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Effect of different plant growth regulators and their levels on vegetative growth of China aster [*Callistephus chinensis* (L.) Nees] cv. Shashank

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Abstract
A field experiment was carried out to evaluate response of plant growth regulators and their levels on vegetative growth of China aster cv. Shashank under taken at Department of Horticulture, Naini Agriculture Institute, Sam Higginbottom university of Agriculture, Technology and Sciences (SHUATS), Allahabad during the year 2016-17. The experiment was laid out in RBD (Randomized Block Design) with 13 treatments combination consisting of the thirteen treatments comprised of control, GA_3 (50, 100, 150 and 200 ppm respectively), NAA (50, 100, 150 and 200 ppm) and CCC (500, 1000, 1500 and 2000 ppm respectively). The results of the study revealed that Maximum plant height (75.74 cm) was recorded in T_4 (GA_3 @ 200ppm) followed by T_3 (68.3 cm, GA_3 @ 150ppm).Minimum plant height (61.89 cm) was recorded in T_0 (control). Maximum plant spread (37.7 cm) was recorded in T_4 (GA_3 @ 200ppm) followed by T_3 (36.91 cm, GA_3 @ 150ppm). Minimum plant spread (23.46 cm) was recorded in T_0 (control). Maximum number of leaves per plant (168.15) was recorded in T_4 (GA_3 @ 200ppm) followed by T_3 (GA_3 @ 150ppm, 160.14). Minimum number of leaves per plant (72.21) was recorded in T_0 (control). Maximum number of branches per plant (32.01) was recorded in T_4 (GA_3 @ 200ppm) followed by T_8 (GA_3 @ 150ppm, 28.33). Minimum number of branches per plant (25.03) was recorded in T_0 (control).

Keywords: China aster, GA_3, NAA, CCC

Introduction
Callistephus is a monotopic genus of flowering plants in aster family. China aster containing the single species *Callistephus chinensis*. It is native to China and has spread to Europe and other tropical countries during 1731 A.D. Aster is also an important flower crop of Siberia, Japan, North America, Switzerland and Europe.
Among annual flowers it ranks next to chrysanthemum and marigold (Sheela 2008) [9]. China aster is a free blooming, half hardy, easy growing, and winter annual, grown for cut flower as well as loose flower. The plant was a single flowering and branching type having a height of about 60cm. Since its introduction to Europe the plant has undergone a remarkable change in form, size and colour of flowers. Now the plat range in height from 15cm to about 1m with pompon flowers about size of a button to large flower heads having single, double, anemone-flowered, peony- flowered, incurved, quilled or shaggy flower types. The aster bloom contains two kinds of florets: ray florets and disc florets. The bloom type depends mainly upon the relative number of the two kinds of florets and their shapes. The most suitable character for the classification of China aster is the shape of ray florets.
Exogenous application of plant growth regulators in fact has revolutionized agriculture, more particularly horticulture in developed countries. Application of plant growth regulators are playing a leading role in production and post-harvest handling of cut flowers. Application of growth regulators have been an essential part of floriculture and utilization of growth substances constituted one of the most important advances in agro-technology for improving the yield and quality parameters of flowers. The plant growth regulators have been used in floriculture to manipulate plant growth in a desire direction (Sharma *et al*., 2001) [8].

Materials and Methods
The present investigation entitled “Effect of different plant growth regulators and their levels on vegetative growth of China aster [*Callistephus chinensis* (L.) Nees] cv. Shashank” was carried out under Allahabad agro climatic conditions at the experimental field of the

Department of Horticulture, Allahabad school of Agriculture, Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad (U.P) in the month of November to March during the Rabi season of the year 2016-2017. It is located on latitude of 20^0 and 15^0 North and longitude of 60^0 and 30 East and at an altitude of 98 meters above mean sea level (MSL). The experimental plot was homogenous in fertility having assured irrigation and other required facilities. The soil of experimental field had sandy loam texture, acidic pH 7.2 and organic carbon content 0.44 %.

