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Effect of foliar application of Fe and Zn on growth, flowering and yield of gerbera (*Gerbera jamesonii*) under protected condition

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ABSTRACT

The experiment on effect of foliar application of Fe and Zn on growth, flowering and yield of gerbera (*Gerbera jamesonii* Bolus) under protected condition was carried out during 2010-2011. The experiment was laid out in Completely Randomized Design (CRD) with three replications comprising six levels of micronutrients, i.e. control (M_1), $FeSO_4$ @ 0.2% (M_2), $FeSO_4$ @ 0.3% (M_3), $ZnSO_4$ @ 0.2% (M_4), $ZnSO_4$ @ 0.3% (M_5) and $FeSO_4$ + $ZnSO_4$ @ 0.2% each (M_6). Growth, flowering, yield and quality attributes influenced by different levels of micronutrients, viz. highest plant height (20.11 and 28.56 cm), plant spread (35.56 and 42.00 cm^2) and number of leaves/plant (10.44 and 15.22) at first flower appearance and at full bloom stage, respectively. The number of suckers/plant (3.89) at last harvest, fresh (128.11g) and dry weight (44.11g), flowering span (275.70 days), number of flowers/plant (15.70) and per square meter (157.40) and yield of flowers (15.70 lacs/ha), diameter of flower (11.64 cm), length of flower stalk (54.00 cm) and thickness (6.22 mm), number of florets/ flower (213.33), longevity (16.44 days) and vase life (10.28 days) of flower were significantly highest when micronutrient was sprayed at level of $FeSO_4$ + $ZnSO_4$ @ 0.2% each (M_6). Whereas, minimum days to the appearance of first flower bud (48.11) and days to opening the first flower (54.67) were also recorded in M_6 ($FeSO_4$ + $ZnSO_4$ @ 0.2% each) level of micronutrient. It is concluded that for the application of $FeSO_4$ + $ZnSO_4$ @ 0.2% each (M_6) at monthly intervals up to 12 months. From economic point of view, it was observed that this treatment was also most profitable as it recorded the highest net returns.

Key words: Flowering, Gerbera, Growth, Iron, Zinc

Gerbera *(Gerbera jamesonii* Bolus*)* is an important commercial cut flower grown throughout the world in a wide range of climatic conditions. In the international market gerbera stands sixth and second in the domestic market.Micronutrients are drawn in all metabolic and cellular functions. Plants differ necessitate for micronutrients; boron (B), iron (Fe), zinc (Zn), copper (Cu), chloride (Cl), manganese (Mn), molybdenum (Mo) and nickel (Ni). These elements are vigorous that makes them essential as catalytically dynamic cofactors of enzymes and yet others fulfil a structural role in stabilizing proteins. 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 (Hatwar *et al.* 2003). As several of enzymes constituent of iron plays a most important catalyst in plant. Iron takes action as catalyst in synthesis of chlorophyll molecule and helps on the incorporation of other elements. It is a key element in different oxidation-reduction reactions of respiration, photosynthesis and alteration of nitrates and sulphates (Reddy and Reddi 2002). As redox-active metal, it is in use in photosynthesis, mitochondrial respiration, nitrogen integration, hormone biosynthesis (ethylene, gibberellic acid, jasmonic acid), fabrication and scavenging of reactive oxygen species, osmoprotection and pathogen defense (Hansch and Mendel 2009). Zinc is indispensable for proper growth and development of plants. Zinc is effective in plant nutrition for the synthesis of plant hormones and 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 (Marschner 1991). Zinc is necessary for the synthesis of auxin IAA and for carbohydrate metabolism, protein synthesis, internodes elongation for stem growth and in pollen formation (Shukla *et al.* 2009). Nowadays, micronutrients are gradually gaining momentum among the flower growers because of their beneficial nutritional support and at the same time ensure better harvest and returns. The concept of insurance request of micronutrients may be economically utilized in the flower crops, mostly where the needs of crop has not been determined. The demand for increasing flower production will require a thorough knowledge on the relationship between micronutrients and

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crop growth. Keeping these facts in view, an attempt was made to evaluate the effect of foliar application of Fe and Zn on growth, flowering and yield of gerbera under protected condition.

