



Effect of different micronutrients on growth, flowering and yield of China aster (*Callistephus chinensis* L. Nees)

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ABSTRACT

An experiment was carried out at Horticulture Research Station, Mondouri, Faculty of Horticulture, Bidhan Chandra Krishi Viswavidyalaya, during October-February in two years 2021 and 2022. The objective of the experiment was to find the most suitable combination of micronutrients i.e. Zinc, Manganese, Boron, Iron with proper doses on growth and flower production of local (pink) variety of China aster (*Callistephus chinensis* L. Nees). The experiment was laid out in randomized block design (RBD) with nine treatments and three replications. These micronutrients were applied in combination as basal dose and foliar spray at 30, 45 and 60 DAT. The observation had been taken on different vegetative, flowering parameters of China aster plants. The data analysis was done by using appropriate statistical methods. Based on the entire experiment, it was determined that the best micronutrients for flower production of the China aster plant in this zone were ZnSO₄, MnSO₄, Boron, and FeSO₄ at 2.5 kg, 2.5 kg, 1 kg, and 1.25 kg per ha, respectively, along with foliar application of the aforementioned micronutrients at 0.2% each at 30, 45, and 60 DAT. It was observed that treatment of application of micronutrients in lower doses of soil application and higher doses of foliar application showed the best results and in control treatment showed the minimum results in growth, flowering and yield of China aster plant.

Key words: Flowering parameters, manganese, zinc, iron, boron, soil application, foliar application.

INTRODUCTION

China aster [*Callistephus chinensis* (L.) Nees] is an important commercial flower crop belongs to the family 'Asteraceae', also called 'Compositae' and native to China. There is only a single species *Callistephus chinensis* from asters have developed and the diploid (2n) chromosome number is 18. There is a wide range of flower colors like pink, pale yellow, white, rose, blue, red, violet, burgundy with two types of florets i.e. ray and disc florets. The farmers mainly cultivate local pink, violet and white varieties. This significant annual flower crop gives comparatively better income to the farmers in India and it is cultivated traditionally as loose and cut flowers. The commercial importance of China aster is increasing in India especially in Maharashtra, Karnataka, Andhra Pradesh, Tamil Nadu, West Bengal (Kumari *et al.*, 10). It is also used in different floral arrangements such as garlands, venis, flower vase, flower bouquet etc. (Khanna *et al.*, 9). After chrysanthemum and marigold its rank comes among traditional and annual flowers.

Nutrients play a crucial role for all round development of this crop (Chezhiyan *et al.*, 3). The deficiencies of different micronutrients affect growth and flowering behavior of China aster plants in the southern part of West Bengal. To overcome these problems and keeping all the essentialities of micronutrients in mind, the experiment was conducted to study the best micronutrient and their doses in China aster. A positive effect got from the foliar spray of iron with regard to growth and flowering behavior of China aster (Verma *et al.*, 19). In a previous study, the effect of foliar application of zinc and iron gave the maximum growth, flowering and overall yield of China aster (Aklade *et al.*, 1). The increased concentration of ZnSO₄ and CuSO₄ showed highest flower yield and highest net return in China aster (Tiwari *et al.*, 17). Higher growth, flowering and yield characters are found from the foliar application of Fe, Zn, Mn and B (Sarvanan, 16).

The present investigation was undertaken to evaluate the effect of different micronutrients, namely zinc, manganese, boron, and iron, applied through soil and foliar spray at varying doses and combinations, on the growth, flowering, and yield of the local (pink) variety of China aster. The study further aimed to identify the most suitable and economically viable combination and dose of these micronutrients for

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achieving enhanced flower production under the agro-climatic conditions of the experimental zone.

