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## **Effect of Micro-nutrient on Plant Growth and Flower Yield of Calendula (*Calendula officinalis* L.) under Prayagraj Agro-climatic Condition, India**

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### **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

### **Article Information**

DOI: 10.9734/IJPSS/2022/v34i2231510

### **Open Peer Review History:**

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/90164>

**Original Research Article**

**Received 26 June 2022**  
**Accepted 31 August 2022**  
**Published 07 September 2022**

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### **ABSTRACT**

The objective of this study was to find out the best level of Micro-nutrient on plant growth and flower yield of Calendula (*Calendula officinalis* L.) and to work out the economics of different treatments. Under Prayagraj Agro-climatic condition cv. Calypso II in the Department of Horticulture, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, (U.P.), India. During the winter season November, 2021 to February, 2022. The experiment was conducted in Randomized Block Design (RBD), with ten treatments of different level of Micronutrients (Copper, Zinc and Manganese), with thrice replicated. The treatment T7 (0.2% Manganese + RDF) found best in term of plant growth and yield with high benefit cost ratio of Calendula followed by treatment T8 (0.4% Manganese + RDF) where as minimum Plant growth, flower yield and Cost Benefit Ratio was recorded in treatment T0 (Control + RDF).

**Keywords:** Benefit cost ratio; calendula; copper; flower yield; growth; manganese; micro-nutrient; zinc.

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## 1. INTRODUCTION

*Calendula* (*Calendula officinalis* L.), the pot marigold, common marigold or Scotch marigold is a plant in the genus *Calendula* of the family Asteraceae. Although its lengthy history of cultivation renders its specific origin obscure, it is most likely native to southern Europe and may have garden origins, and it may possibly be of garden origin. Additionally, it has spread significantly throughout other warm temperate parts of the world and farther north in Europe (north to southern England).

An annual plant called calendula (*Calendula officinalis* L.) with beautiful yellow or orange daisy-like blossoms. When the blooms have fully bloomed, they are plucked and dried for use as a culinary or medicinal herb. You may use the complete flower head or only the petals. The seeds may be used to produce industrial oil, while the blooms can be used to extract absolute oil. It may be direct-seeded in the field and begins to blossom in approximately two months. *Calendula* takes a while to harvest since it takes a long time for the blooms to develop and mature individually.

The amount of flowers produced is influenced by a variety of factors that are directly relevant to the plant's uptake of nutrients. Similar to people, plants need certain nutrients to develop, grow, and finish their life cycle. A balanced amount of nutrients should be given to the plants, trying to take care not to over- or under-fertilize. The classification of nutrients into major (N, P, K), secondary (Ca, mg, S, Cl, Na), and micro-nutrients is based on how important they are to plants (Fe, Zn, Mn, Cu, Mo, B, Co).

## 2. MATERIALS AND METHODS

A field experiment entitled "Effect different level of Micro-nutrients on plant growth and flower yield of *Calendula* (*Calendula officinalis* L.) Under Prayagraj agro-climatic condition" was conducted is randomized block design (RBD) with 10 treatments with 3 replications at Departmental research field of Department of Horticulture, Sam Higginbottom University of Agriculture, Technology and Sciences, during November, 2021 to February, 2022. The seeds of the *Calendula* flower are collected from the Sakata Seed India (P) Ltd. seed company, Gurugram, Haryana.

### 2.1 Statistical Analysis

The data were analysed in randomized block design as per procedure of Cochran and Cox

(1959). Interpretation of results was made on the basis of "F" test and critical difference at 0.05 probability calculated to compare the treatments.

**Table 1. Treatment details**

Treatment	Treatment combinations
T0	Control (RDF)
T1	0.2% Copper + RDF
T2	0.4% Copper + RDF
T3	0.6% Copper + RDF
T4	0.2% Zinc + RDF
T5	0.4% Zinc + RDF
T6	0.6% Zinc + RDF
T7	0.2% Manganese + RDF
T8	0.4% Manganese + RDF
T9	0.6% Manganese + RDF

## 3. RESULTS AND DISCUSSION

The result of the experiment has been presented under the following heading.

