

EFFECT OF FOLIAR APPLICATION OF MICRONUTRIENTS ON GROWTH AND FLOWERING OF GERBERA (*Gerbera jamesonii*) IN NATURALLY VENTILATED POLYHOUSE UNDER PRAYAGRAJ AGRO CLIMATIC CONDITIONS

Comment [E11]: Suggestion:

EFFECT OF MICRONUTRIENTS FOLIAR APPLICATION ON GROWTH AND FLOWERING OF GERBERA (*Gerbera jamesonii*) IN NATURALLY VENTILATED POLYHOUSE UNDER PRAYAGRAJ AGRO CLIMATIC CONDITIONS

ABSTRACT

The present investigation ~~entitled “Effect of Foliar Application of Micronutrients on Growth and Flowering of Gerbera (*Gerbera jamesonii*) in Naturally Ventilated Polyhouse Under Prayagraj Agro Climatic Conditions”~~ was carried out during November 2022 to March 2023 in, Naturally Ventilated Polyhouse, Department of Horticulture, Naini Agricultural Institute, SHUATS, Prayagraj. The experiment was conducted in Randomized Block Design with thirteen treatment combinations, with the application of three micronutrients: ~~like~~ FeSO₄, MgSO₄ and ZnSO₄ 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 T₁₁ i.e., application of ZnSO₄ @ 0.6% was found superior in terms of plant height (28.17cm), number of leaves (13.5), length of the leaves (33.9cm), plant spread (47.68cm), days taken for first flower bud initiation (88.6days), minimum days taken to first harvest (119days), flower diameter (11.35cm), stalk length (43.16cm), stalk diameter (7.16mm), number of flowers per plant (9.17) and vase life (9.66days). Among the different treatments, the highest gross return (142590 Rs/200m²), Net return (55938 Rs/200m²), benefit cost ratio (1.64) was obtained under the use of ZnSO₄ @0.6% (T₁₁).

Key words: Gerbera, micronutrients, FeSO₄, MgSO₄, ZnSO₄

1. INTRODUCTION

Gerbera is an important cut flower crop grown throughout the world in a wide range of climatic conditions. It belongs to the Asteraceae family which is also known as Transvaal daisy or Barberton daisy or African daisy. Gerberas are often associated with happiness, innocence, and purity. It has spread naturally in South Africa, Madagascar and tropical Asia. The first scientific description of gerbera was given by Traugott Gerber J D. It was made by Hooker in the Curtis Botanical Magazine in 1889. The described species *Gerbera jamesonii*, is a South African species. Gerbera is native to tropical region of South America, Africa and Asia. It is a diploid species with somatic chromosome number of $2n = 50$. Gerbera is a dwarf herbaceous perennial and grows in clump with solitary flower heads on a long slender stalk, which grows well in protected structures.

Gerbera is ranked second in the domestic market and sixth globally. Gerberas are broadly and commonly used as cut flowers for flowery array, interior decoration and gifts for particular occasion, wedding ceremony bouquet [7]. It is mainly due to its availability in a wide range of colours by hybridization, including white, yellow, orange, red and pink. Besides being used as cut flowers, gerberas are perfect for beds, borders, pots, and rock gardens. It is a popular cut flower in Holland, Germany and USA [22]. It is popular because of its attractive colours, long vase life and suitability for long distant transport [10].

Micronutrients play vital roles in the growth and development of plants. Among them, ferrous sulphate, zinc sulphate, and magnesium sulphate are three important micronutrients that have a significant impact on the growth and flowering of gerbera plants. Due to their stimulatory and catalytic effects on metabolic processes and ultimately on flower yield and quality [11]. Enhancement in growth characters due to micronutrient application might basically be due to improved photosynthetic and other metabolic activities related to cell division and elongation [5]. Most necessary and essential micronutrients, such as Zn, Fe, Mn, Cu and B have an important role in the growth stage and quality of flower on gerbera.

Ferrous sulphate, also known as iron sulphate, is a micronutrient essential for various metabolic processes in plants. It is a key component of enzymes involved in chlorophyll synthesis, energy transfer, and nitrogen fixation. Iron is an important element in various reactions of respiration, photosynthesis and reduction of nitrate and sulphate [16].

