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Response of integrated nutrient management and micronutrients on quality, nutrient content, uptake and soil of tomato (*Solanum lycopersicum*)

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Abstract

The experiment was conducted to find out the response of integrated nutrient management and micronutrients on quality, nutrient content, nutrient uptake and soil parameters of tomato at College of Agriculture, Anand Agricultural University, Vaso, during *rabi* season in 2019-20 and 2020-21. The randomized block design with factorial concept having 14 treatment combinations with three replications comprising two factors having two levels of micronutrients and seven levels of INM was used. Different treatments of INM and micronutrients improved the quality, nutrient uptake and soil parameters. The maximum titrable acidity (0.92%) recorded with M_1: zinc @ 100 & N_6: 50% RDF + 50% N from vermicompost + bio NPK, while maximum TSS (5.38 °Brix), lycopene (3.08 mg/100 g) and vitamin-C (34.93 mg/100 g) recorded with N_6. For nutrient uptake, M_1: zinc @ 100 ppm recorded maximum nitrogen uptake by plant (119.71 kg/ha). In INM, treatment N_5 recorded maximum nitrogen content (1.72%), phosphorus (0.68%), potash (1.38%), nitrogen uptake (125.75 kg/ha), phosphorus uptake (44.42 kg/ha) and potash uptake (54.95 kg/ha). The INM treatment N_5: 50% RDF + 50% N from FYM + Bio NPK recorded maximum microbial count (6.2×10^7 and 7.5×10^7) during 2019-20 and 2020-21, respectively and also maximum available N_2O (271.77 kg/ha), available P_2O_5 (51.08 kg/ha), available K_2O (257.13 kg/ha), organic carbon (0.45%), minimum electrical conductivity (1.13 dS/m) and pH (7.76).

Key words: INM, Micronutrients, Quality, Nutrient uptake, Soil parameters

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Tomato (*Solanum lycopersicum* Mill.) is the most popular vegetable crops grown all over the world. The judicious integrated use of both nutrient sources provides an ideal environmental conditions for its crop, as the organic source improves soil properties and enhance the activity of soil microbes, immobilize nutrients and slowly releases them, while inorganic sources made available nutrients immediately, avoiding nutrient depression periods and hastens the decomposition of organic material. Besides sustainable agricultural production, all round improvement in physical, chemical and biological make up of soils is main aim of INM (Chadha, 2002). Zinc has important role in metal component of different enzymes (Marschner, 1995) and essential trace element like increases the rate of chlorophyll, antioxidant enzymes and essential component of many proteins. Therefore, a constant and continuous supply of zinc is needed for optimum growth and maximum yield. Boron plays an important role in flowering and fruit formation (Nonnecke, 1989).

Materials and Methods

A field experiment was conducted during *rabi* season of 2019-20 and 2020-21 at College of Agriculture, Anand Agricultural University, Vaso. The seedlings of tomato cv. Gujarat Anand Tomato-5 were transplanted during 1st week of November. Two factors, *viz.* (1) INM which consisted 7 levels, i.e N_1: 100% RDF (100:50:50 NPK kg/ha.), N_2: 75% RDF + 25% N from FYM + Bio NPK, N_3: 75% RDF + 25% N from vermicompost + Bio NPK, N_4: 75% RDF + 25% N from castor cake + Bio NPK, N_5: 50% RDF + 50% N from FYM + Bio NPK, N_6: 50% RDF + 50% N from vermicompost + Bio NPK, N_7: 50% RDF + 50% N from castor cake + Bio NPK and (2) micronutrients which consisted 2 levels, i.e. M_1: zinc @ 100 ppm and M_2: boron @ 100 ppm were used.

There were 14 treatment combinations. The Randomised Block Design with factorial concept was used. Bio NPK consortium was collected from the Department of Agricultural Microbiology, Anand Agricultural University, Anand. Bio-NPK is liquid biofertilizer consists of nitrogen fixers (*Azotobacter* and *Azospirillum*) + PSB and KMB (3 different *Bacillus* sp.). Bio NPK consortium was applied by dipping seedlings before transplanting in Bio NPK @ 5 ml/litre of water and mixing with organic manures @1 litre/60 kg of manures.

