International Journal of Agriculture Sciences
ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 14, Issue 1, 2022, pp.-11043-11045.
Available online at https://bioinfopublication.org/pages/jouarchive.php?id=BPJ0000217

Research Article

EFFECT OF MICRONUTRIENT APPLICATION ON GROWTH, YIELD AND QUALITY OF TURMERIC (*Curcuma longa* l.) *cv*. GNT-2

PATEL D.V., BHALERAO P.P.* AND TANDEL B.M.
Department of Plantation, Spices, Medicinal and Aromatic Crops, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, 396 450, India
*Corresponding Author: Email - pankaj5bhalerao@rediffmail.com

Received: January 09, 2022; Revised: January 27, 2022; Accepted: January 28, 2022; Published: January 30, 2022

Abstract: The field investigation was carried out, with a view to study the "Effect of micronutrient application on growth, yield and quality of turmeric (*Curcuma longa* L.) cv. GNT-2" during 2020-21 at Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, Gujarat. The experiment was conducted by using of different sources of micronutrients *viz*., $FeSO_4$, $ZnSO_4$ and boron to check the growth and yield performance of turmeric crop under south Gujarat condition. The foliar application of micronutrients was applied at 60, 90 and 120 days after planting. Results of experiment revealed that, the growth attributes *viz*., plant height (67.27, 128.53 and 138.47 cm), tillers/plant (4.13, 4.87 and 5.07), number of leaves/plant (8.60, 11.80 and 12.60), length of leaf (56.93, 62.40 and 84.60 cm), breadth of leaf (17.33, 19.47 and 21.27 cm) at 90, 150 and 210 days after planting, respectively were recorded maximum in treatment of $FeSO_4$ 0.5% + $ZnSO_4$ 0.5% + Boron 0.5% (T_8). In case of yield attributing characters and quality, maximum mother rhizomes/plant (3.53), number of fingers rhizomes/plant (16.13), weight of mother rhizomes (52.80 g/plant), weight of finger rhizome (256.93 g/plant), yield of rhizome (310.40 g/plant), fresh rhizomes yield (13.000 97 kg/net plot) and fresh rhizomes yield (33.26 t/ha), curcumin content (4.09 %) and essential oil (3.52 %) in treatment of T_8 ($FeSO_4$ 0.5% + $ZnSO_4$ 0.5% + Boron 0.5%). Economic point of view, turmeric cv. GNT-2 treated with $FeSO_4$ 0.5% + $ZnSO_4$ 0.5% + Boron 0.5% given higher net realization (Rs. 6,70,993/ha) and maximum benefit cost ratio (4.18).

Keywords: *Turmeric, Micronutrients, Growth yield and quality*

Citation: Patel D.V., *et al*., (2022) Effect of Micronutrient Application on Growth, Yield and Quality of Turmeric (*Curcuma longa* l.) *cv*. GNT-2. International Journal of Agriculture Sciences, ISSN: 0975-3710 & E-ISSN: 0975-9107, Volume 14, Issue 1, pp.- 11043-11045.

Academic Editor / Reviewer: S. Sarvade, Dr Avtar Singh

Introduction

Turmeric (*Curcuma longa* L.), a member of Zingiberaceae family and native to South East Asia. India is the largest producer of turmeric followed by Indonesia and Myanmar [1,2] while, India is also a largest consumer and exporter in the world. India rules the world turmeric market with 80% and over 60% share in production and exchange, respectively. In India, turmeric is grown in area of 1,93,000 ha with an average production of 10,52,000 MT. Major states leading in commercial cultivation of turmeric are Telangana, Andhra Pradesh, Karnataka, Gujarat, Maharashtra, Kerala, Tamil Nadu, Orissa, West Bengal, Mizoram, Haryana and Assam. Among all, Telangana is leading producer of turmeric. Gujarat occupies 4,570 ha area and 90,903 MT production [3]. In Gujarat it is grown in the districts of Dahod, Navsari, Surat, Mahisagar, Panchmahal, Dang and Anand. Foliar feeding is a way of supplying supplemental doses of major and minor nutrients, plant hormones, stimulants and other beneficial substances. Micronutrients are key elements in plant growth and development. Deficiencies of Zn, Fe and B have been increasing in some fruit and spices crops. Some reasons are higher crop yields which increase plant nutrient demands, use of high analyse NPK fertilizers containing lower quantities of micronutrient contaminants and decreased use of farmyard manure on many agricultural soils. Micronutrient deficiencies have been verified in many soils through increased use of soil testing and plant analysis. Zn, Fe and B are not only essential but they are equally important like other micro and macronutrients, in spite of other requirement in micro quantities. These elements play very important role in various enzymatic activities and synthesis and thus, they also help in uptake of major nutrients and play an active role in the plant metabolism process starting from cell wall development to respiration, photosynthesis, chlorophyll formation, enzyme activity, hormone synthesis, nitrogen fixation and reduction *etc* [4].

