



Effect of Micronutrients on Growth and Yield of Chrysanthemum (*Dendratherium grandiflorum* Tzeuleu) cv.CO 1

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Authors' contributions

This work was carried out in collaboration between both authors. Both authors read and approved the final manuscript.

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ABSTRACT

Micronutrient is considered as one of the constraints in the optimum production of crops. A field experiment entitled "Effect of micronutrients on growth, yield and quality of chrysanthemum (*Dendratherium grandiflorum* Tzeuleu) cv.CO 1" was carried out at Faculty of Agriculture, Annamalai University, during 2008-2010 in Randomized Block Design with seventeen treatments and three replications. The treatment comprised of various combination of micronutrients viz., Zinc sulphate 0.5 %, Ferrous sulphate 0.5 %, Borax 0.5 %, Manganese sulphate 0.5 %, Copper sulphate 0.5 %, Mixture of all micronutrients 0.5 % and micronutrients mixture at 12.5 kg ha⁻¹, different concentrations with recommended 25 t FYM ha⁻¹ + Recommended Dose of Fertilizer (RDF) and a

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control at 5 different interval. The results of present investigation indicated that, the vegetative growth in term of plant height (54.62 cm), number of branches (10.23), number of leaves (52.15), stem girth (3.33 cm) and flower yield per plant (201.74 g) were found superior under, soil application of micronutrients mixture @ 12.5 kg ha⁻¹ in split as basal, 25, 50 and 75 DAT days after transplanting (T₁₇).

Keywords: Micronutrients; micronutrient mixture; yield; quality.

1. INTRODUCTION

Chrysanthemum is symbolized as royalty and the national flower of Japan. Chrysanthemum is commonly known as Gul-e -daudi (in Hindi) or queen of East. Chrysanthemum is a very popular commercial flower crop in India and global. It belongs to the family Asteraceae (Compositae), native to the northern hemisphere, chiefly Europe and Asia with a few in other areas. The chrysanthemums are now becoming popular day by day due to its unparalleled diversity in shape, size, colour and it has a wide range of growth habits and post harvest life. Chrysanthemum is universally popular due to very fascinating flowers of extremely beautiful and colourful form of florets and pretty foliage. They are grown invariably as annuals in landscape gardens for mass effect in around cities and in farmer's fields for the sale of cut flowers in the market. It is very popular as loose flower, cut flower as well as pot plant. For making garlands, veni, bracelets and in flower decoration and religious offering chrysanthemum is mostly used in our country. In cut flower trade chrysanthemum ranks second after rose at the Dutch auctions, which is a good indicator of global trade. In India, it is grown for both domestic and International trade purposes, which plays a key role in the national economy. It is a well known fact that the successful growth and flowering depends upon the application of balanced nutrition. Though, for maximization of yield and quality of flower crop, various management practices like irrigation, plant density per unit area, season of growing, proper dose of manures and fertilizers, plant protection, etc. Micro-nutrients such as boron (B), iron (Fe), zinc (Zn), copper (Cu), chloride (Cl), manganese (Mn), molybdenum (Mo) and nickel (Ni) are involved in various metabolic processes [1] and cellular functions and plants differ in their need, many micronutrients unavailable to the crop and there is a possibility of the micronutrient deficiencies, inhibiting the growth and development. Crops grown in a majority soils in India suffer from deficiencies of one or more micronutrients [2].

In the recent years, micronutrients are considered as one of the constraints in the optimum production of crops. Calcium and magnesium deficiency is lead to stunted the growth interveinal chlorosis in chrysanthemum. Though their requirement is low, they often make a huge variation in yield and difference in quality of crop produce if there is a deficiency. Micronutrient mixture is involved in all metabolic and cellular functions. Plants differ in their need of micronutrient mixtures like boron, iron, zinc, copper, chlorine, manganese, molybdenum and nickel.

Keeping this view the "Effect of micronutrients on growth, yield and quality of chrysanthemum cv.CO 1" was undertaken. In our country, most of the soils have high pH ultimately binding naturally present micronutrients with soil particles and make them unfavorable to plants required for various metabolic processes. Due to this, flower development and quality of chrysanthemum is badly affected. To overcome this situation, alternate mean is provision of these micronutrients in the form of soil application and foliar spray.

