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Effect of Foliar Application of Micronutrients on Growth and Yield of Marigold (*Tagetes erecta* L.)

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ABSTRACT

The present study was conducted to investigate the effect of foliar application of micronutrients on growth and yield of marigold cv. Yellow Benz Tall during the year 2022-23 at the experimental farm of Annamalai University, Tamil Nadu to find out effect of various levels of micronutrients on marigold. The experiment included nine combinations of Fe and Zn micronutrient treatments with three replications, designed in Randomized Block Design. The treatments were *viz.,* T_1 [Control (75% N + 100% P + 75% K + Nano N and Nano K)], T_2 [T_1 + 0.5% $ZnSO_4$], T_3[T_1 + 0.5% $FeSO_4$], T_4 [T_1+ 0.5% $ZnSO_4$ + 0.5% $FeSO_4$], T_5 [T_1+ 0.25% Chelated Fe], T_6 [T_1+ 0.25% Chelated Fe + 0.5% $ZnSO_4$], T_7 [T_1 + Nano Zn], T_8 [T_1+ 0.5% FeSO4 + Nano Zn], T_9 [T_1+ 0.25% Chelated Fe + Nano Zn]. The results revealed that crop responded significantly to micronutrient application like plant height (72.24 cm), number of primary branches (16.09), number of secondary branches (60.36), number of nodes (30.68), internodal length (6.87 cm), stem girth (4.56 cm) and plant spread (63.17 cm^2) and flowering parameters like days taken for flowering (27.20) shown earliness, duration of flowering (99.48 days), number of flowers per plant (56.39), single flower weight (14.03 g), flower diameter (10.05 cm) and yield parameter like yield per plant (593.36 g) with T_9 (T_1 + 0.25% Chelated Fe + Nano Zn). Foliar application of Fe and Zn improved growth and photosynthetic characteristics in marigold. It promotes nutrient availability and plant uptake, increase crop growth, yield and physiological characters, reduce dependence on costly chemical fertilizer inputs and minimize environmental risks. It is concluded that foliar application of micronutrients in combination of Fe and Zn enhanced growth, flowering and yield parameters.

Keywords: Chelated iron, Foliar application, Marigold, Micronutrient, Yellow Benz Tall, zinc.

INTRODUCTION

Marigold (*Tagetes erecta* L.) belongs to the family Asteraceae; it is an herbaceous annual. The genus *Tagetes* consists of 55 species, among which the African marigold (*Tagetes erecta* L.) and French marigold (*Tagetes patula* L.) are of commercially importance (Mahdi and Said, 2022), lemon marigold (*Tagetes tenuifolia*) and Mexican mint marigold (*Tagetes lucida*) are other important types (Shalaby *et al,* 2022). It is one of the most important ornamental crops in the world. Indian flower growers highly prefer this crop owing to its short life cycle, excellent adaptability to diverse agro-climatic conditions, better shelf-life, prolonged flowering period, ease in cultivation and varied flower shapes and colours (Mishra *et al,* 2022).

The fertilization is one of the important factors that determine the crop growth, adding chemical fertilizers in recommended combinations boost soil chemical, physical as well as biological environment (Mahdi *et al,* 2022). In Indian agriculture, the relevance of micronutrients is well understood as their application has greatly enhanced the production of variety of crops. Historically, there was no need to supplement micronutrients in soil because these were found naturally. However, most soils due to intensive farming practices, increased salinity and soil pH, lack availability of required micronutrients to plants (Jena *et al,* 2022). Usually, micronutrients improve chlorophyll pigments, synthesis of protein and nucleic acid, which further improves growth and flowering of floral crops (Mudassir *et al,* 2021). The suitable amounts of required micronutrients, their time and method of application are vital for enhanced growth and flowering. Foliar spray by direct application on aerial plant parts is effective method than root fertilization to rectify deficiency symptoms, maintain nutritional status and improve growth and produce quality in

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marginal soils (Niu *et al,* 2020). Foliar application promotes nutrient availability and plant uptake, increase crop growth, yield and physiological characters, reduce inputs of chemical fertilizers and minimize environmental risks (Mohana *et al,* 2021).

