International Journal of Plant & Soil Science

Volume 35, Issue 18, Page 135-140, 2023; Article no.IJPSS.102888
ISSN: 2320-7035

Effect of Foliar Spray of Micronutrients on Growth, Yield and Quality of China Aster

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2023/v35i183276

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/102888

Original Research Article

Received: 22/05/2023
Accepted: 08/07/2023
Published: 15/07/2023

ABSTRACT

A field experiment was carried out to study the efficacy of foliar spray of micronutrients on growth, flowering parameter, yield, and quality of China aster during October 2022 to March 2023 at Floriculture Research Field, Department of Horticulture, Sam Higginbottom University of Agriculture Technology & Sciences, Prayagraj (U.P.). The experiment was designed with eleven treatment combinations, including $ZnSO_4$, $FeSO_4$, $CuSO_4$, and $MgSO_4$, along with their interaction effects at concentrations of 0.2% and 0.4% using the foliar spraying method, alongside a control group. The experimental results revealed that the treatment T_{11} ($ZnSO_4$ @0.4% + $FeSO_4$ @0.4% + $CuSO_4$ @0.4% + $MgSO_4$ @0.4%) found best in terms of growth, yield and quality parameters of China aster, followed by treatment T_{10} ($ZnSO_4$ @0.2% + $FeSO_4$ @0.2% + $CuSO_4$ @0.2% + $MgSO_4$

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@0.2%). Whereas treatment T_5 ($FeSO_4$ @0.4%) found the best results in terms of days to first flower bud initiation, days from flower bud initiation to anthesis, and days to 50% flowering. In terms of the economics of the different treatments, the maximum gross return, net return, and benefit-cost ratio were found in T_{11}, followed by T_{10}, while the minimum was recorded in treatment T_1 (Control).

Keywords: China aster; $ZnSO_4$; $FeSO_4$; $CuSO_4$; $MgSO_4$.

1. INTRODUCTION

The flower industry in India holds a prominent position in terms of both production and consumption. Among the various flowering plants cultivated worldwide, China aster (*Callistephus chinensis L.*) stands out as a highly desired annual plant that is grown throughout the year. Belonging to the Asteraceae family, China aster is a diploid crop with a chromosome number of 2n = 18. The genus *Callistephus* derives its name from two Greek words, *Kalistos* meaning "most beautiful" and *Stephus* meaning "a crown," referring to the flower head.

It is commercial cultivated across different countries, including India, France, Germany, Netherlands, the United Kingdom, Siberia, Russia, North America, Japan, Europe, and Switzerland. In India specifically, it thrives in regions such as Karnataka, Tamil Nadu, West Bengal, and Maharashtra. Recent reports reveal that during 2021-2022, flower production in India covered approximately 276 thousand hectares, resulting in a total output of around 2,936 thousand metric tons.

China aster is a robust and prolific annual plant cultivated for its loose flowers, cut flowers, and even as a dried flower. In India, it holds great significance as a traditional flower, finding extensive use in religious ceremonies, garland and bouquet preparations, as well as in flower shows and exhibitions. Its versatility extends to being grown as a potted plant, and its compact varieties are ideal for borders.

While China aster is treasured for its beauty and cultural importance, micronutrients enhance its resilience and play vital roles in plant physiology—activating enzymes, aiding photosynthesis, and facilitating nutrient uptake. Tayade et al. [1] found that foliar application of 0.4% zinc and 0.4% iron increased the number of spikes in gladiolus. Similarly, Joseph et al. [2] recorded that micronutrient treatments improved the growth, flower production, and quality of China aster.