The experiment was laid out in randomized complete block design with three replications. The thirteen treatments comprised of control, GA_3 (50, 100, 150 and 200 ppm respectively), NAA (50, 100, 150 and 200 ppm) and CCC (500, 1000, 1500 and 2000 ppm respectively). One month old uniform sized seedlings of China aster were transplanted at a spacing of 40 cm x 60 cm with a twelve plants in each plot. Solutions of GA_3, NAA and CCC at different concentrations were prepared in 1000 ml volumetric flask by dissolving calculated quantity of chemicals in small quantity of ethyl alcohol and then volume was made up to one litre with distilled water. The prepared solutions were sprayed uniformly over the treatments immediately after preparation at 15 and 30 days after transplanting. Observations on different flowering attributes and quality were recorded and analyzed statistically.

Results and Discussion

The maximum plant height (8.26 cm) at 30 days after transplanting was recorded with the treatment T_4 (GA_3 @ 200 ppm), which was found at par with the treatment T_3 (GA_3 @ 150 ppm), (8.08 cm). The minimum plant height was recorded in T_{12} (CCC @ 2000 ppm) (6.22 cm). The maximum plant height (38 cm) at 60 days after transplanting was recorded with the treatment T_4 (GA_3 @ 200 ppm), which was found at par with the treatment T_3 (GA_3 @ 150 ppm), (33.3 cm). The minimum plant height was recorded in T_{12} (CCC @ 2000 ppm) (12.2 cm). The maximum plant height (57.05 cm) at 90 DAT was recorded with the treatment T_4 (GA_3 @ 200 ppm), which was found at par with the treatment T_3 (GA_3 @ 150 ppm), (51.95 cm). The minimum plant height was recorded in T_{12} (CCC @ 2000 ppm) (31.13 cm). Similar results were also recorded at 120 DAT. Highest plant height (73.1 cm) was recorded in T_4 (GA_3 @ 200 ppm), which was found at par with the treatment T_3 (GA_3 @ 150 ppm), (72.53 cm). The minimum plant height was recorded in T_{12} (CCC @ 2000 ppm) (52.2 cm).

The data pertaining to plant spread at 30 days shows that there was no significant effect of plant growth regulators. The maximum plant spread (19.23 cm) at 60 days after transplanting was recorded with the treatment T_4 (GA_3 @ 200 ppm), which was found at par with the treatment T_3 (GA_3 @ 150 ppm), (18.46 cm). The minimum plant spread was recorded in T_{12} (CCC @ 2000 ppm) (9.46 cm). The maximum plant spread (30.6 cm) at 90 DAT was recorded with the treatment T_4 (GA_3 @ 200 ppm), which was found at par with the treatment T_3 (GA_3 @ 150 ppm), (29.14 cm). The minimum plant spread was recorded in T_{12} (CCC @ 2000 ppm) (18.53 cm). Similar results were also recorded at 120 DAT. Highest plant spread (38.46 cm) was recorded in T_4 (GA_3 @ 200 ppm), which was found at par with the treatment T_3 (GA_3 @ 150 ppm), (37.7 cm). The minimum plant spread was recorded in T_{12} (CCC @ 2000 ppm) (23.46 cm).

The maximum number of leaves (27.4) at 30 days after transplanting was recorded with the treatment T_4 (GA_3 @ 200 ppm), which was found at par with the treatment T_3 (GA_3 @ 150 ppm), (26.24). The minimum number of leaves was recorded in T_{12} (CCC @ 2000 ppm) (17). The maximum number of leaves (72.03) at 60 days after transplanting was recorded with the treatment T_4 (GA_3 @ 200 ppm), which was found at par with the treatment T_3 (GA_3 @ 150 ppm), (70.03). The minimum number of leaves was recorded in T_{12} (CCC @ 2000 ppm) (37.6). The maximum number of leaves (123.76) at 90 DAT was recorded with the treatment T_4 (GA_3 @ 200 ppm), which was found at par with the treatment T_3 (GA_3 @ 150 ppm), (114.13). The minimum number of leaves was recorded in T_{12} (CCC @ 2000 ppm) (51.22). Similar results were also recorded at 120 DAT. Highest number of leaves (168.15) was recorded in T_4 (GA_3 @ 200 ppm), which was found at par with the treatment T_3 (GA_3 @ 150 ppm), (160.15). The minimum number of leaves was recorded in T_{12} (CCC @ 2000 ppm) (72.21).