MATERIALS AND METHODS

The experiment was carried out in an open field condition at the Horticultural Research Station, Mondouri, (22°43' N, 88°34' E, elevation 9.75 m) under Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India during October-February, in two consecutive years 2021 and 2022. The soil conditions, including sand %, silt %, clay %, chemical composition, available nitrogen (kg/ha), available phosphorus (kg/ha), available potassium (kg/ha), organic carbon %, and pH, are defined in Table 1. The area of the whole field was 67.5 square meter and size of each plot was 2.5 m x 1 m (L x W). The total plot numbers for the experiment were twenty-seven. The seeds were first sown in a plot and then the seedlings of 5-6 cm were transplanted after 1

month at 4 mature leaf stage in the main field at 30 cm X 30 cm spacing. N, P and K at 180, 120, 60 kg/ha were applied to the plants as standard dose recommended by the university. The treatment details soil application (at planting) and foliar application are described in Table 2. Micronutrient uptake by plants was measured in laboratory through MDLs (method detection limits). The experiment was carried out in randomized block design (RBD) with nine treatments replicated thrice. Software OPSTAT was used for calculation and analysis of data and the graphs were plotted using Microsoft Excel.

RESULTS AND DISCUSSION

Information about the vegetative parameters are presented in Table 3. Among all the treatments, there is great variation in heights of the plants was observed during this experiment. The different concentration of micronutrients used in this experiment resulted in increased plant height over control (untreated) plant. Plant height variation was ranged from 39.80 cm to 64.20 cm. The plant height 64.20 cm as maximum was observed in T6 followed by T2. The height of the plant 39.80 cm was noted as minimum value in treatment T9 in comparison to other treatments (Fig.1). The growth of the plants gradually increased with the increased doses of micronutrients as soil application and lower concentration of those micronutrients. Similar variation in plant height was observed in gerbera (Sahu *et al.*, 15). Zinc that may have helped in protein synthesis and cell elongation and boron helped in cell division that helped in increase of plant height (Hadhili and Al-Jubouri 5). Iron and magnesium may have played crucial roles in plant growth and development, particularly in processes like enzymatic activities and overall metabolism. Kashyap and Tikey (8) observed similar benefits in gladiolus, highlighting the importance of

Table 1: Soil composition of the experimental field of China aster at Horticultural Research Station, Mondouri, West Bengal, India.

Physical composition of soil (Texture)	Value
Sand %	34.45
Silt %	35.54
Clay %	28.36
Chemical composition of soil	
Available nitrogen (kg/ha)	188.16
Available phosphorus (kg/ha)	16.70
Available potassium (kg/ha)	289.421
Organic carbon %	0.76
pH	6.6-6.7

Note: Soil physico-chemical parameters were analyzed following the standard analytical procedures described by Jackson (6).

Table 2: Treatment details soil application (at planting) and foliar application.

Treatment	Soil application (at planting)	Foliar application
T ₁	Zn (5 kg/ha) + Mn (5 kg/ha) + B (2 kg/ha) + Fe (2.5 kg/ha)	—
T ₂	Zn (2.5 kg/ha) + Mn (2.5 kg/ha) + B (1 kg/ha) + Fe (1.25 kg/ha)	—
T ₃	—	Zn + Mn + B + Fe (@ 0.2% each)
T ₄	—	Zn + Mn + B + Fe (@ 0.1% each)
T ₅	Zn (5 kg/ha) + Mn (5 kg/ha) + B (2 kg/ha) + Fe (2.5 kg/ha)	Zn + Mn + B + Fe (@ 0.2% each)
T ₆	Zn (5 kg/ha) + Mn (5 kg/ha) + B (2 kg/ha) + Fe (2.5 kg/ha)	Zn + Mn + B + Fe (@ 0.1% each)
T ₇	Zn (2.5 kg/ha) + Mn (2.5 kg/ha) + B (1 kg/ha) + Fe (1.25 kg/ha)	Zn + Mn + B + Fe (@ 0.2% each)
T ₈	Zn (2.5 kg/ha) + Mn (2.5 kg/ha) + B (1 kg/ha) + Fe (1.25 kg/ha)	Zn + Mn + B + Fe (@ 0.1% each)
T ₉	Control	—

Application schedule: Soil-applied micronutrients were incorporated as a basal dose at planting, whereas foliar sprays were applied at 30, 45, and 60 days after transplanting (DAT).

Table 3: Effect of micronutrients on vegetative growth of China aster plant.