It has been shown that micronutrients such as Fe and Zn are necessary for plant intensification than those of primary nutrients (Yadegari, 2022). Among the micronutrients, iron is an important micronutrient for plants and it plays a vital role in various physiological and metabolic processes of plants (Jena *et al,* 2023). Iron is necessary for protein, chlorophyll and thylakoid synthesis, respiratory enzymes, energy transportation and cofactor to active the enzymes (George and Manuel, 2013).On other hand, zinc plays crucial role in several biosynthesis processes in plants, acting as a cofactor for numerous enzymes and influencing diverse biological mechanisms including photosynthesis, nucleic acid metabolism and carbohydrate and protein biosynthesis (Choudhary *et al,* 2016). Assimilation network of Zn comprises the synchronised activities of Zn absorption, translocation, trafficking, chelation and sequestration, providing a sufficient amount of Zn to different types of plant cells, at all stages of growth and under various environments (Sobati-Nasab *et al,* 2021).

Even though, the cultivation of marigold is expanding in India, the farmers are not having complete awareness about micronutrient application viz. Fe and Zn in enhancing the yield and quality of marigold. The aim of this research is to determine the effect of foliar application of Fe and Zn on growth and yield of marigold to introduce the best combination of micronutrients for better yield in marigold.

MATERIALS AND METHODS

The experiment was carried out during 2022-2023 at floriculture yard, Department of Horticulture, Annamalai University, Tamil Nadu. Experimental field was located at 11°24' North latitude and 79°44' East longitude at an altitude of 5.79 m above mean sea level. For the estimation of physical and chemical properties of soil, samples were collected from different spots of experimental sites before and after initiation of the experiment and thoroughly mixed to make a representative soil sample. The experiment was carried out in clay loam soil. A popular, high yielding variety of African marigold hybrid cv. Yellow Benz Tall was chosen for the experiment. This field experiment was laid out in randomized block design with three replications.

Treatment details:

The experiment comprised with following eleven treatments *i.e.* T_1 [Control (75% N + 100% P + 75% K + Nano N and Nano K)], T_2 [T_1 + 0.5% $ZnSO_4$], T_3 [T1 + 0.5% $FeSO_4$], T_4 [T_1+ 0.5% $ZnSO_4$ + 0.5% $FeSO_4$], T_5 [T_1+ 0.25% Chelated Fe], T_6 [T_1+ 0.25% Chelated Fe + 0.5% $ZnSO_4$], T_7 [T_1 + Nano Zn], T_8 [T_1+ 0.5% $FeSO_4$ + Nano Zn], T_9 [T_1+ 0.25% Chelated Fe + Nano Zn].

Cultivation practices:

Seeds of Yellow Benz Tall were sown uniformly in pro trays filled with organic growing media. The entire field was ploughed three to four times until fine tilth and exposed to the sun for soil solarisation. The plots were laid with a spacing of 2 m x 1.5 m to form a 3 m^2 area. Twenty-five days old seedlings were transplanted in the main field with a spacing of 45 cm x 30 cm. The crop was irrigated depending on soil moisture status at an interval of 5 days. Earthing up was done at 25th day after transplanting to prevent the crop form lodging. Pinching was done 25th day after transplanting by removing the apical shoots of the plants to promote lateral shoots. Application of nano nutrients such as nano nitrogen and nano potassium were given as foliar application at 20th and 40th DAT (2 sprays each). The foliar application of nano nutrients was given as per the treatments @ 4 ml per liter with power sprayer. Uniform cultural practices were followed for all the treatments.

Observations recorded:

The observations recorded on growth parameters are plant height, primary branches, secondary branches, number of nodes, intermodal length, stem girth, plant spread and flowering yield parameters like days to taken for flowering, duration of flowering in days, number of flowers per plant, single flower weight, flower diameter and yield per plant.

Statistical methods:

The experiment data were statistically analysed using the methods suggested by Panse and Sukhatme (1978). The critical difference was worked out at 5 per cent probability for significance. The analysis was carried out using the personal computer based AGRISTAT package.

Fig. 1: View of experimental field of marigold (*Tagetus erecta* L.)

