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Effect of spacing and foliar application of Micronutrients on growth, flowering and yield of China aster (*Callistephus chinensis* L.)

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Abstract
An experiment was conducted to study the effect of spacing and foliar application of micronutrients on growth, flowering and yield of china aster (*Callistephus chinensis* L. Nees.) cv. Metadoor. The experiment consisted of three spacing (30x25,30x30,40x25;) and with the foliar spray of different micronutrients (Fe, Zn, Mn, B) at 20, 40 and 70 DAT and laid out in factorial randomized block design with three replications. The closer spacing 30x25 cm along with the foliar application of Micronutrient (Fe) produced taller plants (53.21 cm) and flower production was also higher per unit area then other spacing and micronutrients. The interaction of spacing and micronutrients was found that closer spacing with Fe spraying gave higher yield (8.12 flowers/plant) and found economically better than the wider spacing with other micronutrients.

Keywords: china aster, spacing, micronutrients, stalk length, yield, vase life

Introduction
Chin aster (*Callistephus chinensis* L. Nees) is one of the most popular cut flowers as well as loose flowers grown throughout the world. It is gaining fast popularity in India because of its easy cultural practices, diversity of colours and varied uses. Productivity and quality of flower crop can be improved either by using high yielding cultivar or improved horticultural practices such as proper spacing, micronutrients and pinching, apical dominance in aster has been one of the limiting factors for flower production. Productivity of crop completely depends on the genotype, climate and soil type. Keeping above facts in view the present investigation an attempt was made to increase the productivity of China aster by manipulating plant population per unit area. The results on the influence of plant spacing and Micronutrients on growth, flowering and yield of China aster are presented in this paper.

Materials and Methods
The experiment was conducted in winter (Rabi) season at Department of Horticulture, Sam Higginbottom university of Agricultural Sciences and Technology, Allahabad, U.P during 2017-2018. Seed were collected from Allahabad nursery, U.P. Seedlings were grown in plastic trays and 30 days old uniform height seedlings having 6-8 cm height with 4-5 leaf stage were transplanted in 1.5mx1.5m size plots in the field. The experiment was laid out in a factorial randomized block design with 12 treatments (S_1M_1-30x30cm+Fe), T_2(S_1M_2-30x30cm+Zn), T_3(S_1M_3-30x30cm+B), T_4(S_1M_4-30x30cm+Mn), T_5(S_2M_1-40x25cm+Fe), T_6(S_2M_2-40x25cm+Zn), T_7(S_2M_3-40x25cm+B), T_8(S_2M_4-40x25cm+Mn), T_9(S_3M_1-30x25cm+Fe), T_{10}(S_3M_2-30x25cm+Zn), T_{11}(S_3M_3-30x25cm+B), T_{12}(S_3M_4-30x25cm+Mn) with three replications. Field preparation, Intercultural operations, irrigation and other practices were done as per the standard recommendations.

Result and Discussion
Growth characters
Plant height is an important physiological parameter related to growth and development of the crop. In entire stages of plant growth, the plant height was maximum at the closer spacing of T_9 (30cm x25cm)with (spray of Fe(0.3%), decreased gradually as the spacing increased in all the observation recorded at 30,60 and 90 days after transplanting. The maximum plant height was 53.21 cm in a spacingT_9 (30cmx25cm) with (spray of Fe (0.3%) than all other treatments. While the lowest in plant height was 43.84 cm in the treatment T_7 (40cm x 25cm) with B (0.4%) may be due to the reason that there is more competition for light and nutrients uptake

by the plant for its luxuriant growth. So it is evident that for maximum plant height we can go for closest spacing.

Plant spread is also an important growth parameter related to growth and development of the crop. The treatment T_9(30cm x25cm)with (spray of Fe(0.3%) and T_1(30cm x 30 cm)with(spray of Fe(0.3%) recorded maximum plant spread throughout the entire life cycle of plant. The minimum plant spread was recorded in T_7 (40 cm x 25 cm) with (spray of B(0.4%). This may be due to the reason that there might be less competition for light and Nutrients in the wider spacing which might have spread of plant utilizing proper space and sunlight.

