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EFFECT OF MICRONUTRIENTS ON GROWTH AND FLOWERING OF ANNUAL CHRYSANTHEMUM (*GLEBIONIS CORONARIA* L.)

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ABSTRACT

Annual chrysanthemum (*Glebionis coronaria* L.) is an important loose flower crop valued for its attractive blooms and extensive use in garlands, floral decorations and religious ceremonies. Adequate micronutrient nutrition plays a crucial role in improving vegetative growth and flowering through its influence on various physiological and biochemical processes. The present investigation was conducted during the *Rabi* season of 2025-2026 at the Post Graduate Institute for Horticultural Sciences, Sri Konda Laxman Telangana Horticultural University, Telangana, India, to evaluate the effect of soil and foliar application of zinc, boron and iron on the growth and flowering of annual chrysanthemum. The experiment was laid out in a Randomized Block Design comprising nine treatments replicated thrice. The combined soil application of ZnSO₄ (5 kg/ha), Borax (2 kg/ha) and FeSO₄ (2.5 kg/ha) along with foliar application of Zn-EDTA (0.5%), Borax (0.2%) and Fe-EDTA (0.5%) (T₆) recorded significantly superior growth and flowering parameters. The treatment produced the maximum plant height (65.13 cm), plant spread (59.83 cm E-W and 56.97 cm N-S), number of branches (39.37), stem diameter (2.21 cm), chlorophyll content (45.67 SPAD), flowering duration (57.28 days), number of flowers per plant (145.03), single flower weight (6.47 g) and 100 flower weight (764.00 g). It also recorded the earliest flower bud initiation (37.67 days), 50 per cent flowering (62.97 days) and minimum duration from bud initiation to full bloom (12.77 days). The superior performance was attributed to the synergistic effects of zinc, boron and iron on chlorophyll synthesis, enzyme activation, photosynthesis and assimilate translocation. Hence, combined soil and foliar application of these micronutrients can be recommended for improving growth and flowering of annual chrysanthemum under Telangana conditions.

Key words: Annual chrysanthemum, micronutrients, zinc, boron, iron.

Introduction

Annual chrysanthemum scientifically known as *Glebionis coronaria* L. (formerly *Chrysanthemum coronarium*) is one of the most important flower crops grown in India, though it is originated in South Europe. It belongs to the family Asteraceae. It is also known as

‘Crown Daisy’ or ‘Garland chrysanthemum’. The crop is relatively shorter in duration, photo-insensitive and flowering is observed entire year in moderate climatic conditions (Teja *et al.*, 2017). The annual chrysanthemum is popular among the people due to its variation in size, shape and colour of flowers. These flowers have a

constant demand during the days of festivals, functions, in the place of worshipping and decoration throughout the year. It is branching annual with finely cut foliage reaching a height up to a metre, size of flowers varies from 2.5 to 4 cm and colour is usually in shades of yellow and white with cream zone at the centre (Nagdeve *et al.*, 2021).

Balanced plant nutrition is one of the key factors governing growth, flowering and flower quality in ornamental crops. Although macronutrients are required in larger quantities, micronutrients are equally essential because they regulate several physiological and biochemical processes involved in plant growth and development (Ganesh *et al.*, 2013). Among micronutrients, zinc (Zn), boron (B) and iron (Fe) play indispensable roles in maintaining normal plant metabolism. Zinc is involved in auxin synthesis, enzyme activation and protein metabolism, iron is essential for chlorophyll biosynthesis and photosynthetic electron transport, while boron is responsible for cell division, cell wall development, pollen viability and carbohydrate translocation. Deficiency of these nutrients adversely affects vegetative growth, flowering behaviour and flower quality, thereby reducing flower yield and quality (Hansch and Mendel, 2009).

The combined application of micronutrients through soil and foliar methods ensures continuous nutrient availability during critical stages of crop growth. Soil application improves nutrient reserves in the root zone, whereas foliar application provides rapid nutrient absorption and immediate correction of deficiencies. Several researchers have reported beneficial effects of zinc, boron and iron on growth and flowering in chrysanthemum, marigold, gaillardia and other ornamental crops. However, information regarding the combined soil and foliar application of these micronutrients in annual chrysanthemum under Telangana conditions is still limited.