**A. Vegetative growth parameters:** The treatment T<sub>7</sub> has recorded maximum performance in all the parameters at 20, 40 and 60 days respectively in ten treatments follows plant height (10.13, 14.39 and 18.21 cm.), plant spread (6.40, 17.20 and 30.60 cm<sup>2</sup>.), number of leaves (11.93, 26.27 and 60.13), number of branches per plant (3.13, 7.47 and 19.27). The second performance was recorded by T<sub>8</sub> follows plant height (9.87, 14.18 and 17.82 cm.), plant spread (5.87, 17.13 and 30.20 cm<sup>2</sup>.), number of branches (2.67, 7.27 and 19.00), number of leaves (10.87, 25.20 and 59.47). The minimum number of reading observed in T<sub>3</sub> as plant height (9.87, 13.46 and 16.76 cm.), number of branches (1.80, 6.67 and 17.07), and T<sub>0</sub> as number of leaves (8.67, 25.67 and 53.27), plant spread (5.13, 15.53 and 27.40 cm<sup>2</sup>.) shown in the Table 2, Similar results were finding Mn (0.30%) by Abou-Sreea et al. [1] in *Calendula* plants.

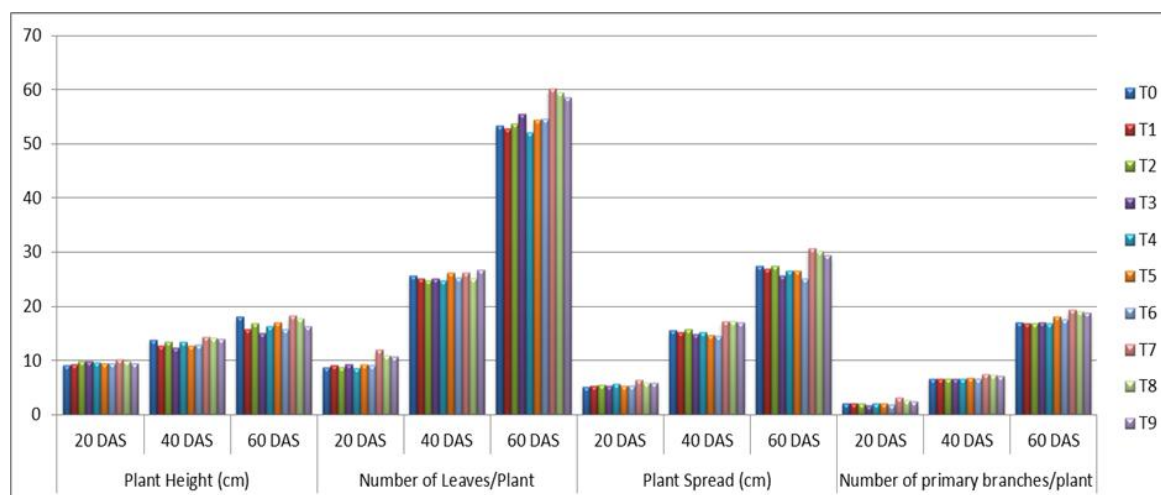
**B. Flowering parameters:** The treatment T<sub>7</sub> has recorded maximum performance in all the parameters as follows flower diameter (6.03 cm.), weight of single flower (5.03 g.) and minimum number of days required for first flower bud emergence from planting (37.53 days). The second performance was recorded T<sub>8</sub> as follows in flower diameter (5.96 cm.), weight of single flower (4.97g.), minimum number of days required for flower bud emergence from planting (37.87 days). The minimum number of reading observed in T<sub>0</sub> as weight of single flower (4.13 g.) and number of days required for first

**Table 2. Effect different level of Micro-nutrients on Vegetative growth parameters of Calendula (*Calendula officinalis* L.)**

Treatment Symbol	Plant Height (cm)			Number of Leaves / Plant			Plant Spread (cm)			Number of primary branches / plant		
	20 DAS	40 DAS	60 DAS	20 DAS	40 DAS	60 DAS	20 DAS	40 DAS	60 DAS	20 DAS	40 DAS	60 DAS
T0	9.11	13.80	18.04	8.67	25.67	53.27	5.13	15.53	27.40	2.13	6.67	16.93
T1	9.24	12.68	15.75	9.13	25.13	52.73	5.27	15.13	26.93	2.13	6.67	16.80
T2	9.87	13.46	16.76	8.73	24.73	53.80	5.47	15.67	27.47	2.07	6.60	16.80
T3	9.80	12.35	14.98	9.33	25.13	55.47	5.27	14.80	25.73	1.80	6.67	17.07
T4	9.56	13.39	16.36	8.53	24.73	52.07	5.60	15.20	26.53	2.13	6.67	16.80
T5	9.43	12.78	17.07	9.20	26.27	54.47	5.27	14.73	26.60	2.13	6.80	18.07
T6	9.43	12.88	15.83	9.13	25.27	54.60	5.40	14.53	25.07	1.87	6.60	17.53
T7	10.13	14.39	18.21	11.93	26.27	60.13	6.40	17.20	30.60	3.13	7.47	19.27
T8	9.87	14.18	17.82	10.87	25.20	59.47	5.87	17.13	30.20	2.67	7.27	19.00
T9	9.42	13.87	16.37	10.73	26.80	58.53	5.87	16.93	29.40	2.53	7.13	18.87
F-Test	S	S	S	S	S	S	S	S	S	S	S	S
S.Ed(±)	0.29	0.56	0.93	0.53	0.64	2.61	0.09	0.93	1.26	0.12	0.28	0.91
C.V.	3.69	5.17	6.83	6.70	3.05	5.77	2.00	7.25	5.60	6.74	5.09	6.27
C.D. at 5%	0.61	1.19	1.96	1.11	1.34	5.49	0.19	1.95	2.65	0.26	0.60	1.90

