

Original Research Article

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Evaluation of Nutrient Concentration and Uptake in Magnesium and Iron Deficient Gerbera

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ABSTRACT

A pot culture experiment was conducted using Goliath cultivar of Gerbera as a test crop to study the importance of Iron (Fe) and Magnesium (Mg) in the cultivation of Gerbera. The experiment was laid out with different treatments (factor A) including T1 as control (complete nutrition), T2 (excluding Magnesium) and T3 (excluding Iron), thereby accounting for 16 treatment combinations with five different days of harvesting (factor B). In both the deficiency cases (T2 and T3), there is a significant reduction in nutrient concentration of Mg and Fe in different plant parts such as crown + leaves (0.26% and 167 ppm), roots (0.15% and 145 ppm) and flowers (0.08% and 60 ppm) respectively. The nutrient uptake by gerbera plant also reduced due to the nutrient deficient treatments because of the lower production of the dry matter and also the lower nutrient concentration which causes a great setback in the cultivation of the gerbera due to low quality flowers with lower vase life and less aesthetic value. The experiment will generate information on the importance of Magnesium and Iron in the nutrition of gerbera which has got higher floricultural importance at international trade.

Keywords

Gerbera, Iron, Magnesium, Nutrient concentration, Nutrient uptake.

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Introduction

Gerbera (*Gerbera jamesonii*; family Asteraceae) is one of the most popular commercial flower crop and ranks 4th among cut flower demands (Sujatha *et al.*, 2002). In India, 0.190 million hectares of area is under flower cultivation with a production of 1.031 million loose of flowers and 690.27 million of cut flowers in the year 2010-2011. Maharashtra is one of the pioneer states known for its protected flower cultivation and the area under protected gerbera cultivation is

mostly confined in Pune, Satara, Kolhapur, Nashik etc. that has nearly 600 hectares of land out of which more than 100 hectares area is being adopted for gerbera cultivation with 1476 lakh flowers per year with a productivity of 250 flowers/m² (Anonymous, 2010). The success of gerbera cultivation under polyhouse depends largely on nutrient management apart from other factors. Plant nutrition is a difficult subject to understand completely, partially because of the variation

between different plants and even between different species or individuals of a given clone. An element present at a low level may cause deficiency symptoms, while the same element at a higher level may cause toxicity. Further, deficiency of one element may present as symptoms of toxicity for another element.

Deficiency of some nutrients may delay flowering and also reduces the aesthetic value. Balancing the plants growth, need periodic monitoring to assure the nutritional requirements are being met. When growers face nutritional problems with visual symptoms, knowing key symptoms of nutrient disorders with critical tissue concentrations would assist growers in problem identification. So, in this research paper, we aimed to study the effect of Mg and Fe on nutrient concentration and uptake of gerbera.

Materials and Methods

The present study was conducted out at the Hi-Tech Floriculture and Vegetable Production Project, College of Agriculture, Pune-5 during August 2013 to February 2014.

The details of the materials used and techniques adopted for this investigation are presented as follows.

Planting material

Goliath cultivar of gerbera was selected for present study. The tissue cultured plantlets of Goliath cultivar were procured from M/S Kumar Florist Pvt. Ltd., Pune- 36.

Media

Cocopeat was obtained from Sterlin Farm Research and Services Pvt. Ltd. Cochin (Kerala).

Earthen pots

Earthen pots (30 cm height, 15 cm upper diameter and 5 litres capacity) were used for experiment. Each pot was filled manually with 0.625 kg cocopeat.

Saline bottles

Saline bottles having 500 ml capacity were used for this experiment. These bottles were used after cleaning firstly with dilute nitric acid and then washed with water for 2 - 3 times. Total forty five bottles were used for forty five plants as per the treatments.

Fertilizers

The commercial grade water soluble inorganic fertilizers were used for experimental purpose. Their elemental composition is as below in table 1.

