



## Effects of foliar application of $\text{FeSO}_4$ and $\text{ZnSO}_4$ on leaf tissue nutrients of gerbera (*Gerbera jamesonii*) varieties under protected condition

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### ABSTRACT

The present study was conducted to evaluate the effects of foliar application of  $\text{FeSO}_4$  and  $\text{ZnSO}_4$  on leaf tissue nutrients of gerbera (*Gerbera jamesonii* Bolus) varieties under protected condition during 2010-11. The experiment was laid out in Factorial Completely Randomized Design with three replications and 18 treatment combinations, comprising three varieties of gerbera, viz. Faro ( $V_1$ ), Dana Allen ( $V_2$ ), Roselin ( $V_3$ ) and six levels of micronutrients, i.e. control ( $M_1$ ),  $\text{FeSO}_4 @ 0.2\%$  ( $M_2$ ),  $\text{FeSO}_4 @ 0.3\%$  ( $M_3$ ),  $\text{ZnSO}_4 @ 0.2\%$  ( $M_4$ ),  $\text{ZnSO}_4 @ 0.3\%$  ( $M_5$ ) and  $\text{FeSO}_4 + \text{ZnSO}_4 @ 0.2\%$  each ( $M_6$ ). The present results have shown that the maximum increasing range of nutrients content in leaves as 45.00 to 69.71 ppm, 26.50 to 62.76 ppm, 2.60 to 4.83% and 3.36 to 5.45% of total Fe, Zn, N and K content in leaves, respectively was observed in variety  $V_2$  (Dana Allen) from 1<sup>st</sup> to 12<sup>th</sup> month of gerbera, while the minimum range of nutrients 43.53 to 67.50 ppm, 25.17 to 61.17 ppm, 2.49 to 4.61% and 3.22 to 5.26% of total Fe, Zn, N and K content in leaves, respectively was noted in variety  $V_1$  (Faro) from 1<sup>st</sup> to 12<sup>th</sup> month of gerbera. Similarly, variety  $V_2$  (Dana Allen) gave lowest decrease range (0.94 to 0.50%) of total P content in leaves and variety  $V_1$  (Faro) gave highest decreasing range (0.87 to 0.21%) of total P content in leaves from 1<sup>st</sup> to 12<sup>th</sup> month of gerbera plant. The treatment  $M_6$  ( $\text{FeSO}_4 + \text{ZnSO}_4 @ 0.2\%$  each) was noted highest increasing range of nutrient content in leaves as 45.67 to 70.39 ppm, 27.00 to 62.78 ppm, 2.64 to 4.76% and 3.42 to 5.57% of Fe, Zn, N and K content in leaf during 1<sup>st</sup> to 12<sup>th</sup> month of gerbera plant.

**Key words:** Iron, Micro-nutrients, Nitrogen, Phosphorus, Potassium, Zinc

Gerberas (*Gerbera jamesonii* Bolus) for cut flowers production are considered moderate feeders. This moderate level of fertility produces a plant with a proportional leaf area to flower ratio. Sub-optimal fertility leads to lower leaf yellowing due to nitrogen deficiency. Excessive fertility can lead to lush growth and delayed flowering. The other common nutritional problems include iron deficiency induced by too high of a pH, iron/zinc toxicity induced by too low of a pH, and zinc deficiency. Balancing the needs of the plant and periodic monitoring will help to assure the nutritional requirements are being met. When growers are faced with visual symptoms indicating nutritional problems, accurate diagnosis can be done by plant tissue analysis. Therefore, the standards for leaf tissue nutrient concentrations are important to determine nutritional status of plants and potentially correct nutrition disorders. The

recommended leaf tissue concentration ranges may reflect luxury uptake by the plant in excess of what is required for optimal plant growth (Mills and Jones 1996 and Dole and Wilkins 2005). Although leaf tissue concentration changes according to plant growth stage, the tissue nutrient standards did not account for plant age. In recent years, use of micronutrients is considered to be essential for higher and quality production, which cannot be over emphasized. The micronutrients owing to their metabolic function in the plant system are involved in synthesis of tryptophan as the precursor for auxin, which promotes production of foliage and flowers (Chen *et al.* 1982). Minerals form an important part of plants and affect their physiology in several ways. Elements play a role in building up of plant body, tissue building and metabolic roles; they help in both vegetative and reproductive growth and are indispensable for the production of foliage, flowers, fruits and seeds.  $\text{FeSO}_4$  and  $\text{ZnSO}_4$  on gerbera with maximized number of flowers, flower diameter and early flowering and  $\text{FeSO}_4$  (ferrous sulphate) has recorded maximum plant height and stalk length, stalk girth and vase life of flower (Muthumanickam *et al.* 1999). Therefore, the available standard is broad and general for cut flowers of gerbera. This research was undertaken to

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find effects of foliar application of  $\text{FeSO}_4$  and  $\text{ZnSO}_4$  on leaf tissue nutrients of gerbera Pal *et al.* varieties under protected condition.