2. METHODS

The experiment was carried out in field conditions. The experimental site is located at about 6 km West of Bay of Bengal at 11°24' North latitude and 79° 41' East longitude and at an altitude of +5.79 M above the mean sea level. The experiment was laid out in Randomized Block Design (RBD) with 3 replications and 17 treatments. The treatment comprised of various combinations of micronutrients viz., Zinc sulphate @ 0.5 %, Ferrous sulphate @ 0.5 %, Borax @ 0.5 %, Manganese sulphate @ 0.5 %, Copper sulphate @ 0.5 %, Mixture of all micronutrients @ 0.5 % and micronutrients mixture at 12.5 kg ha⁻¹ on different interval like 25,30, 50, 60 and 75 DAT, soil application and foliar spray. The Chrysanthemum seedlings were transplanted at 45 x 35 cm spacing in ridges and furrows. Micronutrient mixtures foliar spray was sprayed on the 25, 30, 50, 60 and 75 DAT. The

recommended dose of fertilizer (125:120:20 NPK kg/ha) were applied as basal and split in the form of Urea, Diammonium Phosphate and Muriate of Potash. At the time of transplanting, half of the dose of N and the full dose of P_2O_5 and K_2O were applied in a circular band. The remaining half dose of nitrogen was applied to the soil 40 days after transplanting. From randomly tagged five plants, were measured. The experimental data were analyzed statistically as per the procedure described by Panse and Sukhatme [3] and wherever the results are found to be significant, the critical differences were arrived at five per cent level to draw statistical conclusions.

3. RESULTS AND DISCUSSION

3.1 Growth Parameters

3.1.1 Plant height

Among the different treatments, the maximum plant height was recorded in T₁₇ (Soil application of micronutrients mixture @ 12.5 kg ha⁻¹ in split as basal, 25, 50 and 75 DAT) (Table 1.) with the

values of 15.82, 34.13 and 54.62 cm on 60, 90 and 120 DAT respectively, followed by T₁₆ (soil application of micronutrients @ 12.5 kg ha⁻¹ in split as basal, 30 and 60 DAT) with the values of 15.58, 34.88 and 53.51 cm on 60, 90 and 120 DAT respectively. Improvement in the growth characteristics is due to the fact that micronutrients activate several enzymes like catalase, peroxidase, tryptophan synthase, carbonic dehydrogenase, etc. and so regulate various metabolic and physiological activities. The importance of zinc is well known in plant growth and metabolism of carbohydrates, auxins and ribosome functions. Copper acts as a structural element in regulatory proteins and participates in mitochondrial respiration and hormone signalling. Thus, micronutrient helps in the biosynthesis of photo-assimilates and increase in various plant metabolites responsible for cell division and elongation resulting in an increased plant growth characteristic as reported by Singh et al. (2015) in *Gladiolus*. Similar findings are reported by Hembrom [4] in *Gladiolus*, and Katiyar et al. [5] in *Gladiolus*.

Table 1. Effect of micronutrients on Plant height (cm) of Chrysanthemum

Treatment	Plant height (cm)		
	60 DAT	90 DAT	120 DAT
T ₁ - Control	14.56	22.94	43.12
T ₂ - 25t FYM ha ⁻¹ + RDF of N, P and K	15.51	24.16	44.24
T ₃ -T ₂ + Zinc sulphate @ 0.5 % on 30 and 60 DAT	14.53	32.43	51.26
T ₄ -T ₂ + Zinc sulphate @ 0.5% on 25, 50 and 75 DAT	14.58	33.62	52.39
T ₅ -T ₂ + Ferrous sulphate @ 0.5 % on 30 and 60 DAT	13.54	25.76	45.58
T ₆ -T ₂ + Ferrous sulphate @ 0.5 % on 25, 50 and 75 DAT	14.09	27.13	46.69
T ₇ -T ₂ + Borax @ 0.5 % on 30 and 60 DAT	13.94	26.28	45.98
T ₈ -T ₂ + Borax @ 0.5% on 25, 50 and 75 DAT	13.79	27.53	47.07
T ₉ -T ₂ + Manganese sulphate 0.5 % @ 30 and 60 DAT	13.67	26.68	46.34
T ₁₀ -T ₂ + Manganese sulphate 0.5% @ 25, 50 and 75 DAT	14.20	28.03	47.46
T ₁₁ -T ₂ + Copper sulphate 0.5% @ 30 and 60 DAT	15.07	23.36	43.35
T ₁₂ -T ₂ + Copper sulphate 0.5% @ 25, 50 and 75 DAT	15.33	24.51	44.47
T ₁₃ -T ₂ + Mixture of all micronutrients @ 0.5% on 30 and 60 DAT	13.05	28.63	47.86
T ₁₄ -T ₂ + Mixture of all micronutrients @ 0.5% on 25, 50 and 75 DAT	13.30	29.85	48.97
T ₁₅ -T ₂ + Soil application of micronutrients mixture @ 12.5 kg ha ⁻¹ as basal	14.32	32.13	50.11
T ₁₆ -T ₂ + Soil application of micronutrients mixture @ 12.5 kg ha ⁻¹ in split as basal, 30 and 60 DAT	15.58	34.88	53.51
T ₁₇ -T ₂ + Soil application of micronutrients mixture @ 12.5 kg ha ⁻¹ in split as basal, 25, 50 and 75 DAT	15.82	34.13	54.62
S. Ed	0.19	0.65	0.67
CD (p = 0.05)	0.39	1.31	1.35