Polyhouse management

The polyhouse was naturally ventilated (GH-1) type and UV stabilized 200 micron thickness polythene film was used as cladding material. For maintaining temperature, 50 per cent, shade net was provided in the polyhouse. The manually operated movable curtains were fixed on side walls to cover ventilators. The misting system was provided for control of temperature and humidity.

Factor A

- All nutrients as control (T1)
- All nutrients excluding magnesium (T2)
- All nutrients excluding iron (T3)

Factor B

- 115 days of harvesting (D1)
- 130 days of harvesting (D2)
- 145 days of harvesting (D3)
- 160 days of harvesting (D4)
- 175 days of harvesting (D5)

Treatment details

All plants were supplied with recommended dose of fertilizers up to 100 days after transplantation through drip irrigation.

Before flowering

200-60-250 mg N, P₂O₅ and K₂O/plant/alternate day.

After flowering

350-60-300 mg N, P₂O₅ and K₂O/plant/alternate day.

All nutrients

Include complete dose of fertilizers.

Treatment combinations

Factor A (3) x Factor B (5) = 15 (T₁ to T₁₅)

T₁₆: plant harvested at 100 DAP which was supplied all nutrients after recording all observations.

Preparation of nutrient solutions

All nutrients treatment

Different nutrient solutions were prepared separately in tank A and B as per the treatments as shown in table 2.

Treatment excluding magnesium

In Tank B, the quantity of magnesium sulphate (600 g) for preparation of 25 litres nutrient solution was not included in the treatment excluding Mg. The quantity of sulphur in the form of sulphate (216 g) supplied through magnesium sulphate was balanced with 80 g bentosulf which contains 90 per cent elemental sulphur for fulfilling the requirement of sulphur to gerbera. The remaining nutrients were supplied as per the treatment with all nutrients in Tank A and Tank B.

Treatment excluding iron

In Tank A, Fe EDDHA was excluded and remaining nutrients are given as per the all nutrient treatment.

Experimental Methodology

The experiment was started by transplanting the plantlets of Goliath cultivar of gerbera at 3 – 4 leaf stage for 16 treatment combinations in factorial completely randomized design with three replications in 48 pots. Total 48 earthen pots were used for experiment. Each pot was filled with 0.625 kg cocopeat. The cocopeat bricks before utilization were loosened by immersing in plain tap water. Then calcium nitrate treatment was given to leach out the salts like sodium. Generally, 8-10 kg calcium nitrate is sufficient for 100 kg bricks. The cocopeat was washed thoroughly on the polyfilm surface in the tractor trolley, so that leaching of salts is done easily. After transplanting, the plantlets were drenched with a mixture of 100 ml of Bavistin (1.5 g L⁻¹) and Keradex (1 ml L⁻¹).

One week after transplanting, these plantlets were drenched with 80 ml of Tripla (19: 19: 19) @ 1 g L⁻¹ for better root development. Watering was given manually to all plants up to 21 days of transplanting. Fertigation through drippers was started after 21 DAP and continued up to 100 DAP. There after the treatments were started and fertigation was given through saline bottles @ 500ml per plant per alternate day as per the treatments. For fertigation, 10 ml stock solution from tank A and tank B were used which were diluted in one liter of irrigation water and 1.0 ml of concentrated nitric acid was added for maintaining the pH of the solution. These fertigations through saline bottles were continued up to 175 DAP *i.e.*, till the final harvest on every alternate day.

Plant analysis

Plant analysis was carried out after digesting the oven dried plant sample by di-acid digestion using H₂SO₄ and H₂O₂ for analyzing the nutrient concentration and uptake. Nutrient uptake was calculated from dry matter (crown + leaves and flowers) and nutrient concentration.

Nutrient uptake = (Nutrient content X dry matter content) / 100

Results and Discussion

Effect of nutrients on periodical nutrient concentration

Effect of nutrients on Mg content in crown + leaves of gerbera at different days after planting

Significantly lower Mg content in crown + leaves (0.26 % as a mean value) was observed in treatment omitting Mg as compared to all nutrients treatment (Figure 1). There was significant difference in Mg content with days and significantly higher Mg content (0.41 %) was observed at 115 DAP (D1). As the number of days increased, the Mg content decreased in crown + leaves.

The lower Mg content in crown + leaves found in treatment omitting Mg as Mg was not supplied to these plants. The above findings are similar to the findings of Anjaneyulu (2008) who found that the Mg content in leaves less than 0.36 % was considered deficient according to the leaf nutrient norms using DRIS technique in gerbera. The Mg content in crown + leaves of all nutrients and iron excluding treatments were similar to those reported by Kossowski and Strojny (1983) and Gurav and Kale (2002) which shows the importance of Mg in gerbera nutrition.

Effect of nutrients on Mg content in roots of gerbera at different days after planting

From figure 2, it can be seen that significantly lower Mg content in roots (0.15 % as mean value) was observed in treatment excluding Mg. As the number of days increases, the Mg content decreased in roots. The lower Mg content in roots of treatment excluding Mg was due to the deduction of Mg supply to these plants and also due to the inhibition of sugar transport out of magnesium deficient leaves resulting in the inhibition of the root growth which are in conformity with Cakmak *et al.*, 1994; Fischer *et al.*, 1998; Hermans *et al.*, 2004, 2005; Hermans and Verbruggen, 2005.

Effect of nutrients on Mg content in flowers of gerbera at different days after planting

The Mg content was significantly lower in treatment without Mg (0.08 %). As the number of days increases, there was an increase in the Mg content in flower with all nutrients and treatment excluding iron but decreased with treatment excluding Mg (Figure 3). There was no significant difference in Mg content with days. The lower Mg content of flowers in treatment excluding Mg was due to the inhibition of sugar transport out of magnesium deficient leaves resulting in lower quality flowers and also reduction in the vase life of flowers as reported by Cakmak and Yazici (2010) and Hermans *et al.*, 2004, 2005.

Effect of nutrients on Fe content in crown + leaves and roots of gerbera at different days after planting

Significantly lower Fe content in crown + leaves and roots was observed in treatment excluding iron (Figures 4 and 5). With increase in number of days, iron content decreased in crown + leaves and roots.

Table.1 Sources and chemical composition of nutrient solution

Sl. No.	Name of the source	Molecular Weight	Chemical Formula	Nutrient Content (%)
1	Calcium nitrate	236	Ca(NO ₃) ₂ .4H ₂ O	N = 15.50, Ca = 18.80
2	Fe EDDHA 6%	-	Fe – EDDHA	Fe = 6.00
3	Nitric acid	63	HNO ₃	N = 31.55w/v (22.22 v/v)
4	Mono potassium phosphate	136	KH ₂ PO ₄	P ₂ O ₅ = 52, K ₂ O = 34
5	Potassium sulphate	174	K ₂ SO ₄	K ₂ O = 50, SO ₄ = 52.5
6	Potassium nitrate	101	KNO ₃	N = 13, K ₂ O = 45
7	Magnesium sulphate	246	MgSO ₄ .7H ₂ O	Mg = 9.60, SO ₄ = 36
8	Bentosulf	-	-	Elemental S = 90%
9	Borax	381.2	Na ₂ B ₄ O ₇ .10H ₂ O	B = 11.33
10	Manganese sulphate	169	MnSO ₄ .H ₂ O	Mn = 30.50, SO ₄ = 51
11	Zinc sulphate	179	ZnSO ₄ .H ₂ O	Zn = 33, SO ₄ = 15
12	Copper sulphate	249.5	CuSO ₄ .5H ₂ O	Cu =25.45, SO ₄ = 38.47
13	Sodium molybdate	241.96	Na ₂ MoO ₄ .2H ₂ O	Na = 19.01, Mo = 39.65

