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Role of zinc and boron on growth performance of African marigold (*Tagetes erecta* L.)

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Abstract
An experiment was formulated with four micro nutrients *viz.*, Zinc (@ 0.25% and 0.5%), Boron (@ 0.25% and 0.5%), and their combinations were applied as foliar spray in two different intervals (One at 25 days after transplanting and other at 50 days after transplanting) to African marigold var. Pusa Basanti in the Horticulture farm of B.T. College, Madanapalle, Andhra Pradesh during 2017. Observations on plant height, number of branches days to first flowering, number of flowers, single flower weight, flower yield and xanthophyll content were recorded and statistically analyzed. From the experiment, it is concluded that foliar application of Zinc @ 0.5% + Boron @ 0.5% at two different intervals 20 and 40 days after transplanting showed better growth, flowering and xanthophyll content in African Marigold var. Pusa Basanti.

Keywords: African marigold, zinc, boron, flowering

Introduction
Micronutrients are to be necessarily taken up by the plants from soil or supplemented through foliar application for good growth and yield of crops and maximizing the efficient use of applied N, P and K. In the absence of these micronutrients, the plants are known to suffer from physiological disorders which eventually lead to imbalanced growth and low yield. Marigold is such a potential flower crop which responds to micro nutrients. Balakrishnan (2005) [2] found that application of FeS04, MnS04 and their combination produced maximum plant spread, number of branches, leaf area, fresh and dry matter accumulation, crop growth rate, number of flowers per plant, yield of flowers and carotene content in *Tagetes erecta* cv. Siracole. Patokar *et al.* (2017) [8] stated that foliar application of 0.5% zinc recorded significantly maximum vegetative growth in respect of plant height, spread, yield in respect of number of flowers plant and flower yield, quality in respect of flower diameter, weight of flower and longevity of intact flower and the earliest first flower bud initiation in marigold. Hence, an investigation was to find out the influence of zinc and boron on growth, flowering and yield of African marigold.

Materials and Methods
The present investigation with four micro nutrients *viz.*, Zinc (@ 0.25% and 0.5%), Boron (@ 0.25% and 0.5%), and their combinations were applied as foliar spray in two different intervals (One at 25 days after transplanting and other at 50 days after transplanting) to African marigold var. Pusa Basanti in the Horticulture farm of B.T. College, Madanapalle, Andhra Pradesh during 2017. The experiment was laid out in randomized block design with three replications. Regular cultural practices were adopted to raise the crop successfully. Observations on plant height, number of branches days to first flowering, number of flowers, single flower weight, flower yield and xanthophyll content were recorded and statistically analyzed.

Results and Discussion
Significant variations were noticed among the eleven treatments investigated. Maximum plant height (108.79 cm) was recorded under the treatment T9 (Zinc @ 0.5% + Boron @ 0.5%). This is followed by the treatment T7 (Zinc @ 0.25% + Boron @ 0.5%) which recorded a plant height of 106.83 cm. However, the minimum plant height (99.79 cm) was noticed under the treatment T1 (Control). Maximum number of branches (17.82) was recorded under the treatment T9 (Zinc @ 0.5% + Boron @ 0.5%) and the minimum number of branches (12.44 were noticed under T1 (Control).
The increased values obtained under the treatment T9 may be due to the application of micronutrient, Zn as it encourages, cell multiplication, cell division and cell differentiation

resulting in increased photosynthesis and translocation of food material which enhanced the plant height and is also improved root system of plants resulting in absorption of more water and nutrients and its utilization. Moreover, micronutrients activate several enzymes (catalase, carbonic dehydrogenize, tryptophan synthates etc.) and involved various physiological activities. Similar results were also obtained by Kakade *et al*. (2009) [5] in china aster, Balakrishnan (2005) [2] in marigold and Ahmad *et al*. (2010) [3] in Rose.

