T_8	BA	50 ppm
T_9	BA	75 ppm
T_{10}	Control	water

China aster is generally propagated through seeds. The seedlings of "Kamini" cultivar were transplanted in the plot at the spacing of 30 x 30 cm. The recommended cultural practices were followed during the experimentation. Plant growth regulators *i.e.*, GA_3, Alar and BA were applied by spraying method as per the treatments during morning hours at 30 and 45 days after transplanting. The data on vegetative parameters like plant height, leaf area, leaf length, leaf width, number of branches, fresh and dry weight of plants were recorded and statistically analysed as per the procedure described by Panse and Sukhatme (1985) [7].

Result and Discussion

The results obtained from the present investigation as well as relevant discussion have been presented under following heads:

Vegetative characters

Plant height (cm)

The maximum plant height (15.71, 30.61 and 47.03 cm) was recorded with treatment 200 ppm of GA_3 which was found to be statistically at par with the treatment 150 ppm of GA_3 (14.58, 29.15 and 44.79 cm) at 30, 60 and 90 DAT, respectively. Whereas, significantly minimum plant height was recorded in 1500 ppm of Alar (10.49, 21.09 and 32.96 cm) at 30, 60 and 90 DAT, respectively are presented in the Table 2. The promotive effect of gibberellins on growth may be due to increasing internodal length which might be due to enhanced cell division and cell enlargement and also due to increased plasticity of cell, promotion of protein synthesis coupled with higher apical dominance. These results are in confirmation with that of Srikanth *et al*. (2013) [13], Kumar *et al*. (2015) [5], Sharma and Joshi (2015) [10], Vijayakumar *et al*. (2017) [14], Ragini and Singh (2018) [8] and Deepti *et al*. (2021) [2] in china aster. The reduction in plant height with the Alar application over control due to inhibitory role of growth retardants on cell division and cell elongation of apical meristematic cells and also on gibberellin synthesis (Cathey, 1960) [1].

Leaf area (cm^2)

The maximum leaf area was recorded in the treatment 200 ppm of GA_3 (49.13, 84.03 and 114.17 cm^2) at 30, 60 and 90 DAT, respectively. While the minimum leaf area was recorded in 500 ppm of Alar (34.53, 63.53 and 79.17 cm^2) at 30, 60 and 90 DAT, respectively are presented in the Table 2. This is might be due to gibberellic acid play a vital role in making the leaves photosynthetically more active for longer period resulting in increased production of carbohydrates. Similar results were reported by Sharma and Joshi (2015) [10], Ragini and Singh (2018) [8] in china aster and Girisha *et al*. (2012) [3] in daisy.

Leaf length (cm)

The maximum leaf length was recorded in the treatment 200 ppm of GA_3 (3.18, 5.84 and 6.57 cm) at 30, 60 and 90 DAT, respectively. Whereas, significantly minimum leaf length was observed in the treatment Alar at 1500 ppm (2.37, 4.27 and 4.94 cm) at 30, 60 and 90 DAT, respectively are presented in the Table 2. GA_3 gives positive effect on leaf length due to increasing cell division and cell elongation with association of increasing plasticity of cell wall and formation of energy rich phosphates (Shivakumar, 2000) [11]. The present results are in close conformity with Ragini and Singh (2018) [8] in china aster and Girisha *et al*. (2012) [3] in daisy.

Leaf width (cm)

The maximum leaf width was recorded in the treatment 75 ppm of BA (2.92, 4.97 and 6.51 cm) at 30, 60 and 90 DAT, respectively. While minimum leaf width was recorded in 500 ppm of Alar (1.78, 3.38 and 4.93 cm) at 30, 60 and 90 DAT, respectively are presented in the Table 3. This is might be due to increased cell division, cell enlargement and distribution of assimilates in plants and thus cause to better development of leaves (Carey, 2008). Similar results were reported by Ragini and Singh (2018) [8] in china aster.

Number of branches per plant

Among the different growth regulators, significantly maximum number of branches per plant were recorded in 200 ppm of GA_3 (5.83, 9.27 and 12.74) was found statistically at par with the 150 ppm of GA_3 (5.43, 8.33 and 11.83) at 30, 60 and 90 DAT, respectively. However, the minimum number of branches per plant were recorded in control (3.73, 6.28 and 9.55) at 30, 60 and 90 DAT, respectively are presented in the Table 3. The increase in number of branches per plant with the application of GA_3 might be due to enhanced cell division and cell enlargement, promotion of protein synthesis coupled with higher dry matter accumulation in the plant. The findings are in line with the results obtained by Nandre *et al*. (2009) [6], Vijayakumar *et al*. (2017) [14] and Sonu *et al*. (2018) [12] in china aster.

Chlorophyll content (SPAD)

The maximum chlorophyll content (SPAD) was recorded in 200 ppm of GA_3 (47.13, 56.72 and 68.50) was found statistically at par with the treatment 150 ppm of GA_3 (46.93, 54.40 and 64.46) at 30, 60 and 90 DAT, respectively. Significantly the minimum chlorophyll content was noticed in the treatment Alar at 500 ppm (35.50 and 50.08) at 30 and 90 DAT, respectively and control recorded minimum chlorophyll content (43.22) at 60 DAT are presented in the Table 3. GA_3 enhances the chlorophyll content due to gibberellin moves readily in all directions and in all tissues in china aster. These results are in confirmation with that of Vijayakumar *et al*. (2017) [14] in china aster, Raveendra *et al*. (2018) [9] in chrysanthemum, Khangjarakpam *et al*. (2019) [4] in African

marigold and Girisha *et al*. (2012) [3] in daisy.