Table.2 Preparation of stock solution A) All nutrients treatment

Sl. No.	Name of salt/ fertilizer	Quantity required for preparation of 1000 liters of stock solution	Quantity required for preparation of 25 liters of stock solution	Nutrient supplied through 1000 liters	Nutrient supplied through 25 liters
Tank A					
1	Calcium nitrate	65 kg	1.625 kg	10.075 kg N, 12.22 kg Ca	251.85 g N, 305.5 g Ca
2	Fe EDDHA 6%	3 kg	75 g	0.18 kg Fe	4.5 g Fe
3	Nitric acid	500 ml	12.5 ml	157.76 g N	3.94 g N
Tank B					
1	Mono potassium phosphate	20 kg	500 g	10.4 kg P ₂ O ₅ , 6.8 kg K ₂ O	260 g P ₂ O ₅ , 170 g K ₂ O
2	Potassium sulphate	20 kg	500 g	10 kg K ₂ O, 10.5 kg SO ₄	250 g K ₂ O, 262.5 g SO ₄
3	Potassium nitrate	8 kg	200 g	1.04 kg N, 3.6 kg K ₂ O	26 g N, 90 g K ₂ O
4	Magnesium sulphate	24 kg	600 g	2.304 kg Mg, 8.640 kg SO ₄	57.6 g Mg, 216 g SO ₄
5	Borax	270 g	6.75 g	30.591 g B	0.7647 g B
6	Manganese sulphate	100 g	2.5 g	32.5 g Mn, 51.00 g SO ₄	0.763 g Mn, 1.275 g SO ₄
7	Zinc sulphate	170 g	4.25 g	56.1 g Zn, 25.5 g SO ₄	1.4025 g Zn, 0.638 g SO ₄
8	Copper sulphate	50 g	1.25 g	12.725 g Cu, 19.235 g SO ₄	0.3181 g Cu, 0.481 g SO ₄
9	Sodium molybdate	10 g	0.25 g	1.901 g Na, 3.965 g Mo	0.0475 g Na, 0.099 g Mo
10	Nitric acid	500 ml	12.5 ml	157.76 g N	3.94 g N

Table.3 Effect of nutrients on Mg uptake by gerbera plant at different Days after planting (g plant⁻¹)

Treatments	D1	D2	D3	D4	D5	Mean
T ₁	0.12	0.15	0.18	0.22	0.25	0.19
T ₂	0.11	0.11	0.10	0.08	0.05	0.09
T ₃	0.11	0.11	0.12	0.12	0.12	0.12
Mean	0.11	0.13	0.14	0.14	0.14	

	Treatment	DAP	Interaction
SE (±)	0.002	0.003	0.005
CD5%	0.006	0.008	0.014

Observation at 100 DAP: 0.12 g plant⁻¹

Table.4 Effect of nutrients on Fe uptake by gerbera plant at different Days after planting (mg plant⁻¹)

Treatments	D1	D2	D3	D4	D5	Mean
T ₁	7.90	9.74	11.27	13.00	14.57	11.29
T ₂	7.52	8.78	9.49	9.76	10.34	9.18
T ₃	6.56	6.10	5.10	3.91	2.59	4.85
Mean	7.33	8.21	8.62	8.89	9.17	

	Treatment	DAP	Interaction
SE (±)	0.13	0.098	0.220
CD5%	0.363	0.281	0.628

Observation at 100 DAP: 7.56 mg plant⁻¹

Fig.1 Effect of nutrients on Mg content in crown + leaves of gerbera at Different days after planting

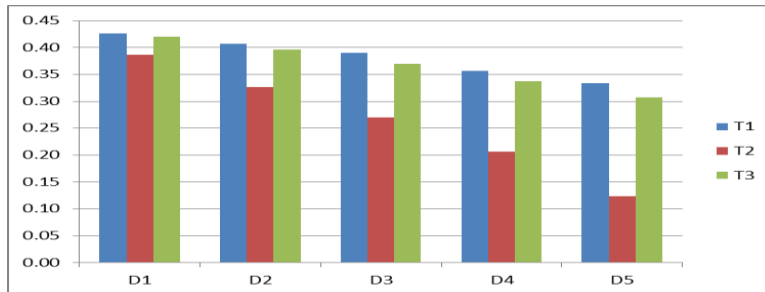


Fig.2 Effect of nutrients on Mg content in roots of gerbera at different days after planting