3.2 Number of Leaves Per Plant

Among the different treatments, the maximum number of leaves per plant (Table 2) was observed in T₁₇ which recorded the value of 24.63, 39.90 and 52.15 on 60, 90 and 120 DAT respectively, followed by T₁₆ (24.13, 38.65 and 51.05 on 60, 90 and 120 DAT respectively). The minimum number of leaves per plant were observed in T₁ (control) having the values of 17.49, 24.28 and 37.41 on 60, 90 and 120 DAT respectively. Among the different treatments, T₁₇ recorded the maximum number of branches per plant with the value of 3.13, 6.90 and 10.23 on 60, 90 and 120 DAT respectively followed by T₁₆ (3.01, 6.70 and 9.99) on 60, 90 and 120 DAT respectively. The minimum number of branches per plant were observed in T₁ (control) with the values of 1.62, 3.86 and 6.16 on 60, 90 and 120 DAT respectively.

3.3 Stem Girth

Among the different treatments, the maximum stem girth was observed in T₁₇ which recorded

1.50, 2.92 and 3.33 cm on 60, 90 and 120 DAT respectively followed by T₁₆ (soil application of micronutrients @ 12.5 kg ha⁻¹ in split as basal, 30 and 60 DAT) with the values of 1.46, 2.83 and 3.28 cm on 60, 90 and 120 DAT respectively. The lowest stem girth of 0.83, 1.52 and 2.15 cm on 60, 90 and 120 DAT respectively were observed in control (T₁). Improvement of the above said growth characters might be due to the constant supply of all the micronutrients mixture in four splits. This splitted application throughout the growth period ensured the availability of micronutrients for the growth of the plant without much loss due to leaching and chelation. Furthermore, the constant supply of micronutrients enhanced the plant metabolic activities responsible for cell division and elongation which ultimately favoured the growth attributes of chrysanthemum. It may be due to zinc being an essential constituent of cell components and constituents of the various cells these characters Syed Tanveer Shah et al. [6]. Similar findings were registered by John AQ & Paul TM [7] in Chrysanthemum. Belgaonkar et al. [8] in annual Chrysanthemum.

Table 2. Effect of micronutrients on number of leaves per plant of chrysanthemum

Treatment	Number of leaves per plant		
	60 DAT	90 DAT	120 DAT
T ₁ - Control	17.49	24.28	37.41
T ₂ - 25t FYM ha ⁻¹ + RDF of N, P and K	18.09	25.54	38.60
T ₃ -T ₂ + Zinc sulphate @ 0.5 % on 30 and 60 DAT	23.04	36.13	48.51
T ₄ -T ₂ + Zinc sulphate @ 0.5% on 25, 50 and 75 DAT	23.54	37.39	49.94
T ₅ -T ₂ + Ferrous sulphate @ 0.5 % on 30 and 60 DAT	19.89	29.31	42.18
T ₆ -T ₂ + Ferrous sulphate @ 0.5 % on 25, 50 and 75 DAT	20.75	30.82	43.53
T ₇ -T ₂ + Borax @ 0.5 % on 30 and 60 DAT	20.19	29.81	42.71
T ₈ -T ₂ + Borax @ 0.5% on 25, 50 and 75 DAT	21.01	31.35	44.38
T ₉ -T ₂ + Manganese sulphate 0.5 % @ 30 and 60 DAT	20.46	30.32	43.30
T ₁₀ -T ₂ + Manganese sulphate 0.5% @ 25, 50 and 75 DAT	21.27	31.86	44.89
T ₁₁ -T ₂ + Copper sulphate 0.5% @ 30 and 60 DAT	18.69	26.79	39.79
T ₁₂ -T ₂ + Copper sulphate 0.5% @ 25, 50 and 75 DAT	19.29	28.06	40.98
T ₁₃ -T ₂ + Mixture of all micronutrients @ 0.5% on 30 and 60 DAT	21.52	32.36	45.39
T ₁₄ -T ₂ + Mixture of all micronutrients @ 0.5% on 25, 50 and 75 DAT	22.02	33.62	46.49
T ₁₅ -T ₂ + Soil application of micronutrients mixture @ 12.5 kg ha ⁻¹ as basal	22.52	34.88	47.66
T ₁₆ -T ₂ + Soil application of micronutrients mixture @ 12.5 kg ha ⁻¹ in split as basal, 30 and 60 DAT	24.13	38.65	51.05
T ₁₇ -T ₂ + Soil application of micronutrients mixture @ 12.5 kg ha ⁻¹ in split as basal, 25, 50 and 75 DAT	24.63	39.90	52.15
S. Ed	0.42	0.91	0.86
CD (p = 0.05)	0.84	1.83	1.73