Fresh and dry weight of plant (g)

The maximum fresh weight of plant was recorded in the treatment 200 ppm of GA_3 (113.32 g) which was found at par with the treatment 150 ppm of GA_3 (108.15 g). The maximum dry weight of plant was noticed in the treatment 200 ppm of GA_3 (51.45 g) which was found at par with the treatment 150 ppm of GA_3 (48.69 g) are presented in the Table 3. This might be due to increase the photosynthetic rate in leaves of plant through changes in plastid development and chloroplast structure which resulted in increase in whole biomass. The present results are in close conformity with Khangjarakpam *et al*. (2019) [4] in African marigold.

Table 2: Effect of growth regulators on plant height, leaf area and leaf length in china aster cv. Kamini

Treatments	Plant height (cm)			Leaf area (cm^2)			Leaf length (cm)		
	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT
T_1 - GA_3 100 ppm	12.36	25.82	40.67	40.66	71.37	91.07	2.03	3.96	5.68
T_2 - GA_3 150 ppm	14.58	29.15	44.79	43.76	78.6	97.87	2.11	4.18	5.74
T_3 - GA_3 200 ppm	15.71	30.61	47.03	49.13	84.03	114.17	2.42	4.57	6.35
T_4 - Alar 500 ppm	12.30	25.80	38.74	34.53	63.53	79.17	1.78	3.38	4.93
T_5 - Alar 1000 ppm	11.50	23.81	35.28	35.37	65.25	85.23	1.99	3.46	5.35
T_6 - Alar 1500 ppm	10.49	21.09	32.96	37.6	66.33	86.2	2.05	3.63	5.58
T_7 - BA 25 ppm	13.19	26.56	42.33	34.77	64.4	83.9	2.21	4.14	5.42
T_8 - BA 50 ppm	12.40	26.09	40.77	36.47	66.4	86.2	2.32	4.44	6.23
T_9 - BA 75 ppm	11.78	24.09	39.79	38.13	69.23	88.03	2.92	4.97	6.51
T_{10} - Control	11.77	23.70	39.44	37.93	68.07	87.27	2.27	3.89	5.54
SE(m) ±	0.59	1.16	1.93	1.99	3.00	4.23	0.14	0.26	0.26
C.D. at 5%	1.74	3.44	5.74	5.91	8.92	12.57	0.43	0.78	0.76
C.V. %	8.06	7.80	8.33	8.87	7.46	8.15	11.31	11.28	7.73

Table 3: Effect of growth regulators on leaf width, number of branches per plant, chlorophyll content, fresh and dry weight of plant in china aster cv. Kamini

Treatments	Leaf width (cm)			Number of branches per plant			Chlorophyll content (SPAD)			Fresh weight of plant (g)	Dry weight of plant (g)
	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT		
T_1 - GA_3 100 ppm	2.03	3.96	5.68	5.07	7.70	11.13	41.57	49.36	59.52	100.39	43.93
T_2 - GA_3 150 ppm	2.11	4.18	5.74	5.43	8.33	11.83	46.93	54.40	64.46	108.15	48.69
T_3 - GA_3 200 ppm	2.42	4.57	6.35	5.83	9.27	12.74	47.13	56.72	68.50	113.32	51.45
T_4 - Alar 500 ppm	1.78	3.38	4.93	4.49	7.00	10.83	35.50	44.19	50.08	79.01	37.21
T_5 - Alar 1000 ppm	1.99	3.46	5.35	4.78	7.27	10.93	36.53	45.00	51.20	75.50	34.17
T_6 - Alar 1500 ppm	2.05	3.63	5.58	4.95	7.80	11.17	38.67	46.77	53.68	72.99	32.38
T_7 - BA 25 ppm	2.21	4.14	5.42	3.76	6.32	9.63	36.67	44.24	52.30	82.87	40.72
T_8 - BA 50 ppm	2.32	4.44	6.23	3.84	6.55	9.77	39.33	46.36	54.59	85.04	42.43
T_9 - BA 75 ppm	2.92	4.97	6.51	4.17	6.73	9.87	40.67	48.03	56.02	86.34	43.20
T_{10} - Control	2.27	3.89	5.54	3.73	6.28	9.55	39.67	43.22	55.48	64.34	27.74
SE(m) ±	0.14	0.26	0.26	0.22	0.34	0.51	1.87	2.38	2.96	4.08	2.12
C.D. at 5%	0.43	0.78	0.76	0.66	1.01	1.54	5.55	7.07	8.80	12.13	6.29
C.V. %	11.31	11.28	7.73	8.39	8.03	8.36	8.04	8.62	9.07	8.15	9.12

Conclusion

On the basis of results obtained from the present investigation, it can be concluded that foliar application of GA_3 200 ppm at 30 and 45 days after transplanting increased the plant height, leaf area, number of branches per plant, chlorophyll content, fresh and dry weight of the plant. Thus, the treatment GA_3 at 200 ppm was found to be suitable for enhancing vegetative parameters of china aster cv. Kamini.

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