MATERIALS AND METHODS

An experiment was carried out on effect of six levels of micronutrients on gerbera at Hi-tech Horticulture Park (Greenhouse Unit-2), Department of Horticulture, College of Agriculture, Junagadh Agricultural University, Junagadh during the year 2010-11 under protected condition. Temperature and relative humidity were maintained throughout the experiment, 23^0C - 25^0C and 80 – 85%, respectively. The experiment was laid out in Completely Randomized Design (CRD) with three replications comprising six levels of micronutrients, i.e. control (M_1), $FeSO_4$ @ 0.2% (M_2), $FeSO_4$ @ 0.3% (M_3), $ZnSO_4$ @ 0.2% (M_4), $ZnSO_4$ @ 0.3% (M_5) and $FeSO_4$ + $ZnSO_4$ @ 0.2% each (M_6) were selected for this study. Healthy tissue cultured plants were planted in raised beds of 45 cm height, 75 cm base and 60 cm top in two rows at spacing of 30 cm × 30 cm. As per treatments the micronutrients were sprayed after one month of planting and subsequently at one month intervals up to 12 months. Five plants from each replication of a cultivar were used for recording observation. The recommended packages of practices were followed for raising the successful crop. Data on growth, flowering, yield and quality characters were recorded up to six months after one month of transplanting. All the mean values of the recorded data on various biometrical parameters were subjected to statistical analysis as per the procedure given by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

The results of study revealed that application of different levels of Fe and Zn had produced a significant effect on growth parameters, viz. plant height, plant spread, number of leaves, number of suckers and fresh and dry weight of plant. The data revealed that the plant height was significantly affected by different levels of Fe and Zn (Table 1). The highest plant height at first flower appearance (20.11 cm) and at full bloom (28.56 cm) was obtained with treatment M_6. The treatment M_1 recorded significantly lowest plant height at first flower appearance (16.89 cm) and at full bloom (25.67 cm). Result from Table 1 revealed that, there was significant difference in plant spread with highest in treatment M_6, i.e. 35.56 cm^2 and 42.00 cm^2 at first flower appearance and at full bloom, respectively. Significantly, the lowest plant spread was observed in treatment M_1, i.e. 29.67 cm^2 and 34.67 cm^2 at first flower appearance and full bloom, respectively. Significantly, the highest number of leaves/plant at first flower appearance (10.44) and full bloom (15.22) was observed in treatment M_6 (Table 1). Whereas, the significantly lowest number of leaves/plant at first flower appearance (8.94) and full bloom (12.06) was observed in treatment M_1. The maximum number of suckers/plant (3.89) at the end of first year was recorded by treatment M_6. Whereas, the minimum number of suckers/plant (2.89) was given by treatment M_1. The fresh and dry weight of plant was significantly affected by different levels of Fe and Zn (Table 1). The highest fresh (128.11g) and dry weight (44.11g) of plant was obtained with treatment M_6. Significantly, the lowest fresh (113.44g) and dry weight (34.56g) of plant was obtained with treatment M_1. Micronutrients play a vital role in production of vegetative growth and ultimately encourage the growth parameters, viz. plant height, plant spread, number of leaves, number of suckers which results in increased fresh and dry weight of plant by involving in oxidation-reduction process, photosynthesis, and breakdown of IAA, auxin and protein synthesis etc. Fe and Zn, being a essential component of several dehydrogenase, protenase, peptidase and promotes growth harmones and closely associated with growth, all these factors contributed to cell multiplication, cell enlargement and cell differentiation resulting in increased photosynthesis and translocation of food material which enhanced the height. It favours the formation of metabolites required for growth and ultimately encouraged the plant to show maximum growth in terms of plant height, number of leaves, plant spread, number of suckers/plant and fresh and

Table 1 Effect of micronutrients on growth parameters of gerbera under protected condition

Treatment	Plant height at first flower appearance	Plant height at full bloom	Plant spread at first flower appearance	Plant spread at full bloom	Number of leaves at first flower appearance	Number of leaves at full bloom	Number of suckers per plant at last harvest	Fresh weight of plant (g)	Dry weight of plant(g)
M_1-Control	16.89	25.67	29.67	34.67	8.94	12.06	2.89	113.44	34.56
M_2- FeSO4 @ 0.2 %	19.67	27.22	34.89	40.00	9.33	13.33	3.11	120.11	40.22
M_3- FeSO4 @ 0.3 %	19.33	27.33	34.67	40.67	10.11	14.17	3.22	124.44	42.00
M_4- ZnSO4 @ 0.2 %	19.22	27.44	34.56	40.00	10.06	14.11	3.33	120.11	40.00
M_5- ZnSO4 @ 0.3 %	19.44	28.11	34.89	40.89	10.00	14.06	3.44	121.11	41.11
M_6- FeSO4 + ZnSO4 @ 0.2 %	20.11	28.56	35.56	42.00	10.44	15.22	3.89	128.11	44.11
SEm	0.56	0.46	1.12	1.23	0.11	0.26	0.21	2.14	1.20
CD (P=0.05)	1.61	1.32	3.21	3.55	0.30	0.75	0.61	6.16	3.46

Table 2 Effect of micronutrients on flowering and yield parameters of gerbera under protected condition

Treatment	Days to appearance of first flower bud	Days to open first flower	Flowering spans (days)	Number of flowers/ plant	Number of flowers/ sq. meter	Yield of flowers per hectare/year (No. of cut flowers in lacs)
M_1-Control	60.89	66.80	261.56	12.57	126.20	12.57
M_2- FeSO4 @ 0.2 %	53.00	60.00	270.56	14.00	139.90	14.00
M_3- FeSO4 @ 0.3 %	51.00	58.44	270.44	14.33	143.30	14.33
M_4- ZnSO4 @ 0.2 %	55.00	60.89	268.56	14.37	144.50	14.37
M_5- ZnSO4 @ 0.3 %	51.67	58.89	272.22	14.47	143.90	14.47
M_6- FeSO4 + ZnSO4 @ 0.2 %	48.11	54.67	275.70	15.70	157.40	15.70
SEm	1.47	1.48	1.67	0.31	3.25	0.31
CD (P=0.05)	4.22	4.27	4.98	0.90	9.58	0.90

dry weight of plant. These findings are in close conformity with those of Joshi *et al.* (2003) in rose, Kher *et al.* (2002) in chrysanthemum, Singh (2004) in gladiolus, Kakede *et al.* (2009) in China aster, Khan (2000) in dahlia, Mona *et al.* (2002), Kumar and Haripriya (2010) in nerium, Yadav *et al.* (2003) in tuberose, Jadhav *et al.* (2005) and Pimple *et al.* (2006) in gerbera.

The data from investigation revealed that application of different levels of Fe and Zn exerted a significant influence on flowering and yield parameters, viz. days to appearance of first flower, days to open first flower, flowering span, number of flowers/plant and per sq. meter and yield of flowers/ha in lacs.The perusal of data presented in Table 2 indicated that the minimum days required to appearance first flower bud (48.11) and days to open first flower (54.67) was recorded in treatment M_6, while the significantly maximum days required to appearance first flower bud (60.89) and days to open first flower (66.80) was recorded in treatment M_1. There was significant difference in flowering span with highest in treatment M_6, i.e. 275.70 days, whereas the significantly lowest in treatment M_1, i.e. 261.56 days. Plant receiving micronutrient caused early bud opening with longest flowering span. Similar results were also obtained by Jitendra *et al.* (2003) in carnation, Kumar *et al.* (2003) and Biswas *et al.* (2003) in tuberose, Katiyar *et al.* (2005) in gladiolus, Balakrishnan *et al.* (2007) in marigold, Kumar and Haripriya (2010) in nerium, Jadhav *et al.* (2005) in gerbera. Lower level of Fe and moderate level of Zn invited early bud initiation and opening. This was due to low level of Fe which helped to accumulate more carbohydrate in plant body which lead to early flower bud initiation as well as bud opening, later which results in lengthening of flowering span. These findings are in close conformity with the findings of Sujatha *et al.* (2002) and Pimple *et al.* (2006) in gerbera. It was observed that the number of flowers/plant and per sq. m was significantly influenced with the application of Fe and Zn. Significantly, the maximum number of flowers per plant (15.70) and per sq. m (157.40) was recorded in treatment M_6. Whereas, the significantly minimum number of flowers per plant (12.57) and per sq. m (126.20) was recorded in treatment M_1. It is revealed that, micronutrients like zinc, manganese and iron are the part of large number of organic compounds which plays an important role by involving in photosynthesis; break down of IAA, auxin and protein synthesis etc. Increased flower yield through foliar application of micronutrients, was also reported by Kumar and Haripriya (2010) in nerium, Muthumanikam *et al.* (1999) and Jadhav (2005) in gerbera. The number of flowers/ha was increased significantly with increasing levels of Fe and Zn. Significantly, the highest yield of flower (15.90 lacs/ha) was observed in treatment M_6, while, the significantly lowest yield of flower (12.57 lacs/ha) was recorded in treatment M_1. The increase in floral characters due to application of Zn and Fe increases vegetative growth and healthy green leaves which in turn resulted in higher assimilate synthesis. Thus, leads to production of more food material, which in turn might have been utilized for better development of buds and flowers. All these increased value of floral characters ultimately the yield of gerbera. Increased number of flowers in present study is in agreement with the results obtained by Chandrappa *et al.* (2006) in anthurium and Anuprita *et al.* (2005) in gerbera. Micronutrients like Zn, Fe etc. through stimulating metabolic activity with stimulating effect on cell wall loosing, increased cell elongation along with cell enlargement. All these causes affect on increased leaf area, thereby causing increased photosynthetic area. Thus, caused increase in carbohydrate food material. A similar trend was in consonance with and Kakade *et al.* (2009) in China aster and Kumar and Haripriya (2010) in nerium.

The data from present investigation revealed that application of different levels of Fe and Zn exerted a significant effect on quality parameters, viz. diameter of flower, stalk length, stalk thickness, number of ray florets and longevity and vase life of flowers. The data shown in Table 3 revealed that diameter of flower was significantly increased by an application of different levels of Fe and Zn. The maximum flower diameter (11.64 cm) was observed in treatment M_6. Whereas, the minimum flower diameter (8.22 cm) was observed in treatment M_1. The plants receiving required micronutrients in an optimum proportion could

Table 3 Effect of micronutrients on quality parameters of gerbera under protected condition

Treatment	Diameters of flower (cm)	Length of flower stalks (cm)	Flower stalk thickness (mm)	Number of ray florets/flower	Longevity of flowers (days)	Vase life of flowers (days)
M_1-Control	8.22	45.89	5.00	170.00	15.00	9.00
M_2- FeSO4 @ 0.2 %	10.11	50.00	5.70	196.11	15.33	9.33
M_3- FeSO4 @ 0.3 %	10.33	50.56	5.88	193.89	15.89	9.89
M_4- ZnSO4 @ 0.2 %	10.33	49.89	6.00	195.00	15.94	10.00
M_5- ZnSO4 @ 0.3 %	10.44	51.11	6.11	190.00	16.06	10.06
M_6- FeSO4 + ZnSO4 @ 0.2 %	11.64	54.00	6.22	213.33	16.44	10.28
SEm	0.39	2.22	0.24	5.80	0.27	0.23
CD (P=0.05)	1.20	3.68	0.69	16.67	0.79	0.67

have results in increasing diameter of flower bud, this might be due to increase in size of ray florets by increasing cell size. Similar results were obtained by Muthumanikam *et al.* (1999) in gerbera and Kumar and Haripriya (2010) in nerium. The perusal of data from Table 3 indicated that micronutrient treatments significantly increased stalk length and thickness of flower. The maximum stalk length (54.00 cm) and thickness (6.22 mm) of cut flower was obtained with an application of treatment M_6. Significantly, the minimum stalk length (45.89 cm) and thickness (5.00 mm) of cut flower was obtained in treatment M_1. The increased height of the plants receiving all the micronutrients could have resulted in increasing stalk length as well as thickness. Similar results were also obtained by Muthumanikam *et al.* (1999) in gerbera. This was due to facts that the moderate dose of micronutrients enhanced the growth rate of vegetative part, increased physiological activity and also more cell elongation, which increased the length of flower stalk. These findings are in close conformity with the results of Sujatha *et al.* (2002) and Gurav *et al.* (2004) in gerbera. The number of ray florets per flower was significantly increased by an application of different levels of Fe and Zn. The maximum number of ray florets/flower (213.33) was observed in treatment M_6. Whereas the minimum number of ray florets/flower (170.00) was observed in treatment M_1. The plants receiving required micronutrients in an optimum proportion could have results in increased number of florets by increasing number of cells. Similar results were obtained by Muthumanikam *et al.* (1999) in gerbera The results of study also revealed that flower obtained from plants that were treated with different levels of Fe and Zn showed the greater longevity as well as vase life as compared to other treatments.The maximum longevity (16.44 days) and vase life (10.28 days) was observed in treatment M_6. Whereas the minimum longevity (15.00 days) and vase life (9.00 days) was observed in treatment M_1. The plants receiving optimum micronutrients could have resulted in increased longevity of flowers, later which results in increased vase life of flower. Similar results were obtained by Muthumanikam *et al.* (1999) in gerbera.

From the result of the experiment, it is concluded that among six levels of micronutrient, i.e. control (M_1), $FeSO_4$ @ 0.2% (M_2), $FeSO_4$ @ 0.3% (M_3), $ZnSO_4$ @ 0.2% (M_4), $ZnSO_4$ @ 0.3% (M_5) and $FeSO_4$ + $ZnSO_4$ @ 0.2% each (M_6) was found to be best of levels of micronutrients, $FeSO_4$ + $ZnSO_4$ @ 0.2% each was effective for all morphological, flowerings, yield and quality parameters of gerbera. Based on the results summarized above and economic point of view, it can be concluded that $FeSO_4$ + $ZnSO_4$ @ 0.2% each of gerbera appeared more economical.

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