3.4 Flower Yield Per Plant (g)

The data on flower yield per plant influenced by various treatments are presented in Table 3. Various treatments significantly influenced the flower yield per plant. Among them, treatment (T₁₇) was found to record the maximum flower yield per plant (201.74 g) followed by T₁₆ and T₄ which recorded the value of 188.54 and 116.14 g respectively. The minimum flower yield per plant (84.63 g) was observed in control T₁. Yield is a complex phenomenon which can be controlled both by morphological and physiological parameters and it can also be manipulated by either genetic factor (or) cultural operation. In the present study, the yield characteristics *viz.*, flower yield per plant was found to be

significantly influenced by the application of micronutrients over control. It shows that the soil is deficient in micronutrients and the crop yield can easily be improved by the application of any micronutrients. However the maximum flower yield per plant (201.74 g) was observed in T₁₇ followed by T₁₆ and T₄. The favourable positive effect of micronutrients in yield might be attributed by their involvement in the synthesis of chlorophyll, growth promoting substances and acceleration in synthesis and mobility of photosynthates, minerals and amino acids from the source to sink that enhances the per plant and per hectare yield.

The increase in the number of florets per spike could be attributed to an increase in

Table 3. Effect of micronutrients on stem girth (cm) of chrysanthemum

Treatment	Stem girth (cm)			Flower yield (g plant ⁻¹)
	60 DAT	90 DAT	120 DAT	
T ₁ - Control	0.83	1.52	2.15	84.63
T ₂ - 25t FYM ha ⁻¹ + RDF of N, P and K	0.87	1.63	2.25	87.23
T ₃ -T ₂ + Zinc sulphate @ 0.5 % on 30 and 60 DAT	1.35	2.65	3.12	113.54
T ₄ -T ₂ + Zinc sulphate @ 0.5% on 25, 50 and 75 DAT	1.41	2.73	3.21	116.14
T ₅ -T ₂ + Ferrous sulphate @ 0.5 % on 30 and 60 DAT	1.01	1.99	2.67	94.83
T ₆ -T ₂ + Ferrous sulphate @ 0.5 % on 25, 50 and 75 DAT	1.13	2.17	2.79	100.21
T ₇ -T ₂ + Borax @ 0.5 % on 30 and 60 DAT	1.06	2.06	2.73	96.40
T ₈ -T ₂ + Borax @ 0.5% on 25, 50 and 75 DAT	1.16	2.22	2.85	101.80
T ₉ -T ₂ + Manganese sulphate 0.5 % @ 30 and 60 DAT	1.08	2.11	2.77	98.30
T ₁₀ -T ₂ + Manganese sulphate 0.5% @ 25, 50 and 75 DAT	1.19	2.28	2.89	103.32
T ₁₁ -T ₂ + Copper sulphate 0.5% @ 30 and 60 DAT	0.92	1.76	2.55	90.13
T ₁₂ -T ₂ + Copper sulphate 0.5% @ 25, 50 and 75 DAT	0.97	1.88	2.62	92.63
T ₁₃ -T ₂ + Mixture of all micronutrients @ 0.5% on 30 and 60 DAT	1.21	2.35	2.91	104.47
T ₁₄ -T ₂ + Mixture of all micronutrients @ 0.5% on 25, 50 and 75 DAT	1.26	2.47	3.00	107.66
T ₁₅ -T ₂ + Soil application of micronutrients mixture @ 12.5 kg ha ⁻¹ as basal	1.31	2.58	3.07	110.64
T ₁₆ -T ₂ + Soil application of micronutrients mixture @ 12.5 kg ha ⁻¹ in split as basal, 30 and 60 DAT	1.46	2.83	3.28	188.54
T ₁₇ -T ₂ + Soil application of micronutrients mixture @ 12.5 kg ha ⁻¹ in split as basal, 25, 50 and 75 DAT	1.50	2.92	3.33	201.74
S. Ed	0.03	0.37	0.05	2.24
CD (p = 0.05)	0.07	0.54	0.13	4.48

photosynthesis with enhanced carbohydrate fixation in plants treated with micronutrients, especially Zn [9]. The similar findings were reported by Gurav et al. [10] in flower crops, Sha and Karuppapiah [11] in Chilli and Balakrishnan et al. [12] in African marigolds. Based on the field investigation, it is concluded that the treatment combination of T₁₇ was found to be the best for the effective open field cultivation of chrysanthemum under coastal ecosystem at commercial level [13,14,15].

4. CONCLUSION

Based on the field investigation, it is concluded that the treatment combination of T₁₇ (soil application of micronutrients mixture @ 12.5 kg ha⁻¹ in split as basal, 25, 50 and 75 DAT) was found to be the best for the effective open field cultivation of chrysanthemum under coastal ecosystem at commercial level.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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