In South Gujarat the area of turmeric cultivation increases, hence to get higher production with the better quality is the present day requirements. In view of considering the above facts, the experiment was laid out with the objectives of find out the effect of micronutrients application in turmeric *cv*. GNT-2.

Materials and Methods

A field experiment entitled "Effect of micronutrient application on growth, yield and quality of turmeric (*Curcuma longa* L.) *cv*. GNT-2" during 2020-21 at Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, Gujarat. The experiment was conducted in randomized block design (RBD) which included 9 treatments and 3 replications consisting *viz*., T_1: $FeSO_4$ 0.3%, T_2: $FeSO_4$ 0.5%, T_3: $ZnSO_4$ 0.3%, T_4: $ZnSO_4$ 0.5%, T_5: Boron 0.3%, T_6: Boron 0.5%, T_7: $FeSO_4$ 0.3% + $ZnSO_4$ 0.3% + Boron 0.3% and T_8: $FeSO_4$ 0.5% + $ZnSO_4$ 0.5% + Boron 0.5% and T9: control.

The foliar application of micronutrients was applied at 60, 90 and 120 days after planting. The soil of the experimental site was dark greyish black type having medium to poor drainage and highwater holding capacity. The soil of the experimental plot was clay in texture. The pH values for 0-15 cm and 15-30 cm depths were 7.9 and 8.1, respectively. Before the start of experiment, the experimental plots were prepared by one deep ploughing followed by one harrowing. There is total 27 plots of 4.2m x 4.2m size having raised bed of 110 cm width were prepared for planting of turmeric rhizomes of variety GNT-2 and planted with a spacing of 30cm x 20cm during the last week of May, 2020. The cultural practices and nutrient management (RDF- FYM-20-25 t/ha and 60:60:60 kg NPK/ha) was carried out as par university recommendations. Observations on different growth parameters was recorded at three of crop periods *viz*., 90, 150 and 210 days after planting from five randomly selected plants from each plot

Table-1 *Effect of micronutrients on periodical growth attributes of turmeric cv. GNT-2*

Treatments	Plant height (cm)			Number of tillers per plant			Number of leaves per plant			Length of leaves (cm)			Breadth of leaves (cm)		
	90 DAP	150 DAP	210 DAP	90 DAP	150 DAP	210 DAP	90 DAP	150 DAP	210 DAP	90 DAP	150 DAP	210 DAP	90 DAP	150 DAP	210 DAP
T_1: $FeSO_4$ 0.3 %	56.87	94.47	112.73	2.80	3.93	4.40	6.00	8.00	9.00	41.33	51.20	61.47	14.4	15.73	18.07
T_2:$FeSO_4$ 0.5 %	62.73	111.93	126.27	3.53	4.33	4.73	7.33	9.80	10.73	48.73	57.00	74.53	15.93	17.60	19.60
T_3:$ZnSO_4$0.3 %	55.00	89.60	108.40	2.73	3.80	4.27	5.60	7.33	8.40	38.67	49.33	57.80	13.87	15.07	17.60
T_4:$ZnSO_4$ 0.5 %	59.07	101.87	118.80	3.20	4.00	4.67	6.53	8.73	9.80	44.33	53.73	66.53	15.00	16.53	18.73
T_5: Boron 0.3 %	54.47	88.00	107.07	2.67	3.67	4.33	5.47	7.13	8.27	37.87	48.67	56.67	13.73	14.93	17.40
T_6: Boron 0.5 %	58.00	98.73	114.80	3.00	3.93	4.53	6.33	8.47	9.40	42.87	52.33	64.33	14.67	16.13	18.47
T_7:$FeSO_4$ 0.3 % + $ZnSO_4$ 0.3 % + Boron 0.3 %	64.07	118.73	131.20	3.73	4.47	4.80	8.00	10.60	11.33	51.87	58.93	78.13	16.53	18.47	20.20
T_8:$FeSO_4$ 0.5 % + $ZnSO_4$ 0.5 % + Boron 0.5 %	67.27	128.53	138.47	4.13	4.87	5.07	8.60	11.80	12.60	56.93	62.40	84.60	17.33	19.47	21.27
T_9: Control (No spray)	52.60	82.60	102.67	2.40	3.53	4.20	5.00	6.60	7.60	35.20	46.80	52.60	13.20	14.27	16.93
S. Em.±	2.92	4.72	5.88	0.12	0.20	0.18	0.35	0.49	0.59	2.24	2.59	4.22	0.75	0.86	0.86
C.D. at 5%	8.75	14.15	17.62	0.35	0.59	NS	1.04	1.46	1.77	6.70	7.75	12.64	2.24	2.57	2.58
C.V. %	8.58	8.05	8.64	6.51	8.47	6.94	9.14	9.69	10.55	8.76	8.39	11.01	8.65	9.03	7.98