The number of branches was found to be significant with a planting distance. The maximum number of branches was recorded with spacing of T_1 (30 cm x 30 cm) with (spray of Fe(0.3%) at 60 DAT (13.17 cm) this may be attributed to better uptake of nutrition and sunlight due to less competition and T_9 (30 cm x 25 cm) with (spray of Fe (0.3%) at 90 DAT (18.94 cm). The minimum number of branches (14.50) was recorded in T_7 (40 cm x 25 cm) with (spray of B(0.4%) . this may be due to the reason that there might be less competition for light and nutrients in the wider spacing which might have spread of plant utilizing proper space and sunlight.

Flowering characters

The various planting distances and micronutrients did not significantly influenced the days of floral bud emergence, the treatment combination T_9 (30 cm x 25 cm) with (spray of Fe (0.3%) Were found to be significantly superior (49.45), while maximum number of days taken for the floral bud emergence (57.92) is recorded in T_7 (40 cm x 25 cm) with (spray of B(0.4%). The interaction of spacing and micronutrients had a non - significant influence on the days of floral bud emergence.

The less number of days taken for the 1st flowering was recorded in the treatment T_9 (30 cm x 25 cm) with (spray of Fe (0.3%) were found to be significantly superior (62.07 days) and the maximum days taken for the 1st flowering was recorded in T_6 (40x25cm+Zn(0.4%) (73.92 days). The interaction of spacing and micronutrients had a significant influence on the days taken for 1st flowering. So it is evident that various spacings and micronutrients had a significant effect on the days 1sttaken for flowering.

The less number of days taken for the 50% flowering was recorded in the treatment T_{12}(30x25cm) with spray of Mn(0.3%) were found to be significantly superior (62.07 days) and the maximum days taken for the 1st flowering was (76.78 days) recorded in T_7 (40 cm x 25 cm) with (spray of B(0.4%) . The interaction of spacing and micronutrients had a significant influence on the Days taken for 50% flowering. Among all the treatment combination treatment T_{12} took lesser days for 50% flowering.

Table 1: Effect of spacing and micronutrients on various characters at all growth stages of China aster

Treatments	Plant Height(cm)			Plant Spread(cm)						Number of branches/plant	
	30DAT	60DAT	90DAT	30 DAT		60DAT		90 DAT		60DAT	90DAT
				N-S	E-W	N-S	E-W	N-S	E-W		
T_1	19.25	37.61	51.40	14.80	14.16	23.26	22.86	40.16	38.06	13.17	17.75
T_2	14.01	35.33	47.72	12.60	11.70	20.70	20.86	35.58	34.28	7.96	16.56
T_3	13.78	34.24	47.49	11.73	11.43	20.46	20.41	35.02	34.18	8.00	16.62
T_4	14.59	35.08	48.20	12.80	12.36	21.11	21.00	36.27	34.89	8.41	16.46
T_5	15.30	36.04	48.67	13.10	12.63	21.53	21.20	37.67	36.49	8.79	16.69
T_6	11.72	32.76	46.96	10.56	10.33	20.15	19.33	33.85	32.70	7.85	16.20
T_7	9.37	27.20	43.84	9.60	9.33	19.00	18.6	32.39	31.40	6.15	14.50
T_8	13.50	34.45	46.69	11.00	10.80	20.27	19.66	34.56	33.42	7.842	16.41
T_9	19.63	38.29	53.21	15.10	14.60	24.00	23.06	40.37	38.34	9.95	18.94
T_{10}	16.52	36.62	49.47	13.61	13.40	22.66	22.50	38.61	37.48	9.26	17.05
T_{11}	16.45	36.42	49.32	11.36	13.03	22.43	22.26	38.13	36.95	9.01	17.02
T_{12}	18.28	37.02	50.09	14.33	13.70	23.43	22.86	39.40	37.89	9.62	17.24
C.D 5%	0.68	0.85	1.75	1.106	1.556	1.821	1.556	0.664	0.543	1.78	0.90
C.V	2.663	1.440	2.126	3.628	5.315	5.000	4.321	1.074	0.902	11.901	3.192

Table 2: Effect of spacing and micronutrients on various characters at all growth stages of China aster