**Table 3. Effect different level of Micro-nutrients on earliness of flowering, flower yield and Benefit cost ratio of Calendula (*Calendula officinalis* L.)**

Treatment Symbol	Number of days required for first flower bud emergence	Flower diameter (cm.)	Fresh weight of flower (g.)	Total Number of flowers/plant	Flower yield/plant (g.)	Flowers yield/plot (kg.)	Flower Yield (t./ha)	Net return (₹)	Cost Benefit ratio
T0	41.67	5.47	4.13	29.57	122.21	0.73	13.68	135403	1:1.49
T1	40.67	5.53	4.50	32.07	144.13	0.86	16.14	197203	1:1.69
T2	40.67	5.33	4.30	31.47	135.46	0.81	15.17	156103	1:1.52
T3	41.33	5.20	4.23	30.56	129.30	0.77	14.47	123103	1:1.39
T4	39.67	5.43	4.50	34.33	154.37	0.92	17.28	233503	1:1.82
T5	40.00	5.70	4.27	36.66	156.50	0.93	17.52	230803	1:1.78
T6	40.33	5.83	4.17	35.23	146.85	0.87	16.44	188503	1:1.62
T7	37.53	6.03	5.03	39.87	200.82	1.20	22.49	389203	1:2.36
T8	37.87	5.96	4.97	38.43	190.86	1.14	21.37	345103	1:2.16
T9	38.67	5.93	4.87	36.67	178.70	1.07	20.01	293803	1:1.95
F-Test	S	S	S	S	S	S	S	S	
S.Ed(±)	0.76	0.26	0.24	0.71	9.46	0.05	1.06		
C.V.	2.34	5.68	6.45	2.55	7.43	7.41	7.43		
C.D. at 5%	1.60	0.55	0.50	1.46	19.34	0.11	2.16		



**Fig. 1. Graphical representation of Vegetative growth parameters of Calendula**

bud emergence was maximum (41.67 days), as well as  $T_3$  was recorded minimum flower diameter (5.20 cm.) shown in the Table 3, Similar results were finding by Abou-Sreea et al. [1] in Calendula plants [2-5].

**C. Yield parameters:** The treatment  $T_7$  has recorded maximum performance in all the parameters as follows flower yield per plant (200.82 g.), flower yield per plot (1.20 kg.), flower yield per hectare (22.49 t.) and maximum record total number of flower/plant (39.87). The second performance was recorded by  $T_8$  as follows flower yield per plant (190.86 g.), flower yield per plot (1.14 kg.), flower yield per hectare (21.37 t.), total Number of flower/plant (38.43). The minimum number of reading observed in  $T_0$  flower yield per plant (122.21 g.), flower yield per plot (0.73 kg.), flower yield per hectare (13.68 t.), total number of flower/plant (29.57) shown in the Table 3. Hiller (1995) and Walworth (1998) in separate investigation reported that yield and quality of potato increased with foliar applications of micronutrients such as manganese. Result were also finding by M. H. Rashed et al. (2019) in Agricultural crop [6-12].

**D. Economics of Cultivation:** Maximum Gross return, net returns and cost benefit ratio from flowers was found in the  $T_7$  Maximum gross returns (Rs. 674700,00), Net Return (Rs. 389203,00) and Cost Benefit Ratio (1:2.36) followed by  $T_8$  with gross return (Rs. 641100,00), net return (Rs. 345103,00) and cost benefit ratio (1:2.16) where as minimum Gross return (Rs. 410400,00) in  $T_0$  and Net return (Rs. 123103,00), Cost benefit ratio (1:1.39) was recorded in treatment  $T_3$ , shown in the Table 3.

#### 4. CONCLUSION

Based on the present experimental results obtained it is concluded that the treatment  $T_7$  (0.2% Manganese + RDF) found best in term of Plant Growth, flower yield, Gross return, Net return and Cost benefit ratio of Calendula followed by treatment  $T_8$  (0.4% Manganese + RDF) where as minimum obtained recorded in treatment  $T_0$  (Control + RDF).

#### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:

The peer review history for this paper can be accessed here:  
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