Treatment	Plant height (cm)	Plant spread (cm)	No. of branches/plant	Shoot fresh weight (g/plant)	Shoot dry weight (g/plant)	Root fresh weight (g/plant)	Root dry weight (g/plant)	Plant dry matter (%) = (Shoot and root dry weight / Shoot and Root fresh weight) *100)
T1	55.20	48.00	8.00	149.93	50.51	22.52	11.33	37.83
T2	62.60	48.00	8.67	162.32	52.60	22.40	11.12	36.29
T3	48.40	45.00	10.00	140.43	47.21	22.64	11.33	38.61
T4	53.20	42.30	6.00	135.45	44.70	20.62	10.30	37.66
T5	58.20	47.30	10.33	153.70	51.33	22.92	11.64	37.68
T6	64.20	47.70	9.00	180.75	60.24	25.50	12.91	37.02
T7	61.10	51.70	10.67	210.61	71.72	27.32	13.72	36.41
T8	43.70	32.00	8.33	148.63	49.72	16.81	9.34	35.26
T9	39.8	29.3	4.67	136.35	45.52	19.71	10.92	37.78
SE.m (±)	0.79	1.13	0.603	4.36	4.381	2.476	1.539	3.421
C.D. at 5%	2.36	3.36	1.825	13.184	13.246	N/A	N/A	N/A
C.V.	2.54	4.56	12.433	4.793	14.42	19.257	23.381	16.591

these micronutrients in enhancing plant health and growth.

It is evident from the Table 3, as different micronutrient concentrations were applied, the plant spread significantly varied in terms of North-South direction and East- West direction. Highest plant spread 57.7 cm was observed in T7. Whereas minimum plant spread 29.30 cm was observed in T9 over the other treatments (Fig. 1). Both maximum plant-spread as north and south direction and maximum number of branches per plant were gotten from decreased doses of soil application and higher concentration of foliar application of these four micronutrients (Zn, B, Mn, Fe) combination. These micronutrients may have enhanced physiological processes like carbohydrate metabolism, protein biosynthesis, nutrient transport, root and shoot development and ultimately contributed to plant's ability to spread and lead to increase the plant branch numbers. Similar

findings were observed with micronutrients doses on chrysanthemum cv. Mayur (Vanlalruati *et al.*, 18) and in China aster (Prasad and Bahadur 13).

The number of branches per plant exhibited a significant change as a result of the administration of various micronutrient concentrations (Table 3). The highest number of branches per plant (10.67) was observed in treatment T7, followed by treatment T5, indicating that these treatments were most effective in promoting branch initiation and development. In contrast, the minimum number of branches per plant (4.67) was recorded in treatment T9 (Fig. 1). These results suggest that the application of micronutrients, particularly in the case of T7, positively influenced the vegetative growth of China aster by enhancing branching capacity. The local varieties of China aster exhibited a significant effect on shoot fresh weight due to the application of different doses of micronutrients. The maximum shoot fresh weight (210.6 g) was recorded with treatment T7, demonstrating the superior efficacy of this treatment in promoting shoot biomass accumulation. On the other hand, the minimum shoot fresh weight (135.4 g) was recorded in treatment T4 (Fig. 2). These findings indicate that the differential application of micronutrients played a crucial role in determining the fresh weight of shoots in China aster. It is evident from Table 3 that treatment T7 enabled the local varieties of China aster plants to obtain the maximum shoot dry weight (71.7 g) (Fig. 2). In contrast, very poor performance was recorded in treatment T4 compared to the other treatments. Furthermore, shoot weight increased with

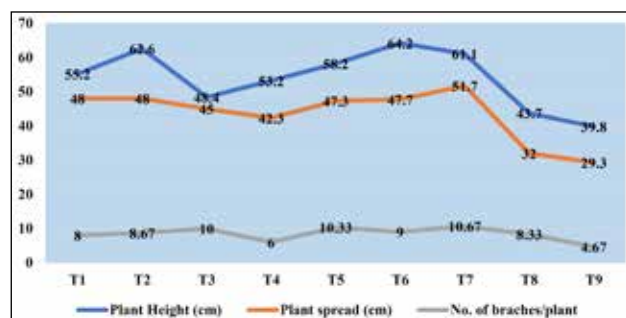


Fig. 1. Effect of different micronutrients on plant height, plant spread and number of branches/plant.