Zinc sulphate is another micronutrient that plays a vital role in the growth and flowering of gerbera. Zinc is effective in plant nutrition for the synthesis of plant hormones and

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balancing intake of P and K inside the plant cells. Zinc deficiency in plants resulted in stunted growth, little leaf and fruit sizes which are recognized to altered IAA metabolism [23]. It involved in numerous enzymatic reactions and is necessary for the synthesis of growth hormones and proteins. Zinc is necessary for the synthesis of auxin IAA and for carbohydrate metabolism, protein synthesis, internodes elongation for stem growth and in pollen formation [21].

Magnesium sulphate, commonly known as Epsom salt, is a micronutrient that provides magnesium, an essential element for plant nutrition. Magnesium is a component of chlorophyll, the pigment responsible for photosynthesis. It is also involved in various enzymatic reactions, carbohydrate metabolism, and the synthesis of nucleic acids and proteins. Adequate magnesium levels promote vigorous growth, enhanced nutrient uptake, and increased flower production in gerbera plants.

In conclusion, the micronutrients ferrous sulphate, zinc sulphate, and magnesium sulphate have a substantial impact on the development and flowering of plants. These micronutrients should be present in sufficient amounts to help prevent deficiencies, support healthy foliage, stimulate root growth, and enhance flower quality. Growers can optimize gerbera cultivation and get desired results by implementing appropriate nutrition management strategies after knowing the effects of these micronutrients.

2. MATERIALS AND METHODS

A field experiment ~~entitled, "Effect of Foliar Application of Micronutrients on Growth and Flowering of Gerbera (*Gerbera jamesonii*) in Naturally Ventilated Polyhouse Under Prayagraj Agro Climatic Conditions"~~ was carried out in the Department of Horticulture, Naini, Agricultural Institute, Sam Higginbottom University of Agriculture, Technology and Sciences during 2022-23. The experiment included application of different concentrations of micronutrients like ferrous sulphate, magnesium sulphate and zinc sulphate with 13 treatments in three replications. The gerbera suckers of rosaline variety were transplanted in the polyhouse with a planting distance of (30x30) cm and had four plants per plot. The experiment was laid out in Randomized Block Design with thirteen treatments and three replications. The experiment included foliar application of micronutrients nutrients, Ferrous sulphate (FeSO_4), Magnesium sulphate (MgSO_4) and Zinc sulphate (ZnSO_4), which were applied with differential concentrations of FeSO_4 at 0.2%, 0.4%, 0.6%, 0.8%; MgSO_4 at 0.2%, 0.4%, 0.6%, 0.8% and ZnSO_4 at 0.2%, 0.4%, 0.6%, 0.8% for 30, 60 and 90 days after planting.

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Comment [E15]: The methodology should be subsections as follow:

1. Experimental Location with Coordinates
2. Sample Preparation
3. Micronutrient Treatment Application
4. Growth Characteristics
5. Statistical Analysis

The four plants of each treatment of replications observations were recorded at 30 days interval. Data were statistically analyzed by the method suggested by Fisher and Yates, 1963.

3. RESULTS AND DISCUSSIONS

Data in table in table 1 indicates significant differences regarding the growth and flowering parameters like plant height(cm), number of leaves per plant, leaf length(cm), plant spread(cm), days taken for first flower bud initiation(days), days taken for first harvest(days) and number of flowers per plant treated with different FeSO₄, MgSO₄ and ZnSO₄ concentrations.

Plant height was recorded with significant variations among different treatments. Maximum plant height (28.17 cm) was recorded in T₁₁- ZnSO₄ at 0.6% followed by treatment T₃-ZnSO₄ at 0.6% (26.05 cm) and the shortest ~~is~~ was found in the treatment T₀- Control (22.65 cm). It may be due to the synthesis of tryptophan, a precursor of indoleacetic acid (auxin) which is accelerated by zinc and IAA is known to promote apical dominance, maintain polarity and growth. And zinc promotes cell elongation, cell multiplication and cell division which resulting in increased photosynthesis and translocation of food materials which enhances plant height [23]. Similar results were reported by Kakade *et al.* [9] in china aster and Ahmad *et al.* [7] in Dutch rose.