Zinc and boron were applied as a foliar spray @ 100 ppm three times at 10 days interval starting from 30 days

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after transplanting. The observations were recorded by average of five randomly selected plants and analysed. Titrable acidity was measured by method described by Ranganna (1979). The TSS in of tomato was recorded by using hand refractometer. Titrimetric method described by Ranganna (1979) was adopted for estimation of ascorbic acid and acetone extraction method given by Ranganna (1986) was used for estimation of lycopene content in tomato. Nutrient uptake of N, P and K was calculated by formula:

$$\text{Uptake of Nutrients (kg/ha)} = \frac{\text{dry matter yield (kg/ha) x nutrient content (\%)}}{100}$$

Results and Discussion

Titrable acidity influenced significantly by different treatment of INM. Maximum titrable acidity (0.94%) was recorded with N_6 (50% RDF + 50% N from vermicompost + Bio NPK) which was at par with N_5 (50% RDF + 50% N from FYM + Bio NPK). This might be due to increased available nutrients and growth promoting substances in the soil by application of vermicompost with Bio-NPK which results in more absorbance of macro and micro nutrients. Among them, potash is also absorbed in optimum quantity which is responsible for increasing in titrable acidity. These results were coincide with Avhad *et.al.* (2016), Gosavi *et.al.* (2010), Laxmi *et.al.* (2015). Among micronutrients, maximum titrable acidity (0.92%) was recorded with M_1 (Zinc @ 100 ppm) which was at par with M_2 (Boron @ 100 ppm). Zinc increases titrable acidity due to more profusing growth by zinc application as well as it enhances metabolic and enzymatic activities especially for enzyme acetone which is responsible for increasing titrable acidity. Similar result found by Mallick *et.al.* (2021) in tomato. (Table 1)

Maximum TSS (5.38 °Brix) was recorded with N_6 (50% RDF + 50% N from Vermicompost + Bio NPK) during which was at par with N_5 (50% RDF + 50% N from FYM + Bio NPK). Improvement in TSS content of tomato fruits with application of vermicompost might be due to increased photosynthetic activity and exhibited regulatory role on absorption and translocation of various metabolites, resulted improved quality parameter. Same result was reported by Avhad *et.al.* (2016), Gosavi *et.al.* (2010), Kumar *et.al.* (2017). Laxmi *et.al.* (2015) in tomato. TSS remained non-significant with micronutrients. (Table 1)

Maximum vitamin-C (34.93 mg/100 g) was recorded with N_6 (50% RDF + 50% N from Vermicompost + Bio NPK). Increase in vitamin-C might be due to application of vermicompost with Bio-NPK could be attributed by enhanced photosynthetic and metabolic activities, which resulted in the synthesis of higher amount of acids, metabolites and glucose. These assimilates might have contributed to synthesis of vitamin-C. Similar result was obtained by Avhad *et,al.* (2016), Gosavi *et,al.* (2010), Kumar *et,al.* (2017). Singh *et,al.* (2015) in tomato. vitamin-C remained non-significant with micronutrients. (Table 1)

Treatment of INM, N_6 (50% RDF + 50% N from Vermicompost + Bio NPK) recorded maximum lycopene (3.08 mg/100 g) which was at par with N_3 (75% RDF + 25% N from Vermicompost + Bio NPK). The reason behind increasing lycopene content with application of vermicompost might be addition of plant growth promoters from vermicompost and micro and macro nutrients available in optimum quantity. Same result was found by Kumar *et al.* (2017) in tomato. Same result is reported by Avhad *et.al.* (2016), Gosavi *et.al.* (2010), Kumar *et.al.* (2017) in tomato. Lycopene remained non-significant with micronutrients. (Table 1). Interaction effect of different treatments of INM and micronutrients remained non-significant for quality parameters of tomato.

Maximum nitrogen uptake by plant (125.75 kg/ha) was recorded with N_5 (50% RDF + 50% N from FYM + Bio NPK). This might be due to application of FYM with Bio-NPK which increased nutrient absorbance by making more available nutrients in the soil. More nutrient content is responsible for higher rate of photosynthesis which increased dry matter of the plant and finally nutrient uptake is increased. Same result obtained by Avhad *et,al.* (2016), Kumari and Tripathi (2018), Tekale *et,al.* (2017) in tomato. Among micronutrients, maximum nitrogen uptake by plant (119.71 kg/ha) was recorded with M_1 (Zinc @ 100 ppm). Application of zinc attributed to improvement in photosynthesis efficiency, metabolism of plant, physiological functions and hