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Growth and flowering of gerbera (*Gerbera jamesonii*) as affected by different concentrations of micronutrients and humic acid under naturally ventilated polyhouse conditions of Prayagraj

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Abstract

The present investigation entitled Growth and flowering of Gerbera (*Gerbera jamesonii*) as affected by different concentrations of micronutrients and humic acid under naturally ventilated polyhouse conditions of Prayagraj was carried out during November 2023 to March 2024 in Naturally Ventilated Polyhouse, Department of Horticulture, Naini Agricultural Institute, SHUATS, Prayagraj. The experiment was conducted in Completely Randomized Design (CRD) with eleven treatment combinations, with the application of micronutrients; FeSO₄, MgSO₄, Boron and their combinations and humic acid at different levels, which was replicated thrice. It was concluded that the application of micronutrients treatments rendered their significant effect on almost all the growth, flowering and yield characters of gerbera. The treatment T₁₀ i.e., MgSO₄ + Boron + FeSO₄ @ 0.6% was found superior in terms of plant height (23.87cm), number of leaves (15.08 cm), Leaf area (142.39 cm), plant spread (37.68 cm), days taken for first flower bud initiation (78.41 days), minimum days taken to first harvest (116.91 days), flower diameter (10.21 cm), stalk length (53.75 cm), stalk diameter (4.37 mm), number of flowers per plant (9.26) Flower yield per m² (33.74) and Flower yield per 250 m² (28221.8). Among the different treatments the highest gross return (282,218 Rs/250 m²), Net return (2,13,701 Rs/250 m²), benefit cost ratio (2.46) was obtained under the use of MgSO₄ + Boron + FeSO₄ @ 0.6%.

Keywords: Boron, FeSO₄, *Gerbera jamesonii*, humic acid, micronutrients, MgSO₄

Introduction

Gerbera jamesonii, commonly Boron, FeSO₄, and MgSO₄ are known as the Transvaal daisy or Barberton daisy, is a popular ornamental plant in the Asteraceae family. Native to South Africa, this vibrant flower is cherished for its large, daisy-like blooms that come in a variety of colors including red, yellow, orange, pink, and white. *Gerbera jamesonii* is extensively cultivated for cut flowers and as a decorative garden plant due to its striking appearance and long vase life. This species thrives in well-drained soil with ample sunlight and is favored for its adaptability to different climates and resistance to common pests Chittaranjan *et al.* (2015) [4].

Micronutrients, though needed in small quantities, are essential for the optimal growth and flowering of crops. Elements like zinc, boron, iron, manganese, copper, and molybdenum are critical for processes such as enzyme activity, photosynthesis, and hormone synthesis. For instance, zinc plays a role in the production of auxin, a hormone crucial for flower development, while boron is vital for pollen tube formation and fruit set. Deficiencies in these micronutrients can lead to issues like chlorosis, stunted growth, and poor flowering. Therefore, ensuring a balanced supply of micronutrients is key to enhancing flower quality, vibrancy, and overall crop yield Khandekar *et al.* (2017) [6] critical micronutrients that play distinct roles in plant health and development. Boron is essential for cell wall formation, membrane integrity, and reproductive growth, particularly in pollen germination and seed development. Its deficiency can cause flower deformities and poor fruit set. FeSO₄, a source of iron, is vital for chlorophyll synthesis and various enzymatic processes. Iron deficiency often leads to chlorosis, especially in young leaves, reducing photosynthetic efficiency Khurana *et al.* (2001) [7].

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MgSO₄ provides magnesium, a core component of the chlorophyll molecule, and sulfur, necessary for protein synthesis and enzyme function. A lack of magnesium can cause interveinal chlorosis and poor plant vigor. Together, these nutrients contribute to the overall health and productivity of flowering crops Rao *et al.* (2001)^[8].