Therefore, the present investigation was undertaken to evaluate the effect of different methods of zinc, boron and iron application on the growth and flowering of annual chrysanthemum and to identify the most effective micronutrient treatment for improving vegetative growth and flowering attributes.

Materials and Methods

The present investigation entitled “Effect of micronutrients on growth and flowering of annual chrysanthemum (*Glebionis coronaria* L.)” was conducted during the *Rabi* season (2025-2026) at the Post Graduate Institute for Horticultural Sciences, Sri Konda Laxman Telangana Horticultural University, Mulugu, Siddipet district, Telangana, India. Healthy and

uniform seedlings of annual chrysanthemum were transplanted at a spacing of 60 × 45 cm. The experiment was laid out in a Randomized Block Design (RBD) with nine treatments and three replications.

Micronutrients were applied through soil at 30 days after transplanting (DAT), while foliar sprays were imposed at 45 DAT. All the recommended cultural practices were followed uniformly throughout the experimental period. Observations on growth parameters, namely plant height, plant spread (East-West and North-South), number of branches per plant, stem diameter and chlorophyll content (SPAD), were recorded at 45 and 60 DAT. Flowering observations included days to flower bud initiation, days to 50 per cent flowering, days from bud initiation to full bloom, duration of flowering, number of flowers per plant, single flower weight and 100 flower weight. Data were subjected to Analysis of Variance (ANOVA) as described by (Panse and Sukhatme, 1985).

Results and Discussion

Growth parameters

Plant height (cm):

Plant height was significantly influenced by different micronutrient treatments. Among the treatments, T₆ [soil application of ZnSO₄ (5 kg ha⁻¹) + Borax (2 kg ha⁻¹) + FeSO₄ (2.5 kg ha⁻¹) along with foliar application of Zn-EDTA (0.5%) + Borax (0.2%) + Fe-EDTA (0.5%)] recorded the maximum plant height (65.13 cm at 60 DAT), which was statistically at par with T₈ (63.10 cm) and T₅ (60.60 cm). The minimum plant height (50.70 cm) was recorded in the control (T₀). Similar findings were reported by Dhyani *et al.*, (2024) in chrysanthemum and Patel *et al.*, (2025) in marigold.

The increased plant height under T₆ may be attributed to the synergistic effect of zinc, boron and iron. Zinc promotes auxin synthesis and cell elongation, iron enhances chlorophyll synthesis and photosynthesis, while boron improves cell division and carbohydrate translocation. These combined effects enhanced assimilate production and utilization, resulting in greater vegetative growth (Naik *et al.*, 2008; Misra, 2001; Yadav *et al.*, 2002).

Plant spread (cm) (East-West):

Significant differences in plant spread (E-W) were observed among the treatments. The maximum plant spread (59.83 cm) was recorded in T₆, which was statistically at par with T₈ (57.43 cm) and T₅ (55.90 cm), whereas the minimum plant spread (46.03 cm) was observed in T₀. These findings are in agreement with those of Thakur *et al.*, (2022), Dhyani *et al.*, (2024) in chrysanthemum and Patel *et al.*, (2025) in marigold.

Table 1: Treatment details.

Tr. No.	Treatment details
T ₁	Soil application - ZnSO ₄ (2.5kg/ha) + Borax (1kg/ha) + FeSO ₄ (1.25kg/ha)
T ₂	Soil application - ZnSO ₄ (5kg/ha) + Borax (2kg/ha) + FeSO ₄ (2.5kg/ha)
T ₃	Foliar application - Zn-EDTA (0.5%) + Borax (0.2%) + Fe-EDTA (0.5%)
T ₄	Foliar application - Formula 6 (0.5%)
T ₅	Soil application - ZnSO ₄ (2.5kg/ha) + Borax (1kg/ha) + FeSO ₄ (1.25kg/ha) + Foliar application - Zn-EDTA (0.5%) + Borax (0.2%) + Fe-EDTA (0.5%)
T ₆	Soil application - ZnSO ₄ (5kg/ha) + Borax (2kg/ha) + FeSO ₄ (2.5kg/ha) + Foliar application - Zn-EDTA (0.5%) + Borax (0.2%) + Fe-EDTA (0.5%)
T ₇	Soil application - ZnSO ₄ (2.5kg/ha) + Borax (1kg/ha) + FeSO ₄ (1.25kg/ha) + Foliar application - Formula 6 (0.5%)
T ₈	Soil application - ZnSO ₄ (5kg/ha) + Borax (2kg/ha) + FeSO ₄ (2.5kg/ha) + Foliar application - Formula 6 (0.5%)
T ₉	Control (water)

Plant spread (cm) (North-South):

The maximum plant spread in the north-south direction (56.97 cm) was recorded in T₆, followed by T₈ (54.97 cm), while the control (T₉) recorded the lowest value (43.90 cm). Similar observations were reported by Thakur *et al.*, (2022) and Dhyani *et al.*, (2024) in chrysanthemum.

Number of branches per plant:

The number of branches per plant differed significantly among the treatments. T₆ produced the highest number of branches (39.37), followed by T₈ (34.00), whereas the control recorded the lowest number (21.10). These findings corroborate the reports of Thakur *et al.*, (2022), Dhyani *et al.*, (2024) in chrysanthemum and Patel *et al.*, (2025) in marigold.

Stem diameter (cm):

Stem diameter was significantly influenced by micronutrient application. The highest stem diameter (2.21 cm) was recorded in T₆, which remained statistically comparable with T₈ (2.11 cm). The lowest stem diameter (1.76 cm) was observed in the control (T₉). Similar results were reported by Bhute *et al.*, (2017) in annual chrysanthemum and Annasamy and Karuppapiah (2023) in chrysanthemum.

The improvement in vegetative growth under combined soil and foliar application of micronutrients may

be attributed to enhanced auxin synthesis, chlorophyll formation, photosynthesis and carbohydrate translocation, which promoted cell division, assimilate production and stem thickening, thereby improving overall plant growth (Naik *et al.*, 2008; Misra, 2001; Yadav *et al.*, 2002).

Chlorophyll content (SPAD):

Chlorophyll content differed significantly among the treatments. T₆ recorded the highest chlorophyll content (45.67 SPAD), which was statistically at par with T₈ (44.40 SPAD), while the lowest value (32.03 SPAD) was observed in the control (T₉). Similar findings have been reported by Mudassir *et al.*, (2021) in tuberose, Swetha *et al.*, (2022) in gaillardia and Pal *et al.*, (2024) in china aster.

The increased chlorophyll content may be attributed to the combined application of zinc, boron and iron, which enhanced chlorophyll biosynthesis, photosynthetic efficiency and nutrient utilization. Iron promoted chlorophyll formation, zinc activated enzymes involved in chlorophyll synthesis and protein metabolism, while boron facilitated nutrient movement and carbohydrate translocation, resulting in higher chlorophyll content (Hansch and Mendel, 2009).

Flowering parameters**Days taken for flower bud initiation:**

The number of days taken for flower bud initiation was significantly influenced by different micronutrient treatments. Among the treatments, T₆ recorded the earliest flower bud initiation (37.67 days), which was statistically at par with T₈ (38.17 days) and T₅ (38.77

**Fig. 1:** Effect of T₆ on single and 100 flower weight compared with the control.

Table 2: Effect of micronutrients on growth and flowering parameters of annual chrysanthemum.