Treatments	Days Of 1st flowering	Days Of 50% Flowering	No of cut flowers /plant	No of cut flowers/hectare (lakhs)	No of days for floral bud formation	Stalk Length (cm)	Flower diameter	Fresh weight	Vase Life(days)
T_1	65.296	66.15	7.81	7.81	50.17	25.49	5.30	1.88	8.14
T_2	70.906	73.55	6.59	6.80	55.94	23.11	4.94	1.40	7.55
T_3	71.220	74.86	5.46	6.23	56.05	23.05	4.80	1.19	7.46
T_4	70.580	73.18	7.05	7.18	54.00	23.15	5.06	1.33	7.56
T_5	69.416	68.64	7.07	7.33	55.40	23.37	4.93	1.54	7.59
T_6	73.920	76.47	5.13	5.66	59.09	22.38	4.44	1.17	7.07
T_7	72.123	76.78	4.40	4.65	57.92	20.36	4.26	1.08	6.92
T_8	73.063	75.97	5.34	5.92	57.25	22.58	4.56	1.28	7.12
T_9	62.070	65.24	8.12	8.10	49.45	26.38	5.77	1.98	8.71
T_{10}	63.753	67.22	7.26	7.67	51.11	23.97	5.07	1.68	7.66
T_{11}	67.176	68.99	7.23	7.38	52.49	23.50	4.93	1.54	8.14
T_{12}	62.926	64.91	7.283	7.71	48.13	24.03	5.13	1.78	7.66
C.D 5%	0.97	0.28	0.39	0.53	1.94	1.16	0 .47	0.14	0.62
C.V	0.835	0.234	3.515	4.623	2.132	2.135	5.232	4.822	5.715

The treatment T_9 (30cm x25cm) with (spray of Fe(0.3%) recorded maximum stalk length (26.38) i.e., after 90 DAT followed by T_1 (30cm x30cm)with (spray of Fe (0.3%) (25.49). while, the minimum stalk length was (20.36) recorded in T_7 (40 cm x 25 cm) with (spray of B(0.4%). The interaction of spacing and micronutrients had a significant effect on the length of the flower stalk.

The flower diameter (5.77) was recorded maximum in the T_9 (30cm x25cm) with (spray of Fe(0.3%) i.e., after 90 DAT followed by T_1 (30cm x30cm)with (spray of Fe (0.3%) (5.30). while, minimum flower diameter (4.26) was recorded inT_7 (40 cm x 25 cm) with (spray of B(0.4%). The interaction of spacing and micronutrients had a significant effect on the flower diameter.

Yield parameters

The maximum cut flowers production per plant (8.12) was recorded in T_9 (30cm x25cm) with (Spray of Fe (0.3%). The production of flowers per plant was found to be minimum (4.40) in T7 (40 cm x 25 cm) with (Spray of B (0.4%). %). The interaction of spacing and micronutrients had a significant effect on the number of cut flowers/plant.

The maximum cut flowers production per hectare (8.10) was recorded in T_9 (30cm x25cm) with (Spray of Fe (0.3%). The production of flowers per hectare was found to be minimum (4.65) in T_7 (40 cm x 25 cm) with (Spray of B (0.4%). The interaction of spacing and micronutrients had a significant effect on the number of cut flowers/hectare

Post harvest parameters

The maximum fresh weight of the flower (1.98) was recorded in T_9 (30cm x25cm) with (spray of Fe (0.3%). The fresh weight of the flower was found to be minimum (1.08) in T_7 (40 cm x 25 cm) with (spray of B (0.4%). The interaction of spacing and micronutrients had a significant effect on the fresh weight of the flower.

The maximum vase life of the flower (8.71) was recorded in T_9 (30cm x25cm) with (spray of Fe (0.3%). The vase life of the flower was found to be minimum (6.92) in T_7 (40 cm x 25 cm) with (spray of B(0.4%). The interaction of spacing and micronutrients had a non-significant effect on the vase life of the flower.

Conclusion

On the basis of experiment, it is concluded that treatment (T_9) with 30x25cm+Fe (0.3%) is the best treatment regarding plant growth parameters (plant height and plant spread), flower parameters (stalk length and flower diameter) and yield parameters (number of cut flowers per plant and per hectare). The treatment with interaction effect of closer spacing and spray of Fe (30x25cm+Fe (0.3%) produced taller plants(it might be due to the apical dominance) and flower production was higher/unit area than wider spacing, it is observed that the increase in the closer spacing of 30x25 significantly higher yield than any other spacing's. Among all the treatment (T_9) with 30x25cm+Fe (0.3%) showed the best results followed by the treatment (T_1)with 30x30cm+Fe (0.3%) and (T_{12}) with 30x25cm+Mn (0.3%) in Allahabad climatic conditions. Treatment T_9 with 30x25 spacing and Fe (0.3%) foliar spray is recommended.

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