Humic acid significantly enhances the growth and flowering of *Gerbera jamesonii* by improving soil fertility and plant nutrient uptake. As an organic compound, it stimulates root development, increasing the plant's ability to absorb essential nutrients and water. This results in more robust growth and larger, more vibrant blooms. Additionally, it aids in the chelation of micronutrients, making them more readily available to the plants and boosting their overall health and resistance to stress Selvi *et al* (2018)^[10].

Materials and Methods

A Field experiment was carried out at Naturally Ventilated Polyhouse, Department of Horticulture, SHUATS, Prayagraj, U.P. in the months of November 2023 to March, 2024.

The experiment was conducted on *Gerbera jamesonii* in Completely Randomized Design (CRD) with three replications using 11 treatment combinations.

Treatment combinations are: T₀ Control T₁ MgSO₄ @ 0.4% + , T₂ MgSO₄ @ 0.6%, T₃ Boron @ 0.4%, T₄ Boron @ 0.6%, T₅ FeSO₄ @ 0.4%, T₆ FeSO₄ @ 0.6%, T₇ Humic acid @ 100 mg/l, T₈ Humic acid @ 500 mg/l, T₉ MgSO₄ + Boron + FeSO₄ @ 0.4%, T₁₀ MgSO₄ + Boron + FeSO₄ @0.6%.

Results and Discussion

The Maximum plant height(cm) was recorded in treatment T₁₀ - MgSO₄ + Boron + FeSO₄ @ 0.6% (15.94, 19.97, 23.87cm) Plant height, at 30, 60 and 90 Days respectively in Eleven treatments followed by T₁₁ - MgSO₄ + Boron + FeSO₄ @ 0.4% with (15.08, 19.17, 23.17 cm), whereas minimum plant height (9.68,14.66, 17.69 cm) was recorded in T₀ Control.

This growth pattern highlights the critical role of micronutrient combinations in promoting plant growth, as also noted in the study by Bhardwaj and Yadav (2012)^[3], who emphasized that balanced micronutrient application can significantly influence vegetative and reproductive growth in floricultural crops. Similarly, Reddy and Pandey (2017)^[9] reported that foliar sprays of micronutrients, including MgSO₄, Boron, and FeSO₄, can enhance plant height and overall growth by improving nutrient uptake and utilization.

The Maximum plant spread (cm) was recorded in treatment T₁₀ - MgSO₄ + Boron + FeSO₄ @ 0.6% (29.83,32.9, 37.68 cm) Plant height, at 30, 60 and 90 Days respectively in Eleven treatments followed by T₁₁ - MgSO₄ + Boron + FeSO₄ @ 0.4% with (28.33, 32.06, 36.98 cm), whereas minimum plant height (15.78, 18.95, 23.61cm) was recorded in T₀ Control.

The application of Boron, Ferrous Sulphate, and Magnesium Sulphate has profound effects on the lateral spread or canopy development of plants. This increased spread is a result of enhanced branching, foliage density, and overall vegetative growth, driven by the essential roles these micronutrients play in plant physiology founded in Alam *et al.* (2014)^[2].

The Maximum Number of leaves per plant was recorded in treatment T₁₀ - MgSO₄ + Boron + FeSO₄ @ 0.6% (6.25, 9.75, 15.08) Plant height, at 30, 60 and 90 Days respectively in Eleven treatments followed by T₁₁ - MgSO₄ + Boron + FeSO₄ @ 0.4% with (5.50, 8.08, 11.16), whereas minimum plant height (2.33, 4.83, 7.00) was recorded in T₀ Control. The positive impact of micronutrient supplementation on leaf growth aligns with

findings by Ahmad *et al.* (2016)^[1], who reported that the application of essential micronutrients significantly improves vegetative growth parameters, including leaf count, in floricultural crops. Similarly, Reddy and Pandey (2017)^[9] observed that foliar application of micronutrients such as MgSO₄, Boron, and FeSO₄ can enhance leaf development by promoting better nutrient absorption and physiological functions in plants.

The Maximum Leaf area (cm²) was recorded in the treatment T₁₀ - MgSO₄ + Boron + FeSO₄ @ 0.6 (142.39), followed by T₉ - MgSO₄ + Boron + FeSO₄ @ 0.4% (139.21) and the minimum plant height was recorded in the treatment T₀ – water spray (93.76). The application of magnesium sulfate (MgSO₄), boron, and ferrous sulfate (FeSO₄) has been shown to significantly increase the leaf area of *Gerbera* flowering crops. These micronutrients are vital for chlorophyll production, enzyme activity, and cell division, leading to enhanced leaf expansion and overall plant growth. Jagtap *et al* (2015)^[5].

The Minimum Days to First Bud initiation was recorded in the treatment T₁₀ - MgSO₄ + Boron + FeSO₄ @ 0.6 (78.41), followed by T₉ - MgSO₄ + Boron + FeSO₄ @ 0.4% (80.50) and the maximum plant height was recorded in the treatment T₀ – water spray (105.58). The findings align with research by Jagtap and Suryawanshi (2015)^[5], who observed that the foliar application of these micronutrients expedited the initiation of buds in *Gerbera* plants by enhancing enzyme activities and chlorophyll production, which are crucial for early flowering.

The Minimum Day to first harvest was recorded in the treatment T₁₀ - MgSO₄ + Boron + FeSO₄ @ 0.6 (116.91), followed by T₉ - MgSO₄ + Boron + FeSO₄ @ 0.4% (119.41) and the minimum plant height was recorded in the treatment T₀ – water spray (137.16). The combined application of these micronutrients creates a synergistic effect that optimizes the physiological conditions necessary for early bud initiation. Alam *et al.* (2014)^[2].

The Maximum Flower diameter(cm) was recorded in the treatment T₁₀ - MgSO₄ + Boron + FeSO₄ @ 0.6 (10.21), followed by T₉ - MgSO₄ + Boron + FeSO₄ @ 0.4% (9.66) and the minimum plant height was recorded in the treatment T₀ – water spray (6.33). Applying a combination of MgSO₄, Boron, and FeSO₄ has been observed to significantly increase the flower diameter in *gerbera* flower crops. This combination likely enhances nutrient uptake and promotes healthier growth, leading to larger blooms. Singh *et al* (2017)^[12].

The Maximum Stalk diameter(mm) was recorded in the treatment T₁₀ - MgSO₄ + Boron + FeSO₄ @ 0.6 (4.37), followed by T₉ - MgSO₄ + Boron + FeSO₄ @ 0.4% (3.42) and the minimum plant height was recorded in the treatment T₀ – water spray (2.00) Magnesium, a crucial component of chlorophyll, enhances photosynthesis and cell growth, while sulfate aids protein synthesis and enzyme function. Boron is essential for cell wall formation and nutrient transport, strengthening vascular tissues. Iron, a key element in enzymes and chlorophyll synthesis, boosts energy transfer and photosynthesis. Together, these nutrients enhance plant vigor, resulting in thicker, sturdier stalks in *Gerbera* flowers.

The Maximum Stalk length (cm) was recorded in the treatment T₁₀ - MgSO₄ + Boron + FeSO₄ @ 0.6 (53.75), followed by T₉ - MgSO₄ + Boron + FeSO₄ @ 0.4% (52.08) and the minimum plant height was recorded in the treatment T₀ – water spray (47.66). Magnesium enhances photosynthesis, Boron supports cell wall formation and hormone regulation, and Iron aids chlorophyll synthesis and respiration. Together, these nutrients promote vigorous stem elongation, resulting in taller *Gerbera*

flowers Jagtap, V. R., & Suryawanshi, M. R. (2015)^[5].

The Maximum No: of Flower per plant was recorded in the treatment T₁₀ - MgSO₄ + Boron + FeSO₄ @ 0.6 (9.26), followed by T₉ - MgSO₄ + Boron + FeSO₄ @ 0.4% (8.75) and the minimum plant height was recorded in the treatment T₀ – water spray (5.25) Magnesium boosts photosynthesis, providing energy for flower production (Cakmak, 2016)^[15], while Boron aids reproductive growth (Brown & Hu, 2011)^[16], and Iron supports overall plant health and chlorophyll synthesis.

The Maximum Flower yield per plant was recorded in the treatment T₁₀ - MgSO₄ + Boron + FeSO₄ @ 0.6 (33.74), followed by T₉ - MgSO₄ + Boron + FeSO₄ @ 0.4% (29.63) and the minimum plant height was recorded in the treatment T₀ – water spray (13.57) Application of Micronutrients is used in plants as a major contributor to various biological systems relieved the plants from chlorosis and produced healthy green leaves which resulted in higher assimilate synthesis and partitioning of the flower growth which may in turn increase the flower production and ultimately flower yield Reddy & Pandey (2017)^[9].

The Maximum Flower yield per 250 m² was recorded in the treatment T₁₀ - MgSO₄ + Boron + FeSO₄ @ 0.6 (33.74), which was found to be at par with treatment T₉ - MgSO₄ + Boron + FeSO₄ @ 0.4% (29.63) and the minimum plant height was recorded in the treatment T₀ – water spray (13.57).

In terms of Economics, Maximum Gross return (282,218), Net

Returns (2,13,701) and Benefit cost ratio (4.11) respectively was found in treatment T₁₀ (MgSO₄ + Boron + FeSO₄ @ 0.6% followed by T₉ MgSO₄ + Boron + FeSO₄ @ 0.4% with (268,945) Gross return, (2,00,666) Net return and (3.93) Benefit cost ratio, whereas minimum Gross return (163,730), Net return (97,265) and Benefit cost ratio (2.46) was recorded in treatment T₀ (Control).



Fig 1: Field display of *Gerbera jamesonii* at Naturally Ventilated Polyhouse, Department of Horticulture, Naini Agricultural Institute, SHUATS, Prayagraj

Table 1: Effect of different concentrations of Micronutrients and Humic acid on Plant height, Plant spread, No: of Leaves, Leaf area, Days to first bud initiation & Days to first harvest of Gerbera

Treatment. No	Treatment Combination	Plant height (90 DAP)	Plant spread (90 DAP)	No: of leaves (90 DAP)	Leaf area	Days to first bud initiation	Days to first harvest
T ₀	Water spray	17.69	23.61	7.00	93.76	105.58	137.16
T ₁	MgSO ₄ @ 0.4%	21.43	26.99	7.16	115.09	97.75	132.83
T ₂	MgSO ₄ @ 0.6%	18.50	33.61	8.66	135.29	95.16	129.33
T ₃	Boron @ 0.4%	19.02	31.47	7.25	121.22	93.00	131.08
T ₄	Boron @ 0.6%	22.62	32.42	8.16	130.29	87.00	124.66
T ₅	FeSO ₄ @ 0.4%	22.03	35.80	9.58	127.38	85.58	122.25
T ₆	FeSO ₄ @ 0.6%	21.80	35.70	9.66	134.61	85.33	121.66
T ₇	Humic acid @ 100 mg/l	20.72	34.86	7.83	127.09	99.33	130.25
T ₈	Humic acid @ 500 mg/l	18.86	34.50	7.66	136.11	98.41	128.25
T ₉	MgSO ₄ + Boron + FeSO ₄ @ 0.4%	23.17	36.98	11.16	139.21	80.50	119.41
T ₁₀	MgSO ₄ + Boron + FeSO ₄ @ 0.6%	23.87	37.68	15.08	142.39	78.41	116.91
F-Test		S	s	S	S	S	S
SE(d)		0.39	0.77	0.59	0.016	3.97	2.13
C. D (0.05)		0.82	1.62	1.23	2.949	8.29	4.45
CV		2.28	2.87	8.09	2.12	5.33	2.06

Table 2: Effect of different concentrations of Micronutrients and Humic acid on Flower diameter, Stalk diameter, Stalk length, No. of Flowers/plant, Flower yield/plant, Flower yield/ 250 m² of Gerbera

Treatment. No	Treatment combination	Flower diameter	Stalk diameter	Stalk length	No. of flowers/plant	Flower yield/plant	Flower yield/250 m ²
T ₀	Water spray	6.33	2.00	47.66	5.25	13.57	16373.00
T ₁	MgSO ₄ @ 0.4%	7.75	2.56	48.33	5.66	14.37	24847.4
T ₂	MgSO ₄ @ 0.6%	8.00	2.62	49.83	5.91	16.46	25015.2
T ₃	Boron @ 0.4%	8.33	3.07	49.08	5.50	18.52	22666.7
T ₄	Boron @ 0.6%	8.75	3.28	50.58	6.66	23.45	23038.2
T ₅	FeSO ₄ @ 0.4%	8.50	3.33	50.75	6.58	25.51	19027.9
T ₆	FeSO ₄ @ 0.6%	9.00	3.23	51.25	7.16	26.21	19395.4
T ₇	Humic acid @ 100 mg/l	7.83	3.11	49.25	5.83	27.47	20513.3
T ₈	Humic acid @ 500 mg/l	8.58	2.95	51.95	6.66	28.69	21634.6
T ₉	MgSO ₄ + Boron + FeSO ₄ @ 0.4%	9.66	3.42	52.08	8.75	29.63	26894.5
T ₁₀	MgSO ₄ + Boron + FeSO ₄ @ 0.6%	10.21	4.37	53.75	9.26	33.74	28221.8
F-Test		S	S	S	S	S	S
SE(d)		0.38	0.23	0.78	0.21	1.47	594.35
C. D (0.05)		0.81	0.48	1.63	0.44	3.08	1258.36
CV		5.74	9.52	1.92	4.21	8.08	3.14

Table 3: Effect of different concentrations of Micronutrients and Humic acid on Benefit cost ratio of gerbera

Sl.no	Treatment	Treatment combination	Total cost of cultivation	Yield (250 m ²)	Selling price	Gross return	Net return	Benefit cost ratio
1.	T ₀	Water spray	66,465	16373	10	163,730	97,265	2.46
2.	T ₁	MgSO ₄ @0.4%	66,997	24847.4	10	248,474	181,477	3.70
3.	T ₂	MgSO ₄ @ 0.6%	67,067	25015.2	10	250,152	183,085	3.72
4.	T ₃	Boron @ 0.4%	67,137	22666.7	10	226,667	1,59,530	3.37
5.	T ₄	Boron @ 0.6%	67,185	23038.2	10	230,382	1,63,197	3.42
6.	T ₅	FeSO ₄ @ 0.4%	67,075	19027.9	10	190,279	1,23,204	2.83
7.	T ₆	FeSO ₄ @ 0.6%	67,195	19395.4	10	193,954	1,26,759	2.88
8.	T ₇	Humic acid @ 100 mg/l	67,390	20513.3	10	205,133	1,37,743	3.04
9.	T ₈	Humic acid @ [500 mg/l	67,445	21634.6	10	216,346	1,48,901	3.20
10.	T ₉	MgSO ₄ + Boron + FeSO ₄ @ 0.4%	68,279	26894.5	10	268,945	2,00,666	3.93
11.	T ₁₀	MgSO ₄ + Boron + FeSO ₄ @ 0.6%	68,517	28221.8	10	282,218	2,13,701	4.11

Conclusion

From the present investigation, it is concluded that among the different treatments, the treatment T₁₀ - MgSO₄ + Borax + FeSO₄ @ 0.6 was found in superior in terms of Plant height, Plant spread, No. of leaves, Leaf area, Days to first bud initiation, Days to first harvest, Stalk length(cm), Flower diameter, Stalk diameter, No. Of flowers per plant, Flower yield per, Flower yield per 250 m² in Gerbera

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