THE ASIAN JOURNAL OF HORTICULTURE
Volume **9** | Issue 1 | June, 2014 | 232-236
e ISSN- 0976-724X | Open Access-*www.researchjournal.co.in* |

Research Paper

Article history **:**
Received : 23.09.2013
Revised : 13.05.2014
Accepted : 24.05.2014

Effect of zinc and iron on growth, yield and quality of chrysanthemum (*Dendrathemum grandiflorum* Tzeuleu)

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ABSTRACT : A field experiment was carried out to study the effect of zinc and iron on growth, yield and quality of chrysanthemum during 2009-2010, in Randomized Block Design comprised of sixteen treatments with three replications in the Department of Horticulture, Annamalai University, Annamalainagar, Tamil Nadu, India. Sixteen treatments were formulated with three levels (0.25, 0.5 and 0.75%) each of zinc sulphate and ferrous sulphate individually and in combination. The control was the usual practice of the farmers. Various biometric observations on growth and physiological viz., plant height, stem girth, number of branches and leaves per plant, leaf area and chlorophyll content, flowering and yield attributes *viz.*, number of flowers per plant, flower stalk length, flower head diameter, flower head weight, flower yield per plant and hectare and quality attributes *viz.*, xanthophyll and carotenoid content, visual rating and shelf life were recorded. The results revealed that the treatment combination of 0.5% zinc sulphate +0.5% ferrous sulphate (T_{12}) was found to be the best in growth, yield and quality attributes followed by 0.5% zinc sulphate +0.75% ferrous sulphate (T_{13}) and 0.5% zinc sulphate +0.25% ferrous sulphate (T_{11}).

KEY WORDS : Micronutrients, Zinc, Iron, Xanthophyll, Carotenoid, Chrysanthemum

HOW TO CITE THIS ARTICLE : Karuppaiah, P. (2014). Effect of zinc and iron on growth, yield and quality of chrysanthemum (*Dendrathemum grandiflorum* Tzeuleu). *Asian J. Hort.*, **9**(1) : 232-236.

Chrysanthemum (*Dendrathemum grandiflorum* Tzeuleu). Syn. *C.morifolium* Ramat, is an important commercial flower crop. It is the second largest flower crop grown all over the world. It's known as "queen of the east". There is hardly any other garden flower which has such diverse and beautiful range of colour shades and shapes as chrysanthemum, making it suitable for every purpose conceivable for a flower crop.

Therefore, its cultivation has expanded in non traditional area also. There is an ample scope to enhance the productivity of chrysanthemum by adopting proper crop management techniques. In order to meet the over increasing demand on production of quality flowers, to increase productivity and to overcome the physiological disorders, application of major and micronutrients are inevitable. Now-a-days, micronutrients especially zinc and iron are gradually gaining momentum among the flower growers because of their beneficial nutritional support and to ensure better harvest and returns. A suitable micronutrient dose, period and method of application will certainly improve the production and quality of flower crops (Gurav *et al.*, 2004). Best response of African marigold for small quantities of micronutrients have been demonstrated by Balakrishnan *et al.* (2007). Hence, a study was undertaken to study the response of zinc and iron on growth, yield and quality of chrysanthemum cv. CO1.

RESEARCH METHODS

The present study was carried out in winter season of 2009-2010 at Annamalainagar, Cuddalore district of Tamilnadu. The experimental field is situated at $11^0$24' N latitude, $76^0$44' E longitude and at an altitude of 5.79m above mean sea level. The mean annual rainfall is 1500mm. The average maximum and minimum temperature and relative humidity are 33.5^{0}C, 22.5^{0}C and 88 per cent, respectively. The soil of the experimental field was clay loam with a pH of 6.5 and contained 250.6, 19.5 and 256.8 kg/ha of available nitrogen, phosphorus and

potassium, respectively Sixteen treatments were laid-out in RBD with three replications. The details of treatment combinations are as follows. T_1-Control, T_2-0.25% $ZnSO_4$, T_3-0.5% $ZnSO_4$, T_4-0.75% $ZnSO_4$, T_5-0.25% $FeSO_4$, T_6-0.5% $FeSO_4$, T_7-0.75% $FeSO_4$, T_8-0.25% $ZnSO_4$+0.25% $FeSO_4$, T_9-0.25% $ZnSO_4$+0.5% $FeSO_4$, T_{10}-0.25% $ZnSO_4$ +0.75% $FeSO_4$, T_{11}-0.5% $ZnSO_4$+0.25% $FeSO_4$, T_{12}-0.5% $ZnSO_4$+0.5% $FeSO_4$+ T_{13}-0.5% $ZnSO_4$+0.75% $FeSO_4$, T_{14}-0.75% $ZnSO_4$ +0.25% $FeSO_4$, T_{15}-0.75% $ZnSO_4$+0.5% $FeSO_4$, T_{16}-0.75% $ZnSO_4$+0.75% $FeSO_4$.