2. MATERIALS AND METHODS

The experiment was conducted in a Randomized Block Design with 11 treatments, each replicated three times at the Floriculture Research Field, Department of Horticulture, Sam Higginbottom University of Agricultural, Technology and Sciences, Prayagraj, from October 2022 to March 2023. Total number of treatments were viz. (T_1) Control, (T_2) $ZnSO_4$ @0.2%, (T_3) $ZnSO_4$ @0.4%, (T_4) $FeSO_4$ @0.2%, (T_5) $FeSO_4$ @0.4%, (T_6) $CuSO_4$ @0.2%, (T_7) $CuSO_4$ @0.4% (T_8) $MgSO_4$ @0.2% (T_9) $MgSO_4$ @0.4%, ($T1_0$) $ZnSO_4$ @0.2% + $FeSO_4$ @0.2% + $CuSO_4$ @0.2% + $MgSO_4$ @0.2% (27.33), (T_{11}) $ZnSO_4$ @0.4% + $FeSO_4$ @0.4% + $CuSO_4$ @0.4% + $MgSO_4$ @0.4%. The planting materials for the experiment, which consisted of China aster genotypes, were obtained from IIHR, Bengaluru (Arka Archana).

Prior to planting, meticulous preparation was undertaken in the experimental field. This involved thorough ploughing to ensure a fine tilth and the removal of weeds, stubbles, and stones. To enhance soil fertility, well-decomposed Farm Yard Manure (FYM) was uniformly mixed at a rate of 10 t ha-1. The application of balanced NPK fertilizers at a ratio of 180:60:60 kg ha-1 further optimized nutrient levels. Planting was carried out with a spacing of 30x30cm between plants, followed by regular irrigation and timely weeding. For the micronutrient treatments, stock solutions of Zinc sulphate, Ferrous sulphate, Copper sulphate, and Magnesium sulphate were prepared and applied through foliar spraying at specific intervals. The entire process adhered to the principles of 'Analysis of variance' as described by Panse and Sukhatme [3].

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

The maximum vegetative growth in China aster, with respect to plant height, plant spread,

Table 1. Effect of micronutrients on plant height (cm), plant spread (cm), number of leaves per plant and number of branches per plant of China aster

Treatment Symbol	Treatment Combinations	Plant height (cm)			Plant spread (cm)			Number of leaves per plant			Number of branches per plant	
		30DAT	60DAT	90DAT	30DAT	60DAT	90DAT	30DAT	60DAT	90DAT	60DAT	90DAT
T_1	Control	6.56	13.50	29.22	6.67	13.19	29.06	6.67	29.11	62.11	1.67	7.78
T_2	$ZnSO_4$@0.2%	7.50	15.11	32.00	7.89	15.75	31.00	7.67	30.11	65.67	2.33	10.00
T_3	$ZnSO_4$@0.4%	7.50	15.63	29.00	7.89	15.94	30.67	7.78	30.11	71.89	3.22	8.11
T_4	$FeSO_4$@0.2%	6.61	14.94	34.44	9.19	15.89	31.22	8.33	32.89	65.11	2.78	10.33
T_5	$FeSO_4$@0.4%	7.02	15.24	31.11	8.42	14.68	29.61	8.22	29.44	69.67	3.11	8.78
T_6	$CuSO_4$@0.2%	6.63	14.50	32.00	7.44	16.56	31.17	7.89	30.33	78.00	1.89	9.89
T_7	$CuSO_4$@0.4%	7.00	16.41	32.67	8.81	15.26	31.39	8.33	28.33	72.00	2.89	8.67
T_8	$MgSO_4$@0.2%	7.17	15.11	34.78	9.22	15.36	30.44	7.78	29.33	74.11	2.56	9.33
T_9	$MgSO_4$@0.4%	6.78	15.50	36.00	9.25	16.11	30.67	7.89	30.44	78.89	1.89	8.67
T_{10}	$ZnSO_4$@0.2%+ $FeSO_4$@0.2%+ $CuSO_4$@0.2%+ $MgSO_4$@0.2%	7.52	17.98	36.33	9.44	16.89	32.33	9.56	31.89	82.44	3.44	10.56
T_{11}	$ZnSO_4$@0.4%+ $FeSO_4$@0.4%+ $CuSO_4$@0.4%+ $MgSO_4$@0.4%	8.11	18.83	38.44	10.00	17.54	33.50	10.00	35.89	91.00	4.56	10.89
	F-test	S	S	S	S	S	S	S	S	S	S	S
	S. Em.	0.27	0.98	1.45	0.59	0.75	0.77	0.27	1.23	3.86	0.35	0.67
	CD at 5%	0.80	2.89	4.28	1.74	2.20	2.28	0.81	3.64	11.42	1.03	1.98