The data pertaining there was no significant effect of plant growth regulators on number of branches at 30 days. The maximum number of branches (13.10) at 60 days after transplanting was recorded with the treatment T_4 (GA_3 @ 200 ppm), which was found at par with the treatment T_3 (GA_3 @ 150 ppm), (12.84). The minimum number of branches was recorded in T_8 (NAA @ 200 ppm) (9.93). The maximum number of branches (22.49) at 90 DAT was recorded with the treatment T_4 (GA_3 @ 200 ppm), which was found at par with the treatment T_3 (GA_3 @ 150 ppm), (21.87). The minimum number of branches was recorded in T_8 (NAA @ 200 ppm) (17.02). Similar results were also recorded at 120 DAT. Highest number of branches (32.01) was recorded in T_4 (GA_3 @ 200 ppm), which was found at par with the treatment T_3 (GA_3 @ 150 ppm), (28.33). The minimum number of branches was recorded in T_8 (NAA @ 200 ppm) (22.24).

The role of GA_3 in increasing height of plant may be 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. The increase in number of branches per plant with application of GA_3 seems to be due to enhanced cell division and cell enlargement, promotion of protein synthesis coupled with higher dry matter accumulation in the plant. Whereas the role of CCC in producing short saturated plants may be because of inhibitory activity on cell elongation thus shortening the length of internode leading to short saturated plants. Because of short saturated plants leading to diversion of flow of photosynthesis towards their growth and development. Similar results were reported by (Doddagoudar *et al*., 2002) [1], (Padma priya and Chezhiyan 2003) [6], (Gupta *et al*., 2015) [2], (Munikrishnappa *et al*., 2014) [4], (Ramesh *et al*., 2001) [7], (Nandre *et al*., 2009) [5].

Table 1: Effect of different plant growth regulators on plant height (cm) at different growth stages of China aster cv. Shashank.

Treatment No.	Treatments	30 DAT	60 DAT	90 DAT	120 DAT
T_0	Control	7.19	20.06	42.93	61.59
T_1	GA_3 @ 50 ppm	7.73	29.2	46.38	68.3
T_2	GA_3 @ 100 ppm	8.04	32.8	47.89	70.13
T_3	GA_3 @ 150 ppm	8.08	33.3	51.95	72.53

T_4	GA_3 @ 200 ppm	8.26	38	57.05	75.74
T_5	NAA @ 50 ppm	7.32	22.8	39.57	62.7
T_6	NAA @ 100 ppm	7.52	24.86	42.93	64.03
T_7	NAA @ 150 ppm	7.58	27.2	44.45	64.74
T_8	NAA @ 200 ppm	8.08	28.8	44.55	67.53
T_9	CCC @ 500 ppm	7.36	16.4	33.93	57.36
T_{10}	CCC @ 1000 ppm	6.42	14.86	33.7	54.46
T_{11}	CCC @ 1500 ppm	6.79	13.86	31.73	52.5
T_{12}	CCC @ 2000 ppm	6.22	12.2	31.13	52.2
	F-test	S	S	S	S
	S.Ed.(±)	0.09	0.98	1.72	1.76
	C.D.at 5%	0.19	2.02	3.55	3.64

Table 2: Effect of different plant growth regulators on Plant spread (cm) at different growth stages of China aster cv. Shashank.

Treatment No.	Treatments	30 DAT	60 DAT	90 DAT	120 DAT
T_0	Control	6.66	9.46	18.53	23.46
T_1	GA_3 @ 50 ppm	8.66	15.93	28	33.82
T_2	GA_3 @ 100 ppm	9.1	17.3	28.53	36.91
T_3	GA_3 @ 150 ppm	11.06	18.46	29.14	37.7
T_4	GA_3 @ 200 ppm	11.36	19.23	30.6	38.46
T_5	NAA @ 50 ppm	7.46	14.93	23.96	27.5
T_6	NAA @ 100 ppm	7.3	14.76	21.73	26.53
T_7	NAA @ 150 ppm	7.1	14.53	21.6	26.4
T_8	NAA @ 200 ppm	6.83	14.43	20.23	26
T_9	CCC @ 500 ppm	7.96	15.6	24.43	30.76
T_{10}	CCC @ 1000 ppm	8.03	15.56	26	31.8
T_{11}	CCC @ 1500 ppm	8.4	15.63	26.53	32.86
T_{12}	CCC @ 2000 ppm	8.5	15.8	27.86	33.21
	F-test	NS	S	S	S
	S.Ed.(±)	-	1.07	1.09	1.17
	C.D.at 5%	-	2.20	2.24	2.42

Table 3: Effect of different plant growth regulators on number of leaves the at different growth stages of China aster cv. Shashank.

Treatment No.	Treatments	30 DAT	60 DAT	90 DAT	120 DAT
T_0	Control	17	37.6	51.22	72.21
T_1	GA_3 @ 50 ppm	23.76	67.56	100.86	150.34
T_2	GA_3 @ 100 ppm	24.03	69.1	108.46	152.27
T_3	GA_3 @ 150 ppm	26.24	70.03	114.13	160.14
T_4	GA_3 @ 200 ppm	27.43	72.03	123.76	168.15
T_5	NAA @ 50 ppm	20.6	59.73	92.38	133.10
T_6	NAA @ 100 ppm	21.36	62.6	95.26	135.08
T_7	NAA @ 150 ppm	22.23	63.66	96.34	138.35
T_8	NAA @ 200 ppm	23.29	64.26	97.89	139.19
T_9	CCC @ 500 ppm	17.36	40.73	74.76	99.34
T_{10}	CCC @ 1000 ppm	18.56	43.13	78.53	101.56
T_{11}	CCC @ 1500 ppm	19.1	47.7	86.31	112.58
T_{12}	CCC @ 2000 ppm	18.83	44.36	82.16	104.80
	F-test	S	S	S	S
	S.Ed.(±)	1.71	4.31	0.89	13.61
	C.D.at 5%	3.54	8.89	1.83	28.09

Table 4: Effect of different plant growth regulators on Number of branches per plant at different growth stages of China aster cv. Shashank.

Treatment No.	Treatments	30 DAT	60 DAT	90 DAT	120 DAT
T_0	Control	5.23	9.93	18.27	25.03
T_1	GA_3 @ 50 ppm	4.63	12.2	20.33	26.83
T_2	GA_3 @ 100 ppm	4.77	12.5	20.65	27.3
T_3	GA_3 @ 150 ppm	4.74	12.84	21.87	28.33
T_4	GA_3 @ 200 ppm	5.74	13.10	22.49	32.01
T_5	NAA @ 50 ppm	3.41	9.75	18.11	24.88
T_6	NAA @ 100 ppm	4.3	9.58	17.83	24.13
T_7	NAA @ 150 ppm	3.14	9.32	17.29	23.51
T_8	NAA @ 200 ppm	3.01	9.20	17.02	22.24
T_9	CCC @ 500 ppm	4.60	10.22	18.66	25.22
T_{10}	CCC @ 1000 ppm	4.13	11.19	19.19	25.53
T_{11}	CCC @ 1500 ppm	4.35	11.63	19.67	25.93
T_{12}	CCC @ 2000 ppm	3.88	11.90	20	26.7
	F-test	NS	S	S	S

	S.Ed.(±)	_	0.39	1.15	1.62
	C.D.at 5%	_	0.79	2.38	3.35

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