Treatment	PH	PS		NB	SD	CC	DTI	DTF	DIB	DF	NFP	WSF	WF
		E-W	N-S										
T ₁	53.33	51.33	47.20	26.40	1.81	33.40	44.13	70.43	18.30	47.64	118.62	4.17	466.60
T ₂	55.30	52.90	48.67	30.00	1.92	36.27	43.40	69.24	17.47	48.74	121.17	4.97	529.47
T ₃	56.40	46.30	50.80	30.27	1.92	39.07	42.60	68.47	16.93	50.36	125.63	5.10	651.00
T ₄	57.17	53.30	51.03	31.03	1.97	40.97	40.33	67.07	16.43	51.10	134.41	5.17	658.00
T ₅	60.60	55.90	53.87	32.50	2.03	43.93	38.77	66.30	14.47	54.08	142.10	5.40	711.67
T ₆	65.13	59.83	56.97	39.37	2.21	45.67	37.67	62.97	12.77	57.28	145.03	6.47	764.00
T ₇	58.90	54.50	52.60	32.40	2.00	41.43	39.87	66.80	16.43	53.65	137.47	5.27	702.33
T ₈	63.10	57.43	54.97	34.00	2.11	44.40	38.17	64.87	13.70	54.25	143.44	5.53	727.67
T ₉	50.70	46.03	43.90	21.1	1.76	32.03	45.87	72.17	20.27	45.23	108.84	3.30	329.33
SEm±	1.68	1.51	1.63	1.52	0.08	1.33	0.88	1.66	0.88	1.10	1.64	0.45	5.81
CD@ 5%	5.03	4.55	4.88	4.57	0.25	4.01	2.64	4.98	2.64	3.30	4.93	1.10	17.42

PH: Plant height (cm); PS: Plant spread (cm); NB: Number of branches; SD: Stem diameter (cm); CC: Chlorophyll content (SPAD); DTI: Days taken for bud initiation; DTF: Days taken for 50 per cent flowering; DIB: Days for bud initiation to full bloom; DF: Duration of flowering; NFP: Number of flowers/plant; WSF: Weight of single flower; WF: Weight of 100 flowers (T₁ -Soil application - ZnSO₄ (2.5kg/ha) + Borax (1kg/ha) + FeSO₄ (1.25kg/ha), T₂ -Soil application - ZnSO₄ (5kg/ha) + Borax (2kg/ha) + FeSO₄ (2.5kg/ha), T₃ -Foliar application - Zn EDTA (0.5%) + Borax (0.2%) + Fe EDTA (0.5%), T₄ -Foliar application - Formula 6 (0.5%), T₅ -Soil application - ZnSO₄ (2.5kg/ha) + Borax (1kg/ha) + FeSO₄ (1.25kg/ha) + Foliar application - Zn EDTA (0.5%) + Borax (0.2%) + Fe EDTA (0.5%), T₆ -Soil application - ZnSO₄ (5kg/ha) + Borax (2kg/ha) + FeSO₄ (2.5kg/ha) + Foliar application - Zn EDTA (0.5%) + Borax (0.2%) + Fe EDTA (0.5%), T₇ -Soil application - ZnSO₄ (2.5kg/ha) + Borax (1kg/ha) + FeSO₄ (1.25kg/ha) + Foliar application - Formula 6 (0.5%), T₈ -Soil application - ZnSO₄ (5kg/ha) + Borax (2kg/ha) + FeSO₄ (2.5kg/ha) + Foliar application - Formula 6 (0.5%), T₉ -Control (water).)

days), whereas the maximum number of days (45.87) was recorded in the control (T₉). Similar findings were reported by Bhute *et al.*, (2017) in annual chrysanthemum, Thirumalamurugan *et al.*, (2021) in marigold and Dhyani *et al.*, (2024) in chrysanthemum.

Days taken for 50 per cent flowering:

Significant differences were observed in the number of days taken to attain 50 per cent flowering. The earliest 50 per cent flowering was recorded in T₆ (62.97 days), which was statistically comparable with T₈ (64.87 days), while the control (T₉) required the maximum number of days (72.17). These findings are in accordance with those reported by Bhute *et al.*, (2017) in annual chrysanthemum, Thirumalamurugan *et al.*, (2021) in marigold and Dhyani *et al.*, (2024) in chrysanthemum.

Days taken for bud initiation to full bloom:

The duration from flower bud initiation to full bloom was significantly influenced by micronutrient application. T₆ recorded the minimum duration (12.77 days), which was statistically at par with T₈ (13.70 days), whereas the maximum duration (20.27 days) was recorded in the control (T₉). Similar observations were reported by Patel *et al.*, (2016) in rose, Swetha *et al.*, (2022) in gaillardia and Dhyani *et al.*, (2024) in chrysanthemum.