Number of leaves per plant was recorded with significant variations among different treatments. Maximum number of leaves (13.5) was recorded in T₁₁- ZnSO₄ at 0.6%, followed by treatment T₃- FeSO₄ at 0.6% (12.25) and the lowest was found in the treatment T₀ -Control (8.5). The foliar application of zinc might be stimulating metabolic activity with stimulating effect on cell wall loosening, increased cell elongation along with cell enlargement and cell differentiation resulting in increased photosynthesis and translocation of food material which might be enhanced the number of leaves (Joseph *et al.* 2019). Similar results were also obtained by Bashir *et al.* [11] in gerbera and Pal. *et al.* [22] in gerbera. Maximum leaf length was of (33.91cm) was recorded in T₁₁- ZnSO₄ at 0.6%, followed by treatment T₃-FeSO₄ at 0.6% (32.25cm) and the lowest was found in the treatment T₀-Control (27.58cm). The application of ZnSO₄ might be stimulating metabolic activity and stimulating effect on cell wall loosening, increased cell elongation along with cell differentiation and cell enlargement resulting in increased photosynthesis and

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translocation of food materials might enhance the leaves length [17]. Similar results were reported by Bashir *et al.* [11] in gerbera and Pal *et al.* [22] in gerbera.

The maximum plant spread (47.68cm) was recorded in treatment T₁₁- ZnSO₄ @0.6% followed by treatment T₃-FeSO₄ @0.6% (46.06cm) and the minimum is found in the treatment T₀-Control (39.01cm). Micronutrients activate several enzymes and involved themselves in chlorophyll synthesis and various physiological activities all these factors help in cell differentiation, cell division and cell multiplication resulting in increase in photosynthesis and translocation of food materials that increased plant spread. Similar findings were reported in Pal *et al.* [22] in gerbera, Tara *et al.* [18] in chrysanthemum and Kakade *et al.* [9] in China aster.

Minimum days to first flower bud initiation was recorded in treatment T₁₁- ZnSO₄ @0.6% (88.66 days) and followed by the treatment T₃-FeSO₄ @0.6% (91.75 days) whereas the maximum number of days taken to first flower bud initiation was recorded in T₀-Control (101.75 days). It may be due to the proper nutritional status i.e., nitrogen, potassium, zinc, copper, etc. and hormonal level within the plants. Sucrose and phyto-hormones moved in combination from leaves to apical meristem due to the application of micronutrients to induce early flowering. Similar findings were reported in Kashyap *et al.* [13] in gladiolus and Chaturvedi [16] in gladiolus.

Minimum days taken for first harvest was recorded in treatment T₁₁- ZnSO₄ @0.6% (119 days) and followed by the treatment T₃-FeSO₄ @0.6% (122 days) whereas the maximum days taken for first harvest was recorded in T₀- Control (132.5 days). Micronutrients like zinc, manganese, boron and iron favours in the storage of more carbohydrates through photosynthesis which plays an important role in chlorophyll synthesis, photosynthesis and respiration. This may be responsible for the beneficial effects of optimum dose of zinc on reducing juvenile phase of plant. Similar findings were reported by Jadhav *et al.* [8] and Kashyap *et al.* [13] in gladiolus.

Maximum Number of flowers per plant was recorded in treatment T₁₁- ZnSO₄ @ 0.6% (9.17) and followed by the treatment T₃ - ZnSO₄ @0.6% (7.83) whereas the minimum number of flowers per plant was recorded in the treatment T₀ - Control (5.33). The increase in flower per plant is due to the application of ZnSO₄, which plays an important role by involving in photosynthesis; break down of IAA (auxin) and protein synthesis and this will lead to produce more food materials which in turn might have been utilized for the

development of more number of flowers [23]. Similar results were also reported by Nag and Biswas [12] and Hardeep *et al.* [4] in tuberose.

The data regarding floral parameters like flower diameter, stalk length, stalk diameter, number of flowers per 200 square meter and vase life of gerbera flower is shown in the table 2. Maximum flower diameter was recorded recorded in treatment T₁₁- ZnSO₄ @ 0.6% (11.35cm) and followed by the treatment T₇ – MgSO₄ @ 0.6% (10.71 cm) whereas the shortest flower diameter was recorded in the treatment T₀ –Control (8.79cm). Micronutrients such as zinc, it helps in regulating semi permeability of cell walls, thus mobilizing more water into flowers and also increase the synthesis of iron which promotes the flower size and weight of the flowers [4]. 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 size [22]. Similar results were reported by Nath and Biswas [12] in tuberose, Thirumalmurugan *et al.* [23] in African marigold.