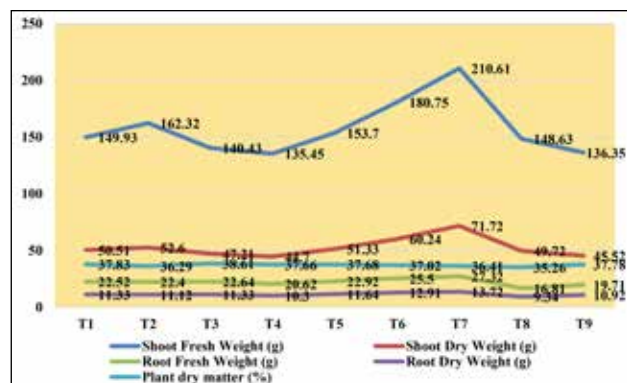


Fig. 2. Effect of different micronutrients on shoot fresh weight, shoot dry weight, root fresh weight, root dry weight and plant dry matter content.

the application of both soil and foliar spray rather than foliar spray alone (Fig. 2). This suggests that the combined application method was more effective in enhancing shoot dry matter accumulation than a single application method. It is evident from Table 3 that treatment T7 also dominated in root production of China aster. Among the treatments, this treatment was found to be the best in root production (27.3 g/plant), followed by treatment T6 (25.5 g/plant), surpassing all other treatments. The minimum root fresh weight (16.8 g) was recorded in treatment T8 (Fig. 2). These results clearly demonstrate that treatment T7 consistently promoted root growth and development, contributing to overall plant vigor.

It is evident from Table 3 that a similar trend was noticed for the improvement of root production in terms of dry weight. Treatment T7 showed the highest value (13.7 g/plant), followed by treatment T6, over all other treatments. The minimum root dry weight (9.3 g) was recorded in treatment T8 (Fig. 2). This consistent pattern further reinforces the effectiveness of treatment T7 in enhancing root biomass accumulation in China aster. In the case of the dry matter production percentage of China aster, it was observed that the highest dry matter production (38.61%) was noted in treatment T3 (Table 3). The minimum dry matter production (35.26%) was recorded in treatment T8 (Fig. 2). These results indicate that while treatment T7 excelled in most growth parameters, treatment T3 was superior in terms of overall dry matter percentage, suggesting that different micronutrient combinations may influence different aspects of plant growth and development.

Shoot fresh and dry weight, root fresh and dry weight as well as plant dry matter production percentage increased with lower doses of soil

Table 3: Effect of different micronutrients on flowering behavior and yield of China aster.

Treatment	Days to first flower bud emergence	Days taken for 50% flowering	No. of flowers/plant	Flower yield per plant (g)
T1	50.30	87.30	23.0	125.40
T2	49.30	80.70	26.0	158.50
T3	47.00	76.70	20.0	105.10
T4	48.00	77.30	12.0	68.70
T5	47.00	91.70	31.0	163.20
T6	53.00	91.00	27.0	166.70
T7	45.00	88.00	33.0	216.00
T8	53.30	86.70	16.70	85.70
T9	51.00	83.30	18.30	93.70
SE.m (±)	1.45	1.40	1.42	8.07
C.D. at 5%	4.56	4.46	4.21	23.96
C.V.	5.39	2.87	10.67	10.57

application and higher concentration of foliar application along with higher concentration of foliar application of these micronutrients. Yadegari (20) found similar result in marigold. These outcomes were confirmed with the reports of Ranjan *et al.* (14) in wheat and Derakhshani *et al.* (4) in chrysanthemum. These micronutrients play important role to strengthen the plant cell walls and facilitate the translocation of carbohydrates from leaves to other parts of the plant, lead to an increase in dry matter percentage and overall yield, enhancing plant growth and productivity (Pramanik *et al.*, 12). Additionally, adequate zinc levels are vital for optimal photosynthetic activity, which is essential for energy production and biomass accumulation in plants (Jayakumar *et al.*, 7).