Twenty five days old seedlings were transplanted in beds of (5.0 x 4.0m) with a spacing of 45 x 35cm. The common fertilizer dose of 125:120:25kg NPK per ha was applied to all the treatments through urea, single super phosphate and MOP, respectively. Micronutrients were applied as foliar spray as per treatment schedule on 30 and 45 days after transplanting. The total chlorophyll content was estimated in a fully expanded third leaf from the tip by adopting the procedure of Yoshida *et al.* (1971) and the xanthophyll and carotenoid contents of the flowers were estimated as per the procedure of Pathmanaban *et al.* (1996) and Lewis (1993), respectively.

RESEARCH FINDINGS AND DISCUSSION

The results of the present study revealed that foliar spray of zinc and iron individually and incombination significantly influenced the plant growth attributes (Table 1). The plants which received 0.5% zinc sulphate and 0.5% ferrous sulphate (T_{12}) expressed the maximum plant height (54.62cm), stem girth (3.33cm) and number of branches per plant (10.23) followed by the treatment combination of 0.5% zinc sulphate and 0.75% ferrous sulphate (T_{13}). Zinc and iron act as the activator of several enzymes, alcoholic dehydrogenase, pyridine nucleotide dehydragenase and carbonic anhydrase (Duarte *et al.*, 1992). Zinc and iron also favour the storage of more carbohydrates through photosynthesis, which may inturn be the attributing factor for the positive effect on growth attributes (Senthamizhselvi, 2000). Further more, the maximum influence of the best treatment might be due to the right combination and appropriate time of application also.

The maximum number of leaves per plant (52.15), leaf area (53.17 cm^2) (Table 1) and chlorophyll content (0.597 mg g^{-1}) (Fig.1) were recorded in T_{12} followed by T_{13}. The significant variation in number of leaves per plant, leaf area and chlorophyll content in the treatment plants than the control might be due to the direct influence of zinc and iron on chlorophyll metabolism and photosynthetic efficiency of the plant as opined by Hatwar *et al.* (2004) in chillies. Also zinc and iron act as catalyst in formation of chlorophyll and several enzymes. Similar findings were reported by Gurav *et al.* (2004) in gerbera and Karuppaiah (2006) in French marigold.

Among the different treatments, the treatment combination of 0.5% zinc sulphate +0.5% ferrous sulphate recorded the maximum number of flowers per plant (89.91), flower stalk length (8.92 cm), flower head diameter (6.40cm) and flower head weight (2.48 g flower-1) followed by T_{13}. (Table 2) The minimum was recorded in control. The increase in flowering attributes might be due to the beneficial role of zinc and iron in enhancing the translocation of carbohydrates, minerals, water and aminoacids from the site of synthesis to the storage tissue especially on flowers which inturn increase the number, size and weight of flowers. Similar results also

Table 1 : Effect of micronutrients on growth and physiological attributes of chrysanthemum