Table-2 *Effect of micronutrients application on yield attributing characters of turmeric cv. GNT-2*

Treatments	No. of mother rhizomes/ plant	No. of finger rhizomes /plant	Finger rhizomes: mother rhizomes ratio	Weight of mother rhizomes (g/plant)	Weight of finger rhizomes (g/plant)	Rhizome yield (g/plant)	Rhizome yield (kg/net plot)	Rhizome yield (t/ha)
T_1: $FeSO_4$ 0.3 %	2.07	10.27	4.97	46.67	229.33	276.00	12.42	29.57
T_2:$FeSO_4$ 0.5 %	2.60	13.53	5.22	49.01	241.10	291.80	13.13	31.26
T_3:$ZnSO_4$0.3 %	1.93	9.20	4.77	45.67	219.33	265.00	11.93	28.39
T_4:$ZnSO_4$ 0.5 %	2.46	11.67	4.75	48.83	238.97	287.80	12.95	30.84
T_5: Boron 0.3 %	1.86	8.93	4.81	44.96	217.67	260.80	11.74	27.94
T_6: Boron 0.5 %	2.14	10.80	5.06	47.80	235.73	282.53	12.71	30.27
T_7:$FeSO_4$ 0.3 % + $ZnSO_4$ 0.3 % + Boron 0.3 %	3.10	14.87	4.80	50.30	244.23	294.53	13.25	31.56
T_8:$FeSO_4$ 0.5 % + $ZnSO_4$ 0.5 % + Boron 0.5 %	3.53	16.13	4.57	52.80	256.93	310.40	13.97	33.26
T_9:Control (No spray)	1.50	7.80	5.24	30.50	180.23	210.73	9.48	22.58
S. Em. ±	0.06	0.28	0.21	1.23	5.83	6.37	0.29	0.68
C.D. at 5 %	0.18	0.85	NS	3.69	17.49	19.11	0.86	2.05
C.V. %	4.48	4.26	7.30	4.24	8.14	3.87	3.87	3.87

Table-3 *Effect of micronutrients application on quality contents of turmeric cv. GNT-2*

Treatment	Curcumin content (%)	Essential oil (%)
T_1: $FeSO_4$ 0.3 %	3.44	2.62
T_2:$FeSO_4$ 0.5 %	3.78	3.08
T_3:$ZnSO_4$0.3 %	3.34	2.49
T_4:$ZnSO_4$ 0.5 %	3.60	2.82
T_5: Boron 0.3 %	3.29	2.42
T_6: Boron 0.5 %	3.52	2.73
T_7:$FeSO_4$ 0.3 % + $ZnSO_4$ 0.3 % + Boron 0.3 %	3.91	3.27
T_8:$FeSO_4$ 0.5 % + $ZnSO_4$ 0.5 % + Boron 0.5 %	4.09	3.52
T_9:Control (No spray)	3.18	2.28
S. Em.±	0.11	0.08
C.D. at 5 %	0.32	0.24
C.V. %	5.21	4.90

Table-4 *Effect of micronutrient application on economics (Rs. ha^{-1}) of turmeric cv. GNT-2*

Treatments	Marketable rhizomes yield (t/ha)	Cost of cultivation (Rs./ha)	Treatment cost (Rs./ha)	Fixed Cost (Rs./ha)	Gross income (Rs./ha)	Net income (Rs./ha)	BCR
T_1	29.57	109057	44343	153400	739250	585850	3.82
T_2	31.26	114157	46203	160360	781500	621140	3.87
T_3	28.39	108832	47045	155877	709750	553873	3.55
T_4	30.84	113782	50453	164235	771000	606765	3.69
T_5	27.94	106987	45406	152393	698500	546107	3.58
T_6	30.27	110707	45078	155785	756750	600965	3.86
T_7	31.56	108292	46500	154792	789000	634208	4.10
T_8	33.26	112882	47625	160507	831500	670993	4.18
T_9	22.58	99547	44359	143906	564500	420594	2.92

Selling rate of turmeric= Rs. 25/kg.

whereas, yield attributing characters were recorded after harvesting of crop and rhizome yield per hectare was calculated on the plot weight basis. The quality parameters *viz*., curcumin content (%) of turmeric rhizomes was estimated by ASTA method [4] and expressed as percentage on moisture free basis however, the essential oil (%) was estimated by distillation method. Statistical analysis of the data was done [5].

Results and Discussion

Influence on growth parameters

The growth parameters *viz*., plant height, number of tillers per plant, number of leaves per plant, length of leaves and breadth of leaves were presented in [Table-1] and has been affected profoundly due to different treatments. Growth parameters of turmeric significantly affected by different micronutrient, except number of tillers/plant at 210 DAP. Among the all treatments, $FeSO_4$ 0.5 % + $ZnSO_4$ 0.5 %+ Boron 0.5 % (T_8) gave maximum plants height of (67.27, 128.53 and 138.47 cm) at 90, 150 and 210 DAP, number of tillers/plant of (4.13, 4.87 and 5.07) at 90, 150 and 210 DAP, number of leaves/plant (8.60, 11.80 and 12.60) at 90, 150 and 210 DAP, length of leaf (56.93, 62.40 and 84.60 cm) at 90, 150 and 210 DAP and breadth of leaf (17.33, 19.47and 21.27 cm) at 90, 150 and 210 DAP. This might be due to the favorable effects of zinc which is essential element in nitrogen metabolism and it also increased the synthesis of auxin which promote the cell size [6]. Moreover, iron plays an important role in promoting growth characters, being a component of ferredoxin, an electron transport protein and is associated with chloroplast. It also helps in photosynthesis might have helped in better vegetative growth [7]. The favorable effects of boron might be attributed to its involvement in cell division and cell expansion. However, it appeared to be concerned with calcium metabolism, uptake of calcium by roots leading to its efficient utilization and regulation of K:Ca ratio as well. Similarly, boron primarily regulates the carbohydrates metabolism in plants [8]. Application of boron promoted P uptake in the plants, which is an important element for plant growth [9].

Influence on yield and yield attributes

Effect of micronutrients significantly influenced the yield and yield attributing characters [Table-2]. The maximum number of mother rhizomes/plant (3.53), number of fingers rhizomes/plant (16.13), weight of mother rhizomes (52.80g/plant), weight of finger rhizome (256.93 g/plant) and fresh rhizomes yield (310.40 g/plant, 13.97 kg/net plot and 33.26 t/ha) was observed in $FeSO_4$ 0.5 % + $ZnSO_4$ 0.5 %+Boron 0.5 % (T_8).

The increase in yield probably may be due to micronutrients application may improve photosynthetic activity, resulting into the increased production and accumulation of carbohydrate and qualified advantageous effect on vegetative growth. The increase in dry matter production may be attributed to greater accumulation of photosynthates by vegetative parts and its subsequent translocation to the sink and improve the rhizomes weight. Also, role of boron which enhance the movement of sugar borate complex from the leaves to the ground food and ultimately increased the yield [10, 11]. The synergetic effect of Zn with P which may serve as a source of energy for the synthesis of auxin in the presence of Zn. Enhanced photosynthetic reaction in the presence of zinc and boron was also reported [12] and explained that presence of zinc activates the synthesis of tryptophan, which is precursor of IAA and it is responsible to stimulate plant growth. Iron plays an important role in promoting growth characters, being a component of ferredoxin, an electron transport protein and is associated with chloroplast. It helps in photosynthesis might have helped in better yield characters.

The role of zinc in many enzymatic reactions and it is necessary for chlorophyll synthesis and carbohydrates formation. Zinc acts as a catalyst in the oxidation reduction processes, metabolism of sugar and mobilization of water into the bulbs by regulating the semi-permeability of cell wall. It may lead to enhance the above value of rhizomes by zinc application. Boron is also an important element in carbohydrate translocation with effects on transpiration (through the control of sugar and starch formation), cell development and elongation, carbohydrate metabolism and synthesis of proteins.