RESULTS AND DISCUSSION

Growth parameters

The data on the effect of foliar application of micronutrients on plant height recorded at 30, 60 and 90 DAT are presented in Table 1 and Fig. 1. A progressive increase in plant height was noted in every treatment at regular intervals. Among the various treatments tested T_9 (T_1 + 0.25% Chelated Fe + Nano Zn) recorded the highest plant height of 72.24 cm at 90 DAT and it was followed by T_8 (T_1+ 0.5% $FeSO_4$ + Nano Zn) which recorded 67.53 cm and T_6 (T_1 + 0.25% Chelated Fe + 0.5% $ZnSO_4$) of 62.57 cm at DAT. The least plant height of 45.20 cm at 90 DAT was observed in T_1 (75% N + 100% P + 75% K + Nano N and Nano K). Similarly, maximum number of primary (16.09) and secondary branches (60.36) was observed in treatment T_9 (T_1 + 0.25% Chelated Fe + Nano Zn) followed by treatment T_8 (T_1+ 0.5% $FeSO_4$ + Nano Zn) and T_6 (T_1 + 0.25% Chelated Fe + 0.5% $ZnSO_4$). However, minimum number of primary and secondary branches was recorded 11.90 and 47.60 in treatment T_1 (Control 75% N + 100% P + 75% K + Nano N and Nano K). The treatments T_2 (T_1 + 0.5% $ZnSO_4$), T_3 (T_1+ 0.5% $FeSO_4$), T_4 (T_1+ 0.5% $ZnSO_4$ + 0.5% $FeSO_4$), T_5 (T_1+ 0.25% Chelated Fe) and T_7 (T_1 + Nano Zn). Also, significantly maximum number of nodes (30.68), internodal length (6.87 cm), stem girth (4.56 cm) and plant spread (63.17cm^2) was recorded and in T_9 (T_1 + 0.25% Chelated Fe + Nano Zn) followed by T_8 (T_1+ 0.5% $FeSO_4$ + Nano Zn) and T_6 (T_1 + 0.25% Chelated Fe + 0.5% $ZnSO_4$).

The positive effect of Fe and Nano Zn in promoting the plant height was might be due to the role of zinc in active synthesis of tryptophan, an amino acid which is a precursor of indole acetic acid (IAA) which stimulates the growth of plant. Zinc has harmonious effect on phosphorus absorption which may function as a source of energy for the synthesis of auxin and it could be indorsed as stem elongation. While Fe, involves in the bioassay of chlorophyll, catalytic function, enzymatic activities and other metabolic processes which helps in increasing the growth of the plants. Fe associate with chloroplast and enhances the rate of photosynthesis leading to better vegetative growth. (Raghatate *et al,* 2015) reported that foliar application of $FeSO_4$ 0.5% + $ZnSO_4$ 0.5% recorded the highest plant height and number of primary branches per plant. Plants with a greater number of branches stimulates cell division, which outcomes in increased biomass and vegetative growth (Yadav *et al,* 2024). Treatments with Fe significantly increased node number compared with treatments without foliar spray of Fe (Bestic-Pennings *et al,* 2024).

Flowering and yield parameters

The results presented in Table 2 and Fig. 2 revealed that significant differences were exhibited among the various treatments on days taken for first flowering. The commencement of flowering was early in T_9 (T_1 + 0.25% Chelated Fe + Nano Zn) with 27.20 day and it was followed by T_8 (T_1+ 0.5% $FeSO_4$ + Nano Zn) and T_6 (T_1+ 0.25% Chelated Fe + 0.5% $ZnSO_4$). While, duration of flowering (99.48 days), number of flowers per plant (56.39), single flower weight (14.03 g), flower diameter (10.05 cm) and yield per plant (593.36 g) performed highest in treatment T_9 (T_1 + 0.25% Chelated Fe + Nano Zn), followed by (T_1+ 0.5% $FeSO_4$ + Nano Zn) and T_6 (T_1+ 0.25% Chelated Fe +

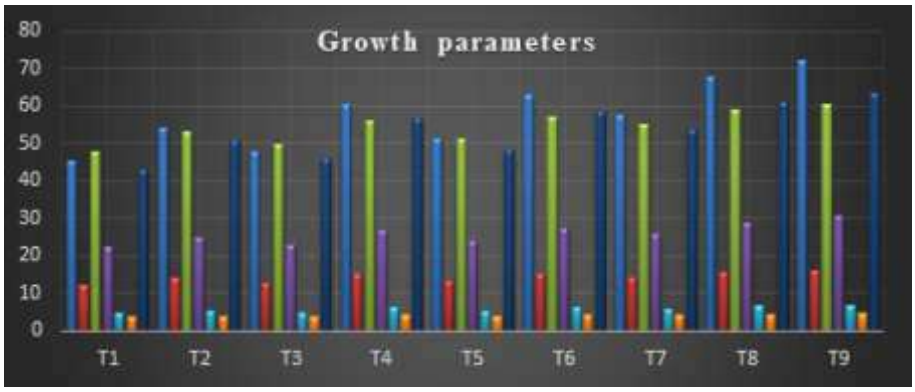

Fig. 1: Effect of treatments on growth parameters of Marigold

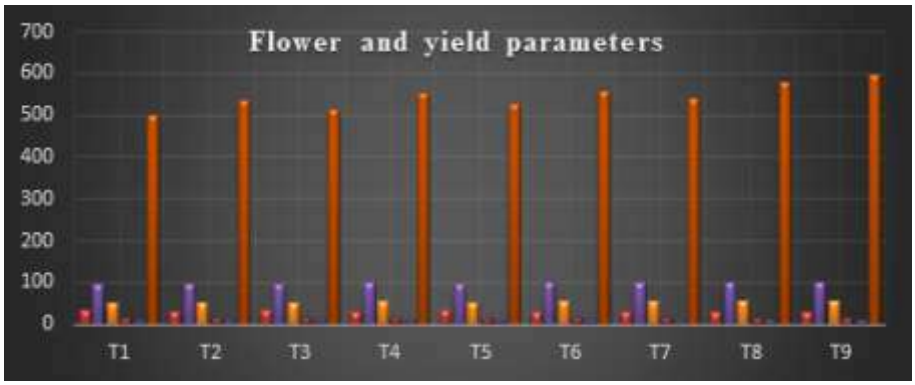

Fig. 2: Effect of treatments on flower and yield parameters of Marigold

Table 1.Effect of foliar application of micronutrients on growth parameters of marigold (*Tagetes erecta* L.) cv. Yellow Benx Tall.

Sr. No	Plant height (cm) at 90 DAT	Number of Primary branches	Number of Secondary branches	Number of nodes	Internodal length (cm)	Stem girth (cm)	Plant spread (cm^2)
T_1	45.2	11.9	47.6	22.19	4.67	3.74	42.68
T_2	53.94	13.87	52.96	24.87	5.37	4.03	50.73
T_3	47.84	12.59	49.56	22.98	4.88	3.82	45.52
T_4	60.49	14.85	56.13	26.81	6.12	4.25	56.48
T_5	50.87	13.18	50.95	23.91	5.1	3.94	48.12
T_6	62.57	15.01	56.98	27.35	6.27	4.31	58.24
T_7	57.24	14.25	54.82	25.67	5.78	4.11	53.75
T_8	67.53	15.47	58.76	28.56	6.48	4.43	60.84
T_9	72.24	16.09	60.36	30.68	6.87	4.56	63.17
S. ED	1.21	0.12	0.55	0.37	0.09	0.03	0.98
CD (p = 0.05)	2.45	0.26	1.11	0.74	0.17	0.06	1.96

0.5% $ZnSO_4$). Increasing the micronutrient concentration shows a significant effect on flowering characters by increasing the concentration of flowers by plants and due to higher concentration of carbohydrates and their translocation from the leaves to developing flower buds and produces higher number of flowers per plant. The application of zinc with combination of Fe played an important role for extending the vegetative growth, pollen function and fertilisation (Annasamy and Karuppapiah, 2024). Sha and Karuppaiah (2005) reported that the increasing flowering characters may be due to the beneficial role of micronutrients in enhancing the translocation of carbohydrates, minerals and amino acids from the site of the synthesis to the storage tissues of flowers.

Table 2. Effect of foliar application of micronutrients on flowering and yield parameters of marigold (*Tagetes erecta* L.) cv. Yellow Benx Tall.

Sr. No	Days taken for flowering	Duration of flowering (days)	Number of flowers/plant	Single flower weight (g)	Flower diameter (cm)	Yield/plant (g)
T_1	32.52	92.29	48.5	13.63	8.87	496.51
T_2	30.64	95.82	51.92	13.77	9.28	531.54
T_3	31.98	93.54	49.66	13.68	8.97	510.48
T_4	29.21	97.45	53.87	13.84	9.69	550.76
T_5	31.56	94.35	51.12	13.73	9.15	523.22
T_6	29	97.86	54.33	13.85	9.76	556.35
T_7	29.99	96.64	53.09	13.8	9.46	539.81
T_8	28.57	98.72	55.23	13.95	9.88	576.85
T_9	27.2	99.48	56.39	14.03	10.05	593.36
S. ED	0.19	0.27	0.33	0.06	0.04	3.86
CD (p = 0.05)	0.39	0.56	0.67	0.02	0.09	7.76

CONCLUSION

It was concluded that the foliar application of Fe and Zn at different concentration combinations had shown a significant effect on growth, flowering and yield parameters of marigold. Among the treatments, T_9 (T_1 + 0.25% Chelated Fe + Nano Zn) had performed as best of all the parameters. Thus, combined application of micronutrients had a more noticeable effect in assessment with the individual use of the micronutrients. Utilizing a combination of micronutrients in cultivation improves the plant health and fostering vigorous crop development. This study delivers valuable information about the foliar application with various treatment combinations of micronutrients where soil have undesirable characteristics and chemical properties in particular.

