Original Research Article

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

ABSTRACT

A field experiment was carried out at Faculty of Agriculture, Annamalai University, during 2019-2020 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} + RDF of N, P and K and a 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) andflower 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 (T_{17}).

Keywords: Micronutrients, Micronutrient mixture, yield and quality

1. INTRODUCTION

Chrysanthemum issymbolised as royalty and the national flower of Japan.Chrysanthemum is commonly known as Gul-e -daudi 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

UNDER PEER REVIEW

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 flower g depends upon the application of balanced nutrition. Keeping this view the "Effect of micronutrients on growth, yield and quality of chrysanthemum cv.CO 1" was undertaken. Though, for maximisation 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 fertilisers, plant protection, etc. Micronutrients are essential for crop growth and are equally important as primary and secondary nutrients. 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.

2. RESEARCH 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^{o}24' North latitude and 79^o 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 × 35 cm spacing in ridges and furrows in 2008-2010. Micronutrient mixtures foliar spray was sprayed on the 25, 30, 50, 60 and 75 DAT. The recommended rate of fertiliser (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

UNDER PEER REVIEW

data were analysed statistically as per the procedure described by Panse and Sukhatme (1978) 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

Among the different treatments, the maximum plant height was recorded in T_{17} (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 T_{16} (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. The higher plant height obtained in the present study could be attributed to the favourable action of soil application of micronutrients mixture @ 12.5 kg ha^{-1} in split as basal, 25, 50 and 75 DAT.

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 (2015) in Gladiolus, and Katiyar *et al*., (2005) in Galdiolus.

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

UNDER PEER REVIEW

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**

The results on the effect of various treatments on the number of leaves per plant are furnished in Table 1. Different treatments significantly influenced the results. Among the different treatments, the maximum number of leaves per plant were observed in T_{17} which recorded the value of 24.63, 39.90 and 52.15 on 60, 90 and 120 DAT respectively, followed by T_{16} (24.13, 38.65 and 51.05 on 60, 90 and 120 DAT respectively). The minimum number of

UNDER PEER REVIEW

leaves per plant were observed in T_1 (control) having the values of 17.49, 24.28 and 37.41 on 60, 90 and 120 DAT respectively. Different treatments significantly influenced the results.Among the different treatments, T_{17} 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 T_{16} (3.01, 6.70 and 9.99) on 60, 90 and 120 DAT respectively. The minimum number of branches per plant were observed in T_1 (control) with the values of 1.62, 3.86 and 6.16 on 60, 90 and 120 DAT respectively.

Among the different treatments, the maximum stem girth was observed in T_{17} which recorded 1.50, 2.92 and 3.33 cm on 60, 90 and 120 DAT respectively followed by T_{16} (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 (T_1).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. 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

UNDER PEER REVIEW

zinc being an essential constituent of cell components and constituents of the various cells these characters Syed Tanveer Shah *et al*.,(2016). Similar findings are registered by John AQ & Paul TM (1999) in Chrysanthemum. Belgaonkar., *et al*., (1996) 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**

UNDER PEER REVIEW

Table.3. Effect of micronutrients on number of branches per plant of Chrysanthemum

Treatment	Number of branches per plant		
	60 DAT	**90 DAT**	**120 DAT**
T_1- Control	1.62	3.86	6.16
T_2-25t FYM ha^{-1} + RDF of N, P and K	1.75	4.16	7.00
T_3-T_2 + Zinc sulphate @ 0.5 % on 30 and 60 DAT	2.78	6.77	9.45
T_4-T_2 + Zinc sulphate @ 0.5% on 25, 50 and 75 DAT	2.90	6.49	9.73
T_5-T_2 + Ferrous sulphate @ 0.5 % on 30 and 60 DAT	2.09	4.97	7.74
T_6-T_2 + Ferrous sulphate @ 0.5 % on 25, 50 and 75 DAT	2.25	5.44	8.22
T_7-T_2 + Borax @ 0.5 % on 30 and 60 DAT	2.14	5.13	7.86
T_8-T_2 + Borax @ 0.5% on 25, 50 and 75 DAT	2.32	5.62	8.36
T_9-T_2 + Manganese sulphate 0.5 % @ 30 and 60 DAT	2.20	5.26	8.04
T_{10}-T_2 + Manganese sulphate 0.5% @ 25, 50 and 75 DAT	2.38	5.81	8.49
T_{11}-T_2 + Copper sulphate 0.5% @ 30 and 60 DAT	1.86	4.46	7.26
T_{12}-T_2 + Copper sulphate 0.5% @ 25, 50 and 75 DAT	1.98	4.75	7.50
T_{13}-T_2 + Mixture of all micronutrients @ 0.5% on 30 and 60 DAT	2.43	5.91	8.61
T_{14}-T_2 + Mixture of all micronutrients @ 0.5% on 25, 50 and 75 DAT	2.55	6.19	8.87
T_{15}-T_2 + Soil application of micronutrients mixture @ 12.5 kg ha^{-1} as basal	2.66	6.48	9.17
T_{16}-T_2 + Soil application of micronutrients mixture @ 12.5 kg ha^{-1} in split as basal, 30 and 60 DAT	3.01	6.70	9.99
T_{17}-T_2 + Soil application of micronutrients mixture @ 12.5 kg ha^{-1} in split as basal, 25, 50 and 75 DAT	3.13	6.90	10.23
S. Ed	**0.12**	**0.17**	**0.20**
CD (p = 0.05)	**0.26**	**0.35**	**0.40**