Influence on quality parameters

The different foliar application of micronutrients was found significant outcomes in term of curcumin content and essential oil [Table-3]. Among the all treatments, $FeSO_4$ 0.5 % + $ZnSO_4$ 0.5 %+ Boron 0.5 % (T_8) recorded maximum curcumin content (4.09 %) and essential oil (3.52 %). This might be due to sufficient quantity of B, Fe and Zn affected terpenoid metabolism line, such as structural component of the cell walls which were influential on membrane stability and other secondary metabolism like curcumin [13].

Influence on economic of treatments

Economic efficiency and the viability of crop cultivation are mainly the outcome of the yield of crops with larger management costs. Higher crop productivity with lesser cost of cultivation could result in better economic parameters like net returns and B:C ratio. The cost of cultivation, gross return, net return and B:C ratios were worked out for different treatments in turmeric are presented in the [Table-4]. The highest benefit cost ratio (4.18) and the maximum net realization (Rs. 6,70,993/ha) was obtained under $FeSO_4$ 0.5 % + $ZnSO_4$ 0.5 % + Boron 0.5 % (T_8) [14].

Application of research: The results indicated that the use of micronutrients with major nutrients increased the turmeric yield and thereby gave remunerative return to the turmeric growers

Research Category: Micronutrients

Abbreviations: RDB - randomized block design

Acknowledgement / Funding: Authors are thankful to Department of Plantation, Spices, Medicinal and Aromatic Crops, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari, 396 450, Gujarat, India

****Principal Investigator or Chairperson of research: Dr Pankaj P. Bhalerao**
University: Navsari Agricultural University, Navsari, 396 450, Gujarat, India
Research project name or number: Research station study

Author Contributions: All authors equally contributed

Author statement: All authors read, reviewed, agreed and approved the final manuscript. Note-All authors agreed that- Written informed consent was obtained from all participants prior to publish / enrolment

Study area / Sample Collection: Regional Horticultural Research Station, Navsari

Cultivar / Variety / Breed name: Turmeric (*Curcuma longa* L.)

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

References

[1] Addisu A. (2014) *The First Stakeholders Meeting. Addis Ababa, Ethiopia, January* 23, 2014.
[2] Pallavi O. (2013) *The Knowledge Management Department of NCDEX India*, 3, 96
[3] Anonymous (2020) *Ministry of Agriculture and Farmers Welfare, Department of Agriculture, Cooperation and Farmers Welfare, Department of Economics and Statistics.*
[4] Das D.K. (2003) *Kalyani publications, Ludhiana*, 1-2.
[5] Manjunath M.M., Sattigeri V.V. and Mangraj K.V. (1991) *Spice India*, 7(2), 7–9.
[6] Panse V.G. and Sukhatme P.V. (1985) *Indian Council of Agricultural Research, New Delhi, India*, 381.
[7] Dake J.A., Price J.H., Kolm V.N. and Wielinski M. (2010) *Academic Paediatrics*, 10(6), 410-416.
[8] Hazra P., Maity T.K. and Mandal A.R. (1987) *Progressive Horticulture*, 19(3-4), 219-222.
[9] Sharangi A. B., Pariari A., Datta S. and Chatterjee R. (2003) *Crop Research*, 25(1), 83-85.
[10] Chermsiri C., Watanabe S. and Attajarusit B. (1995) *Bio-Fertilizers of Soils*, 20(1), 125-129.
[11] Pandita M.L., Pandey S. C. and Mangal J. L. (1976) *Haryana Journal of Horticulture Science*, 9, 170-174.
[12] Singh M., Batra V.K., Bhatia A.K., Singh V. and Arora S.K. (2003) *Vegetable Science*, 30(2), 182-184.
[13] Mallick M.F.R. and Muthukrishnan C.R. (1980) *South Indian Horticulture*, 28(1), 14-20.
[14] Hnamte V.R., Chatterjee L. and Patra P.K. (2018) *Journal of Crop and Weed*, 14(1), 72-77.
[15] Datta S., Chakraborty S., Jana J.C., Debnath A., Roy M.K. and Haque S. (2017) *International Journal of Current Microbiology and Applied Sciences*, 6(5), 1471-1482.