The significant improvement in flowering parameters, including early bud initiation, fewer days to 50 per cent flowering and reduced time to full bloom, may be attributed

to the synergistic effects of zinc, boron and iron through combined soil and foliar application. Zinc promotes auxin synthesis and enzyme activity, iron enhances chlorophyll synthesis and photosynthetic efficiency, while boron facilitates carbohydrate translocation and reproductive development. The continuous supply of these micronutrients enhanced physiological and metabolic activities, resulting in early floral induction and rapid flower development (Kurbah and Fatmi, 2022).

Duration of flowering (days):

Micronutrient treatments significantly influenced flowering duration. The longest flowering duration (57.28 days) was recorded in T₆, which remained statistically at par with T₈ (54.25 days), whereas the shortest flowering duration (45.23 days) was observed in the control (T₉). Similar findings were reported by Chopde *et al.*, (2016) in annual chrysanthemum and Harish *et al.*, (2023) in gladiolus.

The prolonged flowering duration observed under the combined soil and foliar application of micronutrients may be attributed to delayed senescence and sustained physiological activity. Enhanced chlorophyll stability and improved enzymatic functions helped maintain flower freshness for a longer period (Tiwari *et al.*, 2010).

Number of flowers per plant:

The number of flowers per plant differed significantly among the treatments. T₆ recorded the highest number

of flowers per plant (145.03), which was statistically comparable with T_8 (143.44) and T_5 (142.10), whereas the lowest number of flowers (108.84) was observed in the control (T_9). Similar results were reported by Jain *et al.*, (2014) in tuberose, Chopde *et al.*, (2016) in annual chrysanthemum, Wilson *et al.*, (2023) in gerbera, Harish *et al.*, (2023) in gladiolus and Dhyani *et al.*, (2024) in chrysanthemum.

Single flower weight (g):

Significant variation was observed in single flower weight among the treatments. The highest single flower weight (6.47 g) was recorded in T_6 , which was statistically at par with T_8 (5.53 g), while the lowest value (3.30 g) was recorded in the control (T_9). These findings are in agreement with those reported by Karuppaiah (2014) in chrysanthemum, Jena *et al.*, (2022) and Thirumalamurugan *et al.* (2021) in marigold.

100 flower weight (g):

The weight of 100 flowers was significantly influenced by different micronutrient treatments. The highest 100-flower weight (764.00 g) was recorded in T_6 , followed by T_8 (727.67 g), whereas the lowest value (329.33 g) was recorded in the control (T_9). Similar findings were reported by Molla (2025) in chrysanthemum.

The significant improvement in yield-contributing parameters may be attributed to the synergistic effect of zinc, boron and iron through combined soil and foliar application. Zinc and iron may have enhanced enzyme activity, chlorophyll synthesis and photosynthetic efficiency, while boron promoted carbohydrate translocation, pollen viability and flower development. The resulting increase in assimilate availability enhanced flower initiation, cell expansion and dry matter accumulation, producing more and heavier flowers and consequently higher 100 flower weight (Hansch and Mendel, 2009; Kurbah and Fatmi, 2022).

Conclusion

The present investigation demonstrated that the combined soil application of $ZnSO_4$ (5 kg/ha), Borax (2 kg/ha) and $FeSO_4$ (2.5 kg/ha) along with foliar application of Zn-EDTA (0.5%), Borax (0.2%) and Fe-EDTA (0.5%) (T_6) was the most effective treatment for improving growth and flowering of annual chrysanthemum. The treatment significantly enhanced plant height, plant spread, number of branches, stem diameter, chlorophyll content, flowering duration, number of flowers per plant, single flower weight and 100-flower weight, while reducing the number of days required for flower bud initiation, 50 per cent flowering and full bloom. The superior performance

was attributed to the synergistic effect of zinc, boron and iron in improving photosynthesis, enzyme activity and assimilate translocation. Thus, the combined soil and foliar application of these micronutrients showed potential for improving growth and flowering of annual chrysanthemum under the agro-climatic conditions of Telangana.

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