The plants sprayed with Zinc @ 0.5% + Boron @ 0.5% showed earliness in flowering (37.58 days) which is closely followed by those plants sprayed with T7 (Zinc @ 0.25% + Boron @ 0.5%) with 29.52 days. Micronutrients like zinc, favour to storage of more carbohydrates through photosynthesis, which may be enhanced to flower earlier. The result indicated that the foliar application of zinc might be stimulating metabolic activity with stimulating effect on cell wall loosing, increased cell elongation along with cell enlargement and cell differentiation resulting in increased photosynthesis and translocation of food material which might be enhanced the flowering mechanism. Similar results were also obtained by Bashir *et al*. (2013) [3] and Pal *et al*. (2016) [7] in Gerbera.

The data pertaining to the flowering character showed significant variations among the micronutrient treatments. Maximum number of flowers (58.14) was noticed under the treatment T9 (Zinc @ 0.5% + Boron @ 0.5%) which is closely followed by T7 (Zinc @ 0.25% + Boron @ 0.5%) with 56.84 flowers. However, minimum number of flowers (42.01) were recorded under T1 (Control).

The highest single flower weight (7.05 g) was recorded under the treatment T9 (Zinc @ 0.5% + Boron @ 0.5%) which is closely followed by T7 (Zinc @ 0.25% + Boron @ 0.5%) with 6.86 g. Maximum flower yield (415.32 g/plant) was recorded under the treatment T9 (Zinc @ 0.5% + Boron @ 0.5%) which is followed by T7 (Zinc @ 0.25% + Boron @ 0.5% with 387.73 g/plant. However, minimum number of flowers (237.91) were recorded under T1 (Control). The increased yield of flowers might be due to the application of zinc and Boron which 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. Similar results were also reported by Nath and Biswas (2003) [6] and Hardeep *et al*. (2003) [4] in tuberose. Maximum xanthophyll content (18.84 g kg-1 petal meal) was obtained from those plants sprayed with Zinc @ 0.5% + Boron @ 0.5% (T9). This is followed by T7 (Zinc @ 0.25% + Boron @ 0.5% with 17.82 g kg-1 petal meal. However, minimum xanthophyll content (14.72 g kg-1 petal meal) were recorded under T1 (Control).

Better quality flowers of marigold were produced due to application of 0.5% zinc and 0.5% Boron which might be due to enhanced vegetative growth resulted into production of more food material which in turn might have been utilized for better development of flowers. The results are in close conformity with the findings of Shah *et al*. (2016) [9] in marigold.

From the experiment, it is concluded that foliar application of Zinc @ 0.5% + Boron @ 0.5% at two different intervals 20 and 40 days after transplanting showed better growth, flowering and xanthophyll content in African Marigold var. Pusa Basanti.

Table 1: Effect of zinc and boron on performance of African marigold (*Tagetes erecta* L.)

T. No.	Treatment details	Plant height (cm)	Number of branches	Days to first flower initiation	Number of flowers per plant	Single flower weight (g)	Flower yield per plant (g/plant)	Xanthophyll content (g kg-1) petal meal
T1	Control	99.79	12.44	56.73	42.01	4.85	237.91	14.72
T1	Zinc @ 0.25%	101.92	15.34	47.65	51.53	5.37	278.01	15.54
T3	Zinc @ 0.5%	100.51	15.08	45.08	49.44	5.89	242.13	15.02
T3	Boron @ 0.25%	104.99	15.16	44.82	50.64	5.73	291.82	15.32
T5	Boron @ 0.5%	104.97	16.44	44.36	51.79	5.99	261.41	15.64
T6	Zinc @ 0.25% + Boron @ 0.25%	105.81	16.53	40.09	54.99	6.13	339.83	16.52
T7	Zinc @ 0.25% + Boron @ 0.5%	106.83	16.24	39.52	56.84	6.86	387.73	17.82
T8	Zinc @ 0.5% + Boron @ 0.25%	106.02	16.97	41.25	55.49	6.49	370.03	16.99
T9	Zinc @ 0.5% + Boron @ 0.5%	108.79	17.82	37.58	58.14	7.05	415.32	18.84
	S.Ed.	0.48	0.15	0.68	0.52	0.12	5.69	0.15
	CD (p = 0.05)	0.96	0.31	1.37	1.04	0.24	11.45	0.31

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