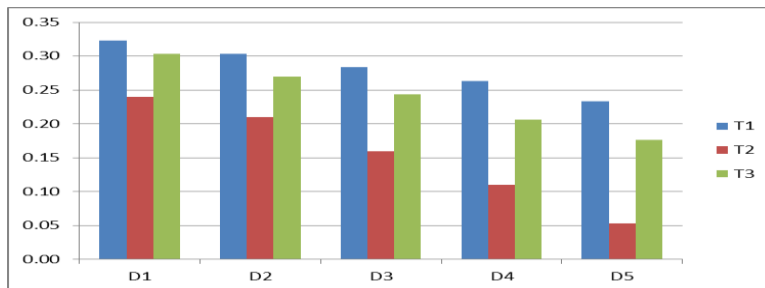


Fig.3 Effect of nutrients on Mg content in flowers of gerbera at different days after planting

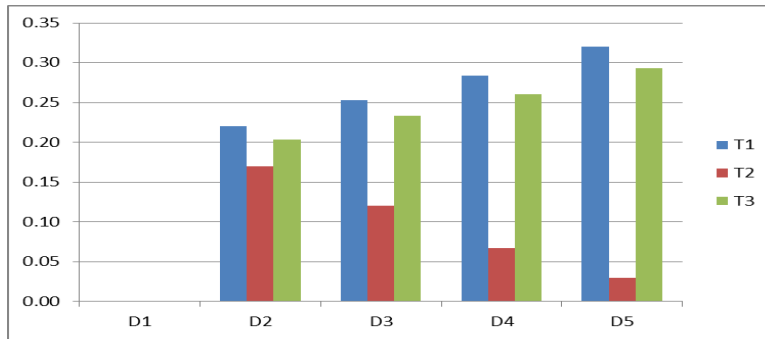


Fig.4 Effect of nutrients on Fe content in crown + leaves of gerbera at Different days after planting

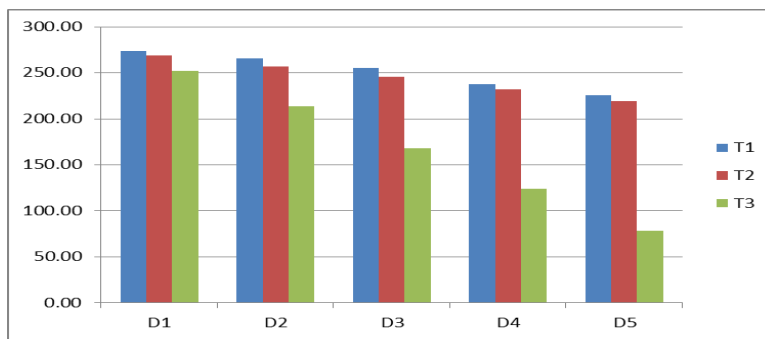


Fig.5 Effect of nutrients on Fe content in roots of gerbera at different days after planting

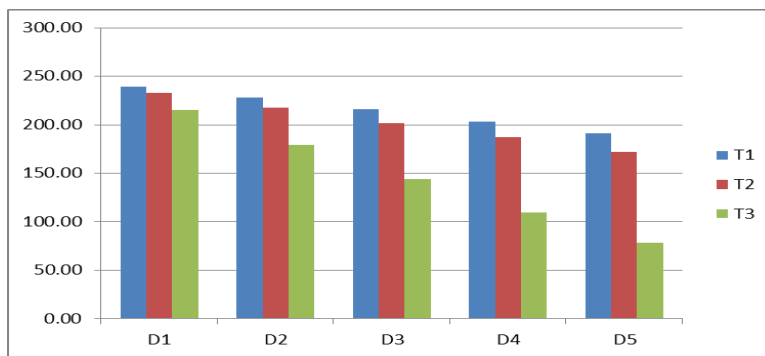
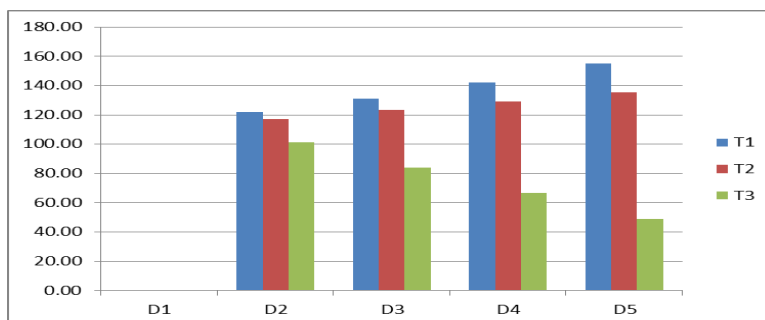