UNDER PEER REVIEW

Table.4. 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**

3.2 Flower yield per plant (g)

The data on flower yield per plant influenced by various treatments are presented in Table 2. Various treatments significantly influenced the flower yield per plant. Among them, treatment (T_{17}) was found to record the maximum flower yield per plant (201.74 g) followed by T_{16} and T_4 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 T_1. Yield is a complex phenomenon which can be

UNDER PEER REVIEW

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 T_{17} followed by T_{16} and T_4. 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 photosynthesis with enhanced carbohydrate fixation in plants treated with micronutrients, especially Zn (Aishwarya Mishra *et al*., 2018). The similar findings were reported by Gurav *et al*., (2004) in flower crops, Sha and Karuppaiah (2005) in Chilli and Balakrishnan *et al*., (2007) in African marigolds. Based on the field investigation, it is concluded that the treatment combination of T_{17} was found to be the best for the effective open field cultivation of chrysanthemum under coastal ecosystem at commercial level.

3. CONCLUSION

Based on the field investigation, it is concluded that the treatment combination of T_{17} (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.

UNDER PEER REVIEW

Reference

Aishwarya Mishra, A.K. Singh and Abhinav Kumar. 2018. Effect of foliar feeding of zinc and iron on flowering and yield attributes of gladiolus (*Gladiolus grandiflorus* L.) cv. Novalux. Plant Archives 18 (2):1355-1358.

Anjali, Ashok H., Pampanna, Y., Jyothi, R. and Suma, T.C. 2023.Effect of Starter Solution, Micronutrient Mixture and Humic Acid on Growth, Flowering and Yield of African Marigold (*Tagetes erecta* L.). Biological Forum - An International Journal 15:3.

Hembrom R, Singh A K, Sisodia A, Singh J and Asmita. 2015. Influence of foliar application of iron and zinc on growth, corm and cormel yield in Gladiolus cv. American Beauty. Environment and Ecology 33(4): 1 544-6.

Katiyar R S, Garg V. K and Singh P K. 2005. Foliar spray of Zn and Cu on growth, floral characteristics and yield of gladiolus grown in sodic soil. Indian Journal of Horticulture 62(3): 272-5.

Gurav, S.B., M. Katwate, B.R. Singh, R.N. Sabale, D.S. Kakade and A.V. Dhane. 2004. Effect of nutritional levels on yield and quality of gerbera. **J. Ornametal Hort., 7(3-4):** 226-229.

Sha, K. and P. Karuppaiah. 2005. Studies on the effect of foliar application of micronutrients in Chilli(*Capsicum annum* L.) C.K.2. In: National seminar on New Frontiers of soil sciences Research Towards sustainable Dept. of Soil Sciences and Agri. Chemistry. Agriculture. Annamalai University, Annamalai nagar, Tamil nadu, India. pp. 320.

Balakrishnan, V., M. Jawaharlal, T. Senthilkumar and M. Ganga. 2007. Response of micronutrients on flowering, yield and xanthophyll content in African marigold. **J. Ornamental Hort., 10(3):** 153-156.

Hatwar, G.P,, S.U. Gondane, S.M. Urkude and O.V.Gohukar.2004. Effect of micronutrients on growth and yield of chilli. **Soils and Crops, 13:** 123-125.

UNDER PEER REVIEW

Naveen Kumar, P. B.L. Misra, M. Ganga, S.R. Dhiman and Lalitha kameshwari. 2009. Effect of micronutrients sprays on growth and flowering of chrysanthemum. **Indian J. Hort. Sci., 76(6):** 426-428.

Syed Tanveer Shah, Sami Ullah, Nadeem Khan, Muhammad Sajid, Abdur Rab, Noor Ul Amin, Asif Iqbal, Ahmad Naeem, Mazhar Iqbal, Saeed Ul Haq, Shahid Rahman, Fawad Ali Shah and Said Rawan.2016.Effect of zinc as a foliar spray on growth and flower production of Marigold (*Tagetes erecta* L.): Pure Appl. Biol., 5(4): 738-743.

John AQ & Paul TM (1999). Response of Chrysanthemum morifolium Ramat, to different levels of nitrogen and phosphorous. Applied Biol Res 1(1): 35-38.

Belgaonkar DV, Bist MA &Wankade MB (1996). Effect of levels of nitrogen and phosphorus with different spacing on growth and yields of annual chrysanthemum. J Soil Crop 6(2): 154 158.

UNDER PEER REVIEW