#### MATERIALS AND METHODS

The present study was conducted to evaluate the effects of foliar application of  $\text{FeSO}_4$  and  $\text{ZnSO}_4$  on leaf tissue nutrients of gerbera varieties under protected condition at Hi-tech Horticulture Park (Greenhouse Unit-2), Department of Horticulture, College of Agriculture, Junagadh Agricultural University, Junagadh during the year 2010-11. Temperature and relative humidity were maintained throughout the experiment,  $23^{\circ}\text{C}$  -  $25^{\circ}\text{C}$  and 80 – 85%, respectively. The experiment was laid out in Factorial Completely Randomized Design (FCRD) with three replications and 18 treatment combinations, comprising three varieties of gerbera, viz. Faro ( $V_1$ ), Dana Allen ( $V_2$ ), Roselin ( $V_3$ ) and six levels of micronutrients, i.e. control ( $M_1$ ),  $\text{FeSO}_4$  @ 0.2% ( $M_2$ ),  $\text{FeSO}_4$  @ 0.3% ( $M_3$ ),  $\text{ZnSO}_4$  @ 0.2% ( $M_4$ ),  $\text{ZnSO}_4$  @ 0.3% ( $M_5$ ) and  $\text{FeSO}_4$  +  $\text{ZnSO}_4$  @ 0.2% each ( $M_6$ ). 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. The leaf samples were collected as per the procedure given by Chapman and Pratt (1961). Fully matured 8 to 10 leaves were collected at flower initiation stage from each plot. The leaf samples after proper labeling were placed in butter paper bags and brought to the laboratory. They were washed first with tap

water and then with 0.1 N HCL to remove any adhering dirt or spray residues. Finally they were washed with distilled water. The leaves after drying on absorbent papers were placed in the butter paper bags. These bags were kept in the hot air oven at  $65^{\circ}\text{C}$  for drying. After complete drying the leaf samples were powdered with the help of porcelain mortar and pestle and kept in the air tight amber coloured bottles. Initial analysis for N, P, K, Fe and Zn before first spraying of the plant and subsequently at monthly intervals up to 12 months. The estimation of different nutrients from the leaf samples were done according to the standard procedures recommended by the following. Micro Kjeldahl (Chapman and Pratt 1961) method for N, Ammonium phospho molybdate yellow colour (Jackson 1967) method for P, Flame photometric (Jackson 1967) method for K, Acid extract Atomic Absorption Spectro Photo-metric (Lindsay and Norvell 1978) Method for Fe and Zn. The data were subjected to statistical analysis as described by Panse and Sukhatme (1985).

#### RESULTS AND DISCUSSION

The data presented in Tables 1 to 5 revealed that the effect of varieties on total nutrient content in leaves at monthly interval was found significant except in 1<sup>st</sup> month of gerbera plant. All the total nutrient content in leaves was increased at monthly interval for all varieties except total P content in leaves of gerbera was decreased. The maximum increasing range of nutrient content in leaves as 45.00 to 69.71 ppm, 26.50 to 62.76 ppm, 2.60 to 4.83% and 3.36 to 5.45% of total Fe, Zn, N and K content in leaves,

Table 1 Effect of foliar application of Fe and Zn on total Fe content in leaves of gerbera varieties under protected condition at monthly intervals

Treatment	Total Fe content in leaves (ppm)											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
<i>Varieties</i>												
V1-Faro	43.53	45.38	46.06	48.28	49.64	51.61	53.11	56.00	58.28	61.89	64.00	67.50
V2-Dana Allen	45.00	47.00	48.00	50.17	51.86	53.61	55.11	58.17	60.22	63.74	66.21	69.71
V3-Roselin	44.62	46.68	47.56	49.78	51.33	53.15	54.63	57.70	59.76	63.25	65.67	69.18
CD (P=0.05)	0.33	0.48	0.49	0.51	0.55	0.50	0.50	0.49	0.48	0.47	0.46	0.45
SEm	NS	1.38	1.42	1.48	1.57	1.43	1.45	1.40	1.36	1.34	1.32	1.30
<i>Micronutrient treatments</i>												
M1-Control	42.44	44.28	44.67	46.56	47.74	49.54	51.56	54.36	56.21	60.56	62.52	65.82
M2- $\text{FeSO}_4$ @ 0.2%	44.19	46.65	47.44	49.33	50.79	52.72	54.33	57.38	59.44	63.44	65.33	68.72
M3- $\text{FeSO}_4$ @ 0.3%	44.34	46.89	47.89	49.56	51.23	53.17	54.67	57.76	59.67	63.67	65.67	69.17
M4- $\text{ZnSO}_4$ @ 0.2%	43.30	45.22	46.28	48.41	49.34	51.23	53.08	56.07	57.78	62.06	64.12	67.28
M5- $\text{ZnSO}_4$ @ 0.3%	43.64	45.53	46.50	48.57	49.87	51.54	53.36	56.33	58.06	62.40	64.4	67.70
M6- $\text{FeSO}_4$ + $\text{ZnSO}_4$ @ 0.2% (each)	45.67	47.69	49.22	51.33	53.00	54.61	56.11	58.89	61.11	65.00	66.98	70.39
CV(%)	0.48	0.68	0.70	0.73	0.79	0.71	0.71	0.69	0.66	0.65	0.66	0.65
CD (P=0.05)	NS	1.96	2.01	2.09	2.25	2.03	2.05	1.98	1.87	1.86	1.90	1.90
SEm	4.62	4.42	4.46	4.44	4.64	4.03	3.95	3.61	3.40	3.18	3.05	2.89

I to XII indicate the months (January to December) of sample tested.

Table 2 Effect of foliar application of Fe and Zn on total Zn content in leaves of gerbera varieties under protected condition at monthly intervals

Treatment	Total Zn content in leaves (ppm)											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
<i>Varieties</i>												
V1-Faro	25.17	25.67	28.27	31.67	35.58	37.78	40.97	44.17	48.12	51.52	56.09	61.17
V2-Dana Allen	26.50	27.28	29.78	33.36	37.13	39.43	42.30	45.5	49.45	52.85	57.42	62.76
V3-Roselin	25.83	26.80	29.33	32.63	36.57	38.83	41.74	44.94	48.95	52.15	56.82	62.00
CD (P=0.05)	0.39	0.40	0.39	0.38	0.37	0.37	0.36	0.36	0.35	0.36	0.35	0.36
SEm	NS	1.15	1.12	1.11	1.06	1.06	1.03	1.03	1.02	1.03	1.02	1.03
<i>Micronutrient treatments</i>												
M1-Control	24.14	24.96	27.32	30.94	34.12	36.27	39.02	42.17	46.05	49.30	53.60	58.50
M2- FeSO <sub>4</sub> @ 0.2%	25.12	25.53	28.23	31.72	35.26	37.12	40.08	43.15	47.03	50.10	54.78	59.17
M3- FeSO <sub>4</sub> @ 0.3%	25.28	25.86	28.62	32.10	35.63	37.76	40.48	43.61	47.46	50.74	55.03	59.93
M4- ZnSO <sub>4</sub> @ 0.2%	26.24	26.78	29.27	33.06	36.64	38.84	42.02	45.12	49.07	52.47	57.04	62.12
M5- ZnSO <sub>4</sub> @ 0.3%	26.44	26.94	29.44	33.48	37.08	39.28	42.36	45.56	49.39	52.79	57.36	62.44
M6- FeSO <sub>4</sub> + ZnSO <sub>4</sub> @ 0.2% (each)	27.00	27.5	30.22	33.7	37.52	39.72	42.58	45.78	49.73	53.13	57.70	62.78
CV(%)	0.56	0.56	0.55	0.54	0.53	0.52	0.51	0.50	0.51	0.50	0.51	0.50
CD (P=0.05)	NS	1.62	1.58	1.57	1.52	1.51	1.48	1.46	1.45	1.46	1.45	1.46
SEm	6.34	6.41	5.69	5.04	4.32	4.08	3.77	3.40	3.12	2.91	2.68	2.56

I to XII indicate the months (January to December) of sample tested.

Table 3 Effect of foliar application of Fe and Zn on total N content in leaves of gerbera varieties under protected condition at monthly intervals.

Treatment	Total N content in leaves (%)											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
<i>Varieties</i>												
V1-Faro	2.49	2.74	2.98	3.26	3.4	3.51	3.68	3.91	4.06	4.31	4.45	4.61
V2-Dana Allen	2.60	2.86	3.11	3.48	3.62	3.73	3.88	4.13	4.28	4.53	4.67	4.83
V3-Roselin	2.52	2.80	3.06	3.34	3.48	3.60	3.76	4.00	4.14	4.40	4.53	4.70
CD (P=0.05)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
SEm	NS	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
<i>Micronutrient treatments</i>												
M1-Control	2.41	2.61	2.84	3.10	3.22	3.30	3.50	3.65	3.87	4.03	4.12	4.25
M2- FeSO <sub>4</sub> @ 0.2%	2.55	2.80	3.05	3.32	3.46	3.57	3.74	3.97	4.12	4.46	4.55	4.72
M3- FeSO <sub>4</sub> @ 0.3%	2.62	2.87	3.12	3.39	3.53	3.63	3.80	4.06	4.20	4.48	4.57	4.74
M4- ZnSO <sub>4</sub> @ 0.2%	2.61	2.86	3.09	3.36	3.50	3.61	3.78	4.03	4.17	4.45	4.53	4.67
M5- ZnSO <sub>4</sub> @ 0.3%	2.52	2.77	3.02	3.29	3.43	3.54	3.71	3.94	4.09	4.40	4.51	4.64
M6- FeSO <sub>4</sub> + ZnSO <sub>4</sub> @ 0.2% (each)	2.64	2.89	3.14	3.41	3.55	3.67	3.89	4.09	4.21	4.56	4.67	4.76
CV(%)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
CD (P=0.05)	NS	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
SEm	5.41	5.40	5.08	4.76	4.48	4.23	4.04	3.80	3.67	3.46	3.35	3.23

I to XII indicate the months (January to December) of sample tested.

Table 4 Effect of foliar application of Fe and Zn on total P content in leaves of gerbera varieties under protected condition at monthly intervals

Treatment	Total P content in leaves (%)											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
<i>Varieties</i>												
V1-Faro	0.87	0.83	0.77	0.71	0.67	0.60	0.52	0.43	0.37	0.32	0.25	0.21
V2-Dana Allen	0.94	0.91	0.86	0.82	0.80	0.75	0.69	0.63	0.59	0.56	0.52	0.50
V3-Roselin	0.92	0.89	0.84	0.79	0.76	0.70	0.63	0.56	0.51	0.47	0.42	0.39
SEm	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005	0.005
CD (P=0.05)	NS	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01	0.01
<i>Micronutrient treatments</i>												
M1-Control	0.86	0.80	0.73	0.69	0.62	0.53	0.45	0.39	0.35	0.32	0.26	0.22
M2- FeSO <sub>4</sub> @ 0.2%	0.88	0.83	0.77	0.74	0.68	0.60	0.53	0.48	0.45	0.43	0.38	0.36
M3- FeSO <sub>4</sub> @ 0.3%	0.90	0.85	0.79	0.76	0.70	0.62	0.55	0.50	0.47	0.45	0.40	0.38
M4- ZnSO <sub>4</sub> @ 0.2%	0.92	0.87	0.81	0.78	0.72	0.64	0.57	0.52	0.49	0.47	0.42	0.40
M5- ZnSO <sub>4</sub> @ 0.3%	0.94	0.89	0.83	0.80	0.74	0.66	0.59	0.54	0.51	0.49	0.44	0.42
M6- FeSO <sub>4</sub> + ZnSO <sub>4</sub> @ 0.2% (each)	0.98	0.94	0.89	0.87	0.82	0.75	0.69	0.65	0.64	0.62	0.58	0.56
SEm	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008	0.008
CD(P=0.05)	NS	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02	0.02
CV(%)	2.74	2.58	2.91	3.11	3.34	3.60	3.90	4.27	4.70	5.24	5.92	6.79

I to XII indicate the months (January to December) of sample tested.

Table 5 Effect of foliar application of Fe and Zn on total K content in leaves of gerbera varieties under protected condition at monthly intervals

Treatment	Total K content in leaves (%)											
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII
<i>Varieties</i>												
V1-Faro	3.22	3.37	3.62	3.78	3.95	4.22	4.38	4.46	4.70	4.82	5.02	5.26
V2-Dana Allen	3.36	3.51	3.78	3.93	4.10	4.38	4.52	4.68	4.84	5.00	5.20	5.45
V3-Roselin	3.3	3.43	3.72	3.88	4.05	4.29	4.43	4.59	4.72	4.92	5.12	5.36
CD (P=0.05)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
SEm	NS	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11	0.11
<i>Micronutrient treatments</i>												
M1-Control	3.12	3.24	3.46	3.60	3.80	3.93	4.11	4.23	4.37	4.57	4.71	4.83
M2- FeSO <sub>4</sub> @ 0.2%	3.28	3.40	3.64	3.84	4.09	4.24	4.45	4.59	4.75	4.97	5.14	5.28
M3- FeSO <sub>4</sub> @ 0.3%	3.30	3.46	3.74	3.90	4.14	4.28	4.51	4.65	4.83	5.08	5.27	5.43
M4- ZnSO <sub>4</sub> @ 0.2%	3.32	3.48	3.76	3.92	4.17	4.32	4.54	4.68	4.85	5.11	5.29	5.45
M5- ZnSO <sub>4</sub> @ 0.3%	3.34	3.50	3.78	3.94	4.19	4.34	4.56	4.71	4.88	5.14	5.32	4.47
M6- FeSO <sub>4</sub> + ZnSO <sub>4</sub> @ 0.2% (each)	3.42	3.56	3.82	4.02	4.27	4.43	4.66	4.80	4.98	5.22	5.41	5.57
CV(%)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
CD (P=0.05)	NS	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
SEm	5.00	4.72	4.46	4.23	4.03	3.84	3.67	3.52	3.37	3.24	3.12	3.00