Table 2. Effect of micronutrients on days to first flower bud initiation, days from flower bud initiation to anthesis, days to 50% flowering, flowering duration, number of flowers per plant, flower yield per plant (g), flower yield per hectare (t/ha), weight of flower, diameter of flower, shelf life and benefit cost ratio of China aster

Treatment Symbol	Treatment Combinations	Days to first flower bud initiation	Days from flower bud initiation to anthesis	Days to 50% flowering	Flowering duration	Number of flowers per plant	Flower yield per plant (g)	Flower yield per hectare (t/ha)	Weight of flower	Diameter of flower	Shelf life	Benefit cost ratio
T_1	Control	68.44	12.67	91.22	25.33	21.44	74.88	7.49	3.99	5.07	1.22	2.46
T_2	$ZnSO_4$@0.2%	64.78	10.22	86.89	30.67	26.78	108.05	10.80	4.04	6.03	1.67	3.33
T_3	$ZnSO_4$@0.4%	66.56	10.44	88.33	29.33	26.78	133.27	13.32	5.03	6.72	2.00	3.87
T_4	$FeSO_4$@0.2%	59.78	9.67	83.89	41.78	23.11	94.92	9.45	4.17	7.09	2.22	2.83
T_5	$FeSO_4$@0.4%	58.00	8.89	82.22	42.33	22.67	103.04	10.30	4.60	5.84	1.67	2.83
T_6	$CuSO_4$@0.2%	62.56	10.89	84.67	35.56	24.33	111.59	11.15	4.60	6.36	1.89	3.33
T_7	$CuSO_4$@0.4%	63.78	11.33	86.78	32.22	24.78	114.45	11.34	4.88	6.00	1.44	3.11
T_8	$MgSO_4$@0.2%	64.67	10.78	85.89	27.78	23.00	117.38	11.73	5.21	6.89	2.44	3.7
T_9	$MgSO_4$@0.4%	66.11	12.11	84.89	36.56	24.11	118.86	11.88	4.88	6.34	1.89	3.6
T_{10}	$ZnSO_4$@0.2% + $FeSO_4$@0.2% + $CuSO_4$@0.2% + $MgSO_4$@0.2%	62.56	9.78	84.78	35.00	27.33	154.79	15.47	5.86	7.16	2.78	3.9
T_{11}	$ZnSO_4$@0.4% + $FeSO_4$@0.4% + $CuSO_4$@0.4% + $MgSO_4$@0.4%	62.33	10.11	85.11	41.11	32.33	198.19	19.82	6.14	7.50	3.44	4.04
	F-test	S	S	S	S	1.37	9.45	0.94	0.34	0.12	0.30	
	S. Em.	1.93	0.70	0.88	1.14	4.05	27.87	2.79	1.02	0.37	0.88	
	CD at 5%	5.71	2.08	2.61	3.37	3.64	11.42	1.74	2.2	2.28	1.03	

number of leaves per plant, and number of branches per plant, was recorded with the treatment (T_{11}) $ZnSO_4$ @0.4% + $FeSO_4$ @0.4% + $CuSO_4$ @0.4% + $MgSO_4$ @0.4%, whereas the minimum growth was recorded in treatment (T_1) Control. Increase in growth parameters due to combination of micronutrients indicates the synergistic effect of all the micronutrient viz. $ZnSO_4$, $FeSO_4$, $CuSO_4$ and $MgSO_4$ which plays a major role in stimulating the physiological activities. Zinc plays a vital role in synthesis of tryptophan and thus auxins which stimulates the growth causing internode elongation. While iron, copper and magnesium are involved in the biosynthesis of chlorophyll, catalytic function, enzymatic activities and other metabolic processes which helps in enhancing growth of the plants. Similar results were observed in Kashyap and Tikey (2021) in gladiolus and Verma et al. [4] in China aster.