Treatments	Plant height (cm)	Stem girth (cm)	Number of branches $plant^{-1}$	Number of leaves $plant^{-1}$	Leaf area (cm^2)
T_1 – Control	42.12	2.15	6.16	37.41	29.70
T_2-0.25% $ZnSO_4$	43.35	2.55	7.26	39.79	31.50
T_3-0.5% $ZnSO_4$	45.98	2.77	8.04	40.98	38.12
T_4-0.75% $ZnSO_4$	44.47	2.67	7.74	42.18	35.35
T_5-0.25% $FeSO_4$	44.24	2.62	7.50	40.98	33.45
T_6-0.5% $FeSO_4$	46.69	2.79	8.22	43.53	38.92
T_7-0.75% $FeSO_4$	44.47	2.73	7.86	42.71	37.25
T_8-0.25% $ZnSO_4$+0.25% $FeSO_4$	47.07	2.85	8.36	44.38	39.75
T_9-0.25% $ZnSO_4$+0.5% $FeSO_4$	47.87	2.91	8.61	45.39	42.18
T_{10}-0.25% $ZnSO_4$ +0.75% $FeSO_4$	48.96	3.00	8.87	46.49	44.03
T_{11}-0.5% $ZnSO_4$+0.25% $FeSO_4$	52.11	3.21	9.73	49.94	49.55
T_{12}-0.5% $ZnSO_4$+0.5% $FeSO_4$	54.62	3.33	10.23	52.15	53.17
T_{13}-0.5% $ZnSO_4$+0.75% $FeSO_4$	53.51	3.28	9.99	51.05	51.37
T_{14}-0.75% $ZnSO_4$ +0.25% $FeSO_4$	51.26	3.12	9.45	48.51	47.72
T_{15}-0.75% $ZnSO_4$+0.5% $FeSO_4$	50.11	3.07	9.17	47.66	45.87
T_{16}-0.75% $ZnSO_4$+0.75% $FeSO_4$	47.46	2.89	8.49	44.89	40.55
C.D.	1.35	0.13	0.40	1.73	2.76

reported by Sha and Karuppaiah (2005) in chilli, Balakrishnan *et al.* (2007) in African marigold and Naveenkumar *et al.* (2009) in chrysanthemum.

With regard to flower yield, T_{12} (0.5% $ZnSO_4$+0.5% $FeSO_4$ foliar spray on 30 and 45 DAT) recorded the maximum flower yield per plant (201.74 g plant^{-1}) and flower yield per hectare (21.14 t ha^{-1}) followed by T_{13} and T_{11}. (Table 3) Application of zinc and iron not only relieved the chlorosis and produced healthy green plants but also increased the synthesis of chlorophyll, growth promoting substances and mobility of minerals, water, photosynthates and aminoacids from the source to sink which may inturn increase the flower production and ultimately flower yield. Similar results were also obtained by Nag and Biswas (2002) in tuberose, Balakrishnan *et al.* (2007) in African marigold and Naveenkumar *et al.* (2009) in chrysanthemum. Regarding the

Table 2 : Effect of micronutrients on flowering attributes of chrysanthemum

Treatments	Numbers of flowers per plant	Flower stalk length (cm)	Flower head diameter (cm)	Flower head weight (g flower^{-1})
T_1 – Control	63.02	5.90	3.58	2.13
T_2-0.25% $ZnSO_4$	67.32	6.24	3.89	2.14
T_3-0.5% $ZnSO_4$	73.45	6.81	4.53	2.18
T_4-0.75% $ZnSO_4$	71.60	6.68	4.08	2.15
T_5-0.25% $FeSO_4$	69.47	6.47	4.02	2.15
T_6-0.5% $FeSO_4$	74.35	6.88	4.63	2.20
T_7-0.75% $FeSO_4$	72.53	6.74	4.23	2.17
T_8-0.25% $ZnSO_4$+0.25% $FeSO_4$	75.26	6.97	4.76	2.22
T_9-0.25% $ZnSO_4$+0.5% $FeSO_4$	77.09	7.14	4.92	2.23
T_{10}-0.25% $ZnSO_4$ +0.75% $FeSO_4$	79.22	7.39	5.28	2.23
T_{11}-0.5% $ZnSO_4$+0.25% $FeSO_4$	85.64	8.20	5.98	2.36
T_{12}-0.5% $ZnSO_4$+0.5% $FeSO_4$	89.91	8.92	6.40	2.48
T_{13}-0.5% $ZnSO_4$+0.75% $FeSO_4$	87.78	8.57	6.20	2.46
T_{14}-0.75% $ZnSO_4$ +0.25% $FeSO_4$	83.49	7.82	5.74	2.25
T_{15}-0.75% $ZnSO_4$+0.5% $FeSO_4$	81.36	7.61	5.48	2.24
T_{16}-0.75% $ZnSO_4$+0.75% $FeSO_4$	76.19	7.05	4.87	2.22
C.D. (P=0.05)	2.13	0.35	0.34	0.04

Table 3 : Effect of micronutrients on yield and quality characters of chrysanthemum