Data on flowering characters are presented in Table 3. The application of different doses of micronutrients significantly influenced the number of days to first flower bud emergence in local varieties of China aster. The lowest number of days to first flower bud emergence (45 days) was recorded in treatment T7. This was followed by treatments T3 and T5, which also showed relatively early bud emergence. In contrast, the maximum number of days to first flower bud emergence (53.3 days) was observed in treatment T8 (Fig. 3). With respect to the number of days taken to 50% flowering, the minimum duration (76.7 days) was recorded in treatment T3. This was closely followed by treatment T4, indicating a comparable flowering response. However, the maximum duration to 50% flowering (91.7 days)

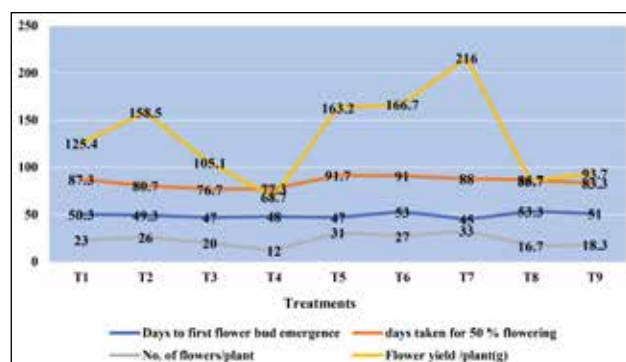


Fig. 3. Effects of different micronutrients on days to first flower bud emergence, days taken for 50 % flowering, number of flowers/plant and flower yield.

was observed in treatment T5. The direct action of nutrients contributed to early flowering in plants under treatment T7 (Fig. 3). Regarding the number

of flowers per plant, the administration of various micronutrient doses resulted in substantial variation among the treatments. The highest number of flowers per plant (33) was recorded in treatment T7. This was followed by treatment T5, which also produced a relatively high number of flowers. Conversely, the minimum number of flowers per branch (12) was observed in treatment T4 (Fig. 3). Furthermore, the local varieties of China aster exhibited significant effects of different micronutrient doses on flower yield per plant (kg). The maximum flower yield (216 g) was obtained with treatment T7. In comparison, the minimum flower yield (68.7 g) was recorded in treatment T4 (Fig. 3). The visual results of micro nutrient spray collectively demonstrate that the treatment T7, enhanced flowering and yield parameters in local varieties of China aster (Fig. 4). Treatments that involved higher doses of nutrient supply through foliar application, combined with lower



Fig. 4. Effects of micronutrients spray on flower quality and yield of China aster.

doses of micronutrients applied to the soil, resulted greater number of flowers per plant and flower yield per plant. This is may be due to the individual effect of each micronutrient that improved flower production in China aster. Zinc and iron played an important role in flower production and ultimately flower yield. Increased concentrations of micronutrients and their synergistic effects contributed to the production of a higher number of flowers per plant. This process enhanced overall flowering and improved flower yield (Annasamy and Karuppapiah 2). As noted in the findings by Poornima *et al.* (11) in rose, iron application plays a critical role in improving flowering parameters.

Based on the findings of the present investigation, it can be concluded that the application of micronutrients, namely ZnSO₄, MnSO₄, boron, and FeSO₄ at 2.5 kg, 2.5 kg, 1 kg, and 1.25 kg per hectare, respectively, as a basal soil application, combined with foliar spraying of the same micronutrients at 0.2% each at 30, 45, and 60 days after transplanting (DAT), proved to be the most effective treatment for enhancing the growth and flower production of the local pink variety of China aster under the agro-climatic conditions of the experimental zone. Therefore, this treatment combination may be recommended for commercial cultivation of China aster in this region to achieve improved growth, flowering, and yield.

AUTHOR'S CONTRIBUTION

Investigation, Writing – Original Draft (SM). Conceptualization, Supervision (TM). Methodology, Supervision (TKC). Data Curation (TR). Formal Analysis (MS). Validation (PN, KT). Resources (MA). Review & Editing (BM).

DECLARATION

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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