Fig.6 Effect of nutrients on Fe content in flowers of gerbera at different days after planting



There was a significant difference in Fe content with days and significantly higher Fe content was observed at 115 DAP (D1). The Fe content in crown + leaves and roots were found lowest in treatment excluding Fe as Fe was not supplied to these plants. The above findings were similar to the findings of Anjaneyulu (2008) who had given the leaf nutrient norms with leaf Fe content 164 – 224 ppm and less than 163 ppm were considered as low and deficient in Fe content.

Effect of nutrients on Fe content in flowers of gerbera at different days after planting

The Fe content was significantly lower (Figure 6) in treatment excluding iron (60.21 ppm as mean value). As the number of days increased, there was an increase in the Fe content in flower with all nutrients and treatment excluding Mg but decreased with treatment excluding iron. There was no significant difference in Fe content with days. The lower Fe content in flowers resulted in the disruption of normal metabolism of the crop due to nutritional disorder of the plant (Da Silva *et al.*, 2016) (Table 3).

Effect of nutrients on periodical nutrient uptake of gerbera

Effect of nutrients on Mg uptake by gerbera plant at different days after planting

The Mg uptake by gerbera plant was significantly lower in treatment excluding Mg ($0.09 \text{ g plant}^{-1}$) as compared to all nutrients treatment. The Mg uptake by gerbera plant was also lower in treatment excluding iron ($0.12 \text{ g plant}^{-1}$) as compared to all nutrients treatment which might be due to the interaction effect with other nutrients. The Mg uptake by gerbera plant was lower in case of treatment without Mg might be due to lower dry matter because of interveinal chlorosis

and lower Mg concentration in the different plant parts as Mg plays an essential role in chlorophyll formation in all photosynthetic organisms (Beale, 1999).

Effect of nutrients on Fe uptake by gerbera plant at different days after planting

From table 4, it can be seen that the Fe uptake by the plant was significantly lower in treatment excluding iron ($4.85 \text{ mg plant}^{-1}$) as compared to all nutrients treatment. The Fe uptake by the plant was also lower in treatment excluding Mg ($9.18 \text{ mg plant}^{-1}$) as compared to all nutrients treatment. The Fe uptake by the plant increased with increase in days with significantly higher uptake at 175 DAP ($9.17 \text{ mg plant}^{-1}$). The Fe uptake by gerbera plant was lower in case of treatment excluding Fe might be due to lower dry matter because of interveinal chlorosis as Fe is a precursor in the biosynthesis of tetrapyrroles including chlorophylls and heme, whose deficiency reduces the growth of both shoot and root of plants (Kumar and Soll, 2000).

The experiment revealed the importance of Magnesium and Iron in maintaining the flower quality of Gerbera. These essential nutrients have crucial roles in the plant growth and development, their deficiency indicating significant reduction of quality (test parameters) in Gerbera. Further research can be opted for nutrient interaction in flower crops which can generate information on the effect of nutrient mixtures in maintaining the quality of flower crops. Critical limits of these nutrients must be identified especially for floriculture crops as the range of optimum levels of these nutrients are narrow.

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