REFERENCES

Annasamy K and Karuppapiah P (2024). Effect of micronutrients on flowering an yield attributes of chrysanthemum (*Dendranthemum grandiflora*Tzeuleu) cv. CO1. *Int J Pl Soil Sci* **36**(2): 48-52.

Bestic-Pennings, A E, Fisher P R and Huang J (2024). Micronutrient Fe and Mn uptake from peat by marigold and perunia. *Scientia Hort* **326**: 1-12. DOI: https://doi.org/10.1016/j.scienta.2023.112706.

Choudhary A, Mishra A, Bola, P K, Moond S K and Dhayal M (2016). Effect of foliar application of zinc and salicylic acid on growth, flowering and chemical constitute of African marigold cv. Pusa Narangi Gainda (*Tagetes erecta* L.). *J Appl Natural Sci* **8**(3): 1467-1470.

George P and Manuel J (2013). Low-cost tissue culture technology for the regeneration of some economically important plants for developing countries. *Int J Agri Environ Biotechnol* **6**: 703-711.

Jena L, Latha M R, Janaki P, Ganga M and Santhanakrishnan V P (2022). Integrated Zinc and Iron management practices for enhancing productivity and flower quality of marigold. *Int J Pl Soil Sci* **34**(21): 443-451.

Jena L, Latha M R, Janaki P, Ganga M and Santhanakrishnan V P (2023). Impact of integrated zinc and iron management practices on biochemical attributes and nutrient uptake of marigold cv. Local orange. *Int J Pl Soil Sci* **35**(11): 47-59.

Mahdi O M S and Said A K A J M (2022). Effect of adding NPK compound fertilizer and spraying with chelated iron on the growth and flowering of two cultivars of African marigold. *Texas J Agri and Biological Sci* **11**: 13-22.

Mishra P P, Beura S. Beura, R, Nath M R and Swastika S (2022). Effect of humic acid and nutrients on various quantitative attributes of African Marigold (*Tagetes erecta* L.) cv. Inca Yellow. *Biological Forum – An Int J* **14**(4a): 789-793.

Mohana M, Sureshkumar R, Sendhilnathan R, Rajkumar M, Barathkumar T R and Karthikeyan P K (2021). Effect of foliar application of organic and micronutrients on certain growth and physiological character of African marigold (*Tagetes erecta*L.) cv. Benz Tall. *Pl Archives* **21**(1): 2034-2037.

Mudassir S, Ahmad R and Anjum A (2021). Foliar application of micronutrients enhances growth, flowering, minerals absorption and postharvest life of tuberose (*Polianthes tuberosa* L.) in calcareous soil. *J Hort Sci and Technol* **4**(2): 41-47.

Niu J, Liu C, Huang M, Liu K and Yan D (2020). Effects of foliar fertilization: A review of current status and future perspectives. *J Soil Sci and Pl Nutri* **21**: 104-118.

Raghatate S M, Moon S S, Tembhare V J and Mohalkar M V (2015). Effect of foliar application of zinc and iron on growth and yield of marigold. *J Soil and Crops* **25**(1): 163-167.

Sha K and Karuppaiah P (2005). *Studies on the effect of foliar application of micronutrients in chilli (Capsicum annum L.),* National seminar on New Frontiers of soil sciences Research Towards sustainable. Annamalai University, p. 320.

Shalaby T A, EI-Newiry N A, EI-Tarawy M, EI-Mahrouk M E, Shala A Y, EI-Beltagi, H S, Rezk A A, Ramadan K M A, Shehata W F and EI-Ramady H (2022). Biochemical and physiological response of marigold (*Tagetes erecta* L.) to foliar application of salicylic acid and potassium humate in different soil growth media. *Gesunde Pflanzen* **75**: 223-236. DOI: https://doi.org/10.1007/s10343-022-00693-4.

Sobati-Nasab, Z, Alirezalu A and Noruzi P (2021). Improvement of physiological and phytochemical parameters of pot marigold (*Calendula officinalis*) using foliar application of zinc. *Agri and Natural Res* **55**: 81-88.

Yadav K L, Meena R, Mishra A, Singh S, Joshi U and Yadav K K (2024). Impact of zinc application on growth, yield and quality of African marigold in semi-arid conditions. *J Scientific Res Reports* **30**(10): 693-705.

Yadegari M (2022). The effect of foliar application of some micronutrient element on the content and composition of the essential oil of Damask rose (*Rosa damascena*Mill.). *Iran Agric Res* **41**(2): 35-49.

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