Treatments	Flower yield per plant (g)	Flower yield per hectare (tha^{-1})	Shelf life (days)	Visual rating
T_1 – Control	84.63	15.64	6.73	6.11
T_2-0.25% $ZnSO_4$	90.13	16.52	6.96	6.98
T_3-0.5% $ZnSO_4$	98.30	17.84	7.44	7.65
T_4-0.75% $ZnSO_4$	92.63	17.35	7.31	7.04
T_5-0.25% $FeSO_4$	94.83	16.96	7.14	7.00
T_6-0.5% $FeSO_4$	100.21	18.10	7.52	7.72
T_7-0.75% $FeSO_4$	96.40	17.56	7.37	7.52
T_8-0.25% $ZnSO_4$+0.25% $FeSO_4$	101.80	18.33	7.60	7.78
T_9-0.25% $ZnSO_4$+0.5% $FeSO_4$	104.47	18.73	7.73	8.01
T_{10}-0.25% $ZnSO_4$ +0.75% $FeSO_4$	107.66	19.12	7.92	8.18
T_{11}-0.5% $ZnSO_4$+0.25% $FeSO_4$	116.14	20.46	8.44	8.67
T_{12}-0.5% $ZnSO_4$+0.5% $FeSO_4$	201.74	21.14	8.75	9.18
T_{13}-0.5% $ZnSO_4$+0.75% $FeSO_4$	188.54	20.86	8.60	8.81
T_{14}-0.75% $ZnSO_4$ +0.25% $FeSO_4$	113.54	20.46	8.27	8.45
T_{15}-0.75% $ZnSO_4$+0.5% $FeSO_4$	110.64	19.61	8.09	8.21
T_{16}-0.75% $ZnSO_4$+0.75% $FeSO_4$	103.32	18.54	7.67	6.79
C.D. (P=0.05)	4.48	0.64	2.13	0.33