Maximum flower stalk length was recorded recorded in treatment T₁₁- ZnSO₄ @ 0.6% (43.16 cm) and followed by the treatment T₇ – MgSO₄ @ 0.6% (41.41 cm) whereas the shortest flower diameter was recorded in the treatment T₀ – Control (37.1 cm). Foliar application of micronutrients promotes cell elongation, cell division and cell enlargement which helps in the increase of flower stalk length. These findings are in strong conformity with Aparna *et al.* [1] in gerbera. Maximum flower stalk diameter was recorded in treatment T₁₁- ZnSO₄ @ 0.6% (7.166 mm) and followed by the treatment T₇ – MgSO₄ @ 0.6% (6.25 mm) whereas the shortest stalk was recorded in the treatment T₀ – Control (5.25mm). The moderate dose of micronutrients enhanced the growth rate of vegetative part, increased physiological activity and also more cell elongation, which increased the diameter of flower stalk [22]. These findings are in close conformity with the results of Sujatha *et al.* [21] and Gurav *et al.* [3] in gerbera.

Maximum number of flowers per 200 square meter was recorded in treatment T₁₁- ZnSO₄ @ 0.6% (20370) and followed by the treatment T₃ – ZnSO₄ @ 0.6% (17407) whereas the minimum number of flowers per plant was recorded in the treatment T₀ – Control (11852). It is due to the application of zinc relieved the plants from chlorosis and produced healthy green leaves which resulted increase photosynthesis; break down of IAA (auxin) and protein synthesis and this will lead to produce more food materials which assimilate synthesis and partitioning of the flower growth which may in turn increase the flower

production. Similar results were also obtained by Joseph *et al.* [2] in China aster, Nath and Biswas [12] in tuberose and Pal *et al.* [22] in gerbera.

Maximum vase life was recorded in treatment T₁₁- ZnSO₄ @ 0.6% (9.66 days) and followed by the treatment T₇ – MgSO₄ @ 0.6% (7.91 days) whereas the minimum vase life was recorded in the treatment T₀ – Control (5.5 days). The increase in vase life of gerbera is due to the increase in number of leaves which increases increase in the dose of ZnSO₄ application which resulted in the formation of more carbohydrate reserve due to the increase photosynthesis which might have delayed the senescence of flowers by reducing the effect of ethylene and this can be the reason for increase in vase life of flower. Similar results were obtained by Pal *et al.* [22] in gerbera. Economics of different treatments in 200 square meter is illustrated in table 3, where the treatment T₁₁ – ZnSO₄ @ 0.6% (142590) followed by treatment T₃ – FeSO₄ @ 0.6% (121849) with net return of 55938 and 35286 respectively. These treatments exhibited maximum Benefit: Cost ratio of 1.64 and 1.407 respectively.

Table 1. Effect of foliar application of micronutrients on growth and floral parameters of gerbera.

Treatments	Plant height (cm)	Number of leaves per plant	Leaf length (cm)	Plant spread (cm)	Days taken for first flower bud initiation (days)	Days taken for first harvest (days)	Number of flowers per plant
T ₀ - Control	22.65	8.5	27.58	39.01	101.75	132.5	5.33
T ₁ -FeSO ₄ @0.2%	24.47	11.08	30	42.5	97.08	126.91	5.83
T ₂ -FeSO ₄ @0.4%	25.5	10.83	30.5	43.29	96.25	126.33	5.91
T ₃ -FeSO ₄ @0.6%	26.05	12.25	32.25	46.06	91.75	122.33	7.83
T ₄ -FeSO ₄ -@0.8%	24.85	11	30.95	44.86	97.41	127.25	6.41
T ₅ -MgSO ₄ @0.2%	23.98	11.41	29.8	41.95	96.66	128.16	5.75
T ₆ - MgSO ₄ @0.4%	25.16	10.58	29.84	43.41	94.08	124.41	6.75
T ₇ - MgSO ₄ @0.6%	25.52	12	31.12	44.73	94.08	126.08	6.66
T ₈ -MgSO ₄ @0.8%	24.14	11.08	31.2	41.9	95.58	126.33	6.91
T ₉ -ZnSO ₄ @0.2%	24.62	10.91	29.41	41.63	97.08	125.83	6.5
T ₁₀ - ZnSO ₄ @0.4%	24.94	12.08	32.08	43.025	94.25	124.16	7.08
T ₁₁ - ZnSO ₄ @0.6%	28.17	13.5	33.91	47.68	88.66	119.66	9.17