3.2 Flowering Parameters

The treatment (T_5) $FeSO_4$ @0.4% took significantly minimum period for first flower bud initiation (58.00 days), days from flower bud initiation to anthesis (8.89 days) and days to 50 percent flowering (82.22 days). Among the different treatments studied, Ferrous sulphate was the earliest in respect to first flower bud initiation, days from flower bud initiation to anthesis and days to 50 percent flowering in China aster. This might be due to reduction of juvenile period, the shoot apical meristem instead of producing leaves and branches starts producing buds. Similarly, these findings align with the results of Kumar *et al*. (2010) in marigold and Likith E. K. (2018) in China aster. Whereas, the treatment (T_{11}) $ZnSO_4$ @0.4% + $FeSO_4$ @0.4% + $CuSO_4$ @0.4% + $MgSO_4$ @0.4% recorded maximum flower duration (42.33 days). This might be due to an increased production of flowering shoots. These results are in close agreement with the findings of Kakade *et al*. [5] in China aster, Chopde *et al*. [6] in gladiolus.

3.3 Yield Parameters

The maximum yield in China aster in respect of number of flowers per plant, flower yield per plant and flower yield per hectare were recorded with the treatment (T_{11}) $ZnSO_4$ @0.4% + $FeSO_4$ @0.4% + $CuSO_4$ @0.4% + $MgSO_4$ @0.4% whereas, minimum was recorded in treatment (T_1) Control. The increase in flower yield might be due to the enhanced vegetative traits, such as plant height, plant spread, number of branches which helps in production of more photosynthesis resulting in greater accumulation of carbohydrates which in turn directly or indirectly lead to the production of more number of flowers per plant. Similar results were also obtained by Poornima *et al*. [7] in rose.

3.4 Quality Parameters

The maximum quality attributes in China aster in respect of the weight of the flower, the diameter of the flower, and shelf life were recorded with the treatment (T_{11}) $ZnSO_4$ @0.4% + $FeSO_4$ @0.4% + $CuSO_4$ @0.4% + $MgSO_4$ @0.4% whereas, minimum was recorded in treatment (T_1) Control. Improvement in flower quality might be attributed to the fact that the application of the combined dose of micronutrients might have promoted the synthesis of plant hormones and increased the quality of flowers. These findings are in line with the observations of earlier works viz. Fahad et al. [8] and Naik et al. [9] in gladiolus.

3.5 Economics of Cultivation

In terms of Economics, maximum Gross Return (Rs. 594600), Net Return (Rs. 447764) and Benefit cost Ratio (1:4.04) from China aster flowers were recorded with the treatment (T_{11}) $ZnSO_4$ @0.4% + $FeSO_4$ @0.4% + $CuSO_4$ @0.4% + $MgSO_4$ @0.4% whereas, minimum was recorded in treatment (T_1) Control [10-12].

4. CONCLUSION

Based on the present investigation it is concluded that the treatment (T_{11}) $ZnSO_4$ @0.4% + $FeSO_4$ @0.4% + $CuSO_4$ @0.4% + $MgSO_4$ @0.4% was found best in terms of plant height, plant spread, number of leaves per plant, flowering duration, weight of flower, diameter of flower, shelf life and benefit-cost ratio, whereas T_5 ($FeSO_4$ @0.4%) found best in days to first flower bud initiation, days from flower bud initiation to anthesis and days to 50% flowering.

ACKNOWLEDGEMENT

I would like to express my deepest gratitude to my supervisor, Prof. (Dr.) V. M. Prasad, Professor, Department of Horticulture, SHUATS, Prayagraj, for his conscientious guidance and unwavering support throughout this research. Without his expert mentorship and constructive criticism, this study would not have been possible.

Additionally, I gratefully acknowledge the invaluable contributions of Dr. Vijay Bahadur, Associate Professor and Head of Department of Horticulture, Naini Agricultural Institute, SHUATS, Prayagraj. His insightful suggestions, excellent guidance, and counsel have played a pivotal role in shaping this research.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/102888