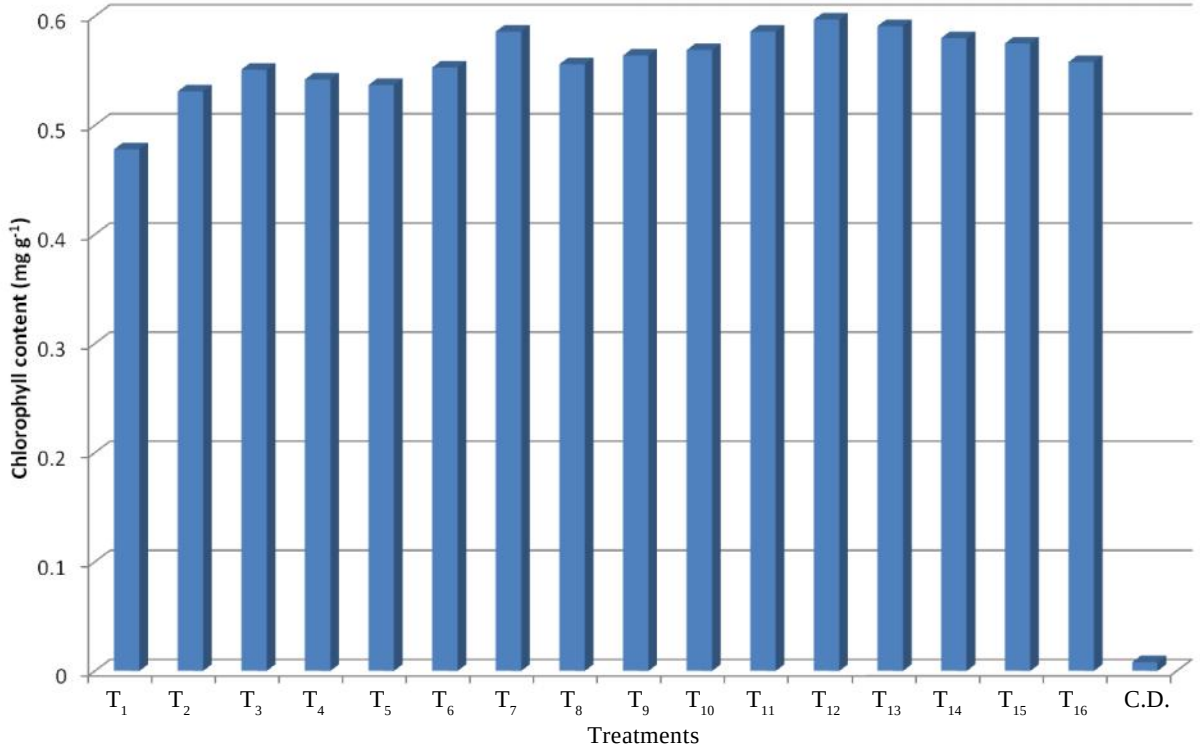

Fig. 1 : Effect of micronutrients on chlorophyll content of chrysanthemum

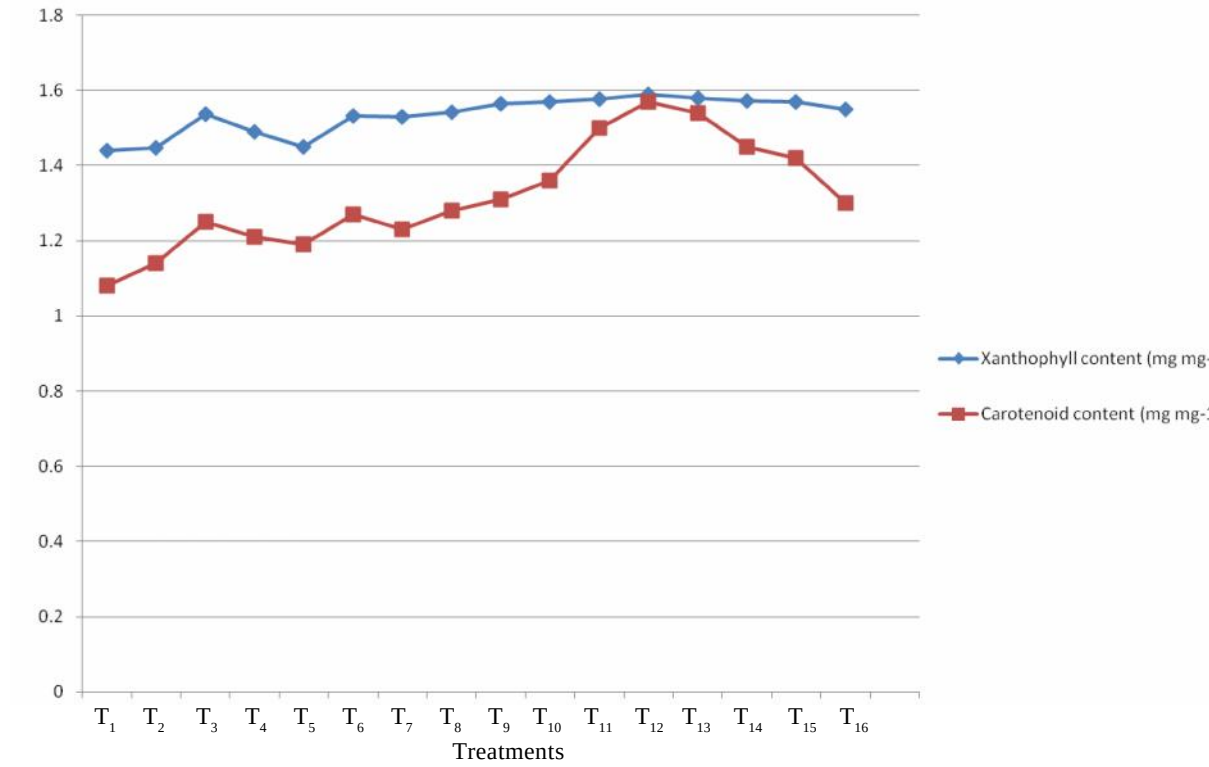

Fig. 2 : Effect of micronutrients on xanthophyll and carotenoid content of chrysanthemum

quality aspects *viz.*, xanthophyll and carotenoid content (Fig. 2), visual rating and shelf life (Table 3), the treatment combination of 0.5% zinc sulphate and 0.5% ferrous sulphate was found to be the excellent treatment followed by T_{13} and T_{11}. Better quality of chrysanthemum flower might be due to higher carbohydrate, other essential nutrients, plant growth regulators and enzymes deposition in flower cells by the zinc and iron physiological role which resulted in production of good quality attractive flowers. This good quality flowers suppress ethylene and abscisic acid and prolong the shelf life and appearance of flowers. Similar findings were given by Tisdale *et al*. (1985) in orchids and Vijayakumar (2009) in asparagus.

From the results, it is concluded that foliar spray of 0.5% zinc sulphate and 0.5% ferrous sulphate on 30 and 45 DAT resulted in better growth, higher flower yield as well as quality of chrysanthemum under open field cultivation.

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