I to XII indicate the months (January to December) of sample tested.

respectively was observed in variety V<sub>2</sub> (Dana Allen) from 1<sup>st</sup> to 12<sup>th</sup> month of gerbera, while the minimum range of nutrient 43.53 to 67.50 ppm, 25.17 to 61.17 ppm, 2.49 to 4.61% and 3.22 to 5.26% of total Fe, Zn, N and K content in leaves, respectively was noted in variety V<sub>1</sub> (Faro) from 1<sup>st</sup> to 12<sup>th</sup> month of gerbera. Similarly, variety V<sub>2</sub> (Dana Allen) gave lowest decrease range (0.94 to 0.50%) of total P content in leaves from 1<sup>st</sup> to 12<sup>th</sup> month of gerbera plant and variety V<sub>1</sub> (Faro) gave highest decreasing range (0.87 to 0.21%) of total P content in leaves from 1<sup>st</sup> to 12<sup>th</sup> month of gerbera plant. These differences may be due to their individual genotypes having different genetical constituents. These findings are in accordance with the results reported by earlier workers (Singh and Sangama 2005, Paraneetha 2006 and Naik *et al.* 2006) in gerbera.

Irrespective of the varieties, the effect of different levels of Fe and Zn on total nutrient content in leaves at monthly interval was found significant and all total nutrient content in leaves increase (Table 1, 2, 4 and 5) at monthly interval except in total P content (Table 3). The treatment M<sub>6</sub> (FeSO<sub>4</sub> + ZnSO<sub>4</sub> @ 0.2% each) was noted highest in increasing range of nutrient content in leaves as 45.67 to 70.39 ppm, 27.00 to 62.78 ppm, 2.64 to 4.76% and 3.42 to 5.57% of Fe, Zn, N and K content in soil during 1<sup>st</sup> to 12<sup>th</sup> month of gerbera plant, whereas the lowest range of decreasing total P content in leaves (0.86% to 0.22%) was observed in control (M<sub>1</sub>) treatment. A significant increase in dry weight of vegetative and flower parts of the plant with foliar application of nutrient might, have been directly responsible for more uptake of nutrient as compared to control. P content in leaves was decrease; this reduction could be attributed to the translocation of sugars and nutrients from the leaf and stem to the developing flower parts. The results of present investigations are in accordance with those reported by Deshmukh and Wavhal (1996) in china aster, Muthumanickam *et al.* (1999) and Ka *et al.* (2008) in gerbera, Kumar and Arora (2000) in gladiolus, and Anjaneyulu (2006) in rose.

Varietal effect was significant for nutrient content in leaves at monthly interval. All nutrient content, viz. Fe, Zn, N and K in leaves was found gradually increased in all the varieties at monthly interval except in P content which was gradually decreased in leaves of gerbera. The maximum increasing range of nutrient content, viz. Fe, Zn, N and K at monthly interval was found in variety V<sub>2</sub> (Dana Allen), and the minimum was recorded by variety V<sub>1</sub> (Faro). However, the highest decreasing range of P content in leaves was noted in Faro variety and lowest in Dana Allen variety of gerbera at monthly interval. In contrast, nutrient content, viz. Fe, Zn, N and K in leaves was found gradually increased in all

the treatments at monthly interval except in P content which was gradually decreased in leaves of gerbera. The treatment M<sub>6</sub> (FeSO<sub>4</sub> + ZnSO<sub>4</sub> @ 0.2% each) recorded the maximum increasing range of nutrient content, viz. Fe, Zn, N and K at monthly interval and treatment M<sub>1</sub> (control) decreasing range of P content in leaves. Based on results summarized above and economic point of view, it can be concluded that FeSO<sub>4</sub> + ZnSO<sub>4</sub> @ 0.2% each and Dana Allen variety of gerbera appeared more economical.

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