T ₁₂ - ZnSO ₄ @0.8%	25.35	10.83	30.18	43.2	96.33	125.5	6.83
F-Test	S	S	S	S	S	S	S
SE(d)	0.229	0.297	0.518	0.445	0.841	1.08	0.584
C. D (0.05)	0.473	0.613	1.07	0.918	1.736	2.22	1.206

Table 2. Effect of foliar application of micronutrients on floral parameters of gerbera.

Treatments	Flower diameter (cm)	Stalk length (cm)	Stalk diameter (mm)	Number of flowers per 200 sq. m	Vase life (days)
T ₀ - Control	8.79	37.1	5.25	11851.84	5.5
T ₁ -FeSO ₄ @0.2%	9.81	39.62	5.5	12962.96	6.33
T ₂ -FeSO ₄ @0.4%	10.38	39.92	5.75	13148.146	6.66
T ₃ -FeSO ₄ @0.6%	10.52	40.95	5.75	17407.403	7.8
T ₄ -FeSO ₄ @0.8%	10.17	39.75	5.66	14259.25	7.083
T ₅ -MgSO ₄ @0.2%	9.83	37.41	5.66	12777.77	6.416
T ₆ - MgSO ₄ @0.4%	9.72	39.33	5.5	14999.99	7.66
T ₇ - MgSO ₄ @0.6%	10.71	41.41	6.25	14814.81	7.91
T ₈ -MgSO ₄ @0.8%	10.33	40.08	6	15370.36	7.25
T ₉ -ZnSO ₄ @0.2%	9.68	39.79	5.5	14444.44	7.33
T ₁₀ - ZnSO ₄ @0.4%	10.15	40.12	5.5	15740.736	7.41
T ₁₁ - ZnSO ₄ @0.6%	11.35	43.16	7.16	20370.366	9.66
T ₁₂ - ZnSO ₄ @0.8%	10.2	41.08	5.08	15185.143	7.41
F-Test	S	S	S	S	S
SE(d)	0.0801	0.3463	0.1424	1299	0.1875
C. D (0.05)	0.165	0.71483	0.294	2681.01	0.387

Table 3. Effect of foliar application of micronutrients on economics of different treatments of gerbera.

Treatments	Gross return (Rs/200m ²)	Net return (Rs/200m ²)	Benefit cost ratio
T ₀ - Control	82985	-3245	0.96
T ₁ -FeSO ₄ @0.2%	90741	4399.89	1.05

T ₂ -FeSO ₄ @0.4%	92036	5472.67	1.06
T ₃ -FeSO ₄ @0.6%	121849	35285.67	1.407
T ₄ -FeSO ₄ @0.8%	99813	13138.56	1.15
T ₅ -MgSO ₄ @0.2%	89446	3141.93	1.03
T ₆ -MgSO ₄ @0.4%	105000	17621.93	1.21
T ₇ -MgSO ₄ @0.6%	103705	17252.79	1.19
T ₈ -MgSO ₄ @0.8%	107590	21063.72	1.24
T ₉ -ZnSO ₄ @0.2%	101108	14737.26	1.17
T ₁₀ -ZnSO ₄ @0.4%	110187	23675.52	1.27
T ₁₁ -ZnSO ₄ @0.6%	142590	55937.78	1.64
T ₁₂ -ZnSO ₄ @0.8%	106295	19502.04	1.22

4. Conclusion

From the present study, it is concluded that the foliar application of micronutrients, i.e., the treatment T₁₁- ZnSO₄ @0.6% found to be superior among all the treatments in terms of growth and flowering like plant height, number of leaves per plant, leaves length, plant spread, days taken for first flower bud initiation, days taken for first harvest, flower diameter, stalk length, stalk diameter, number of flowers per plant, number of flowers per 200 m², vase life, gross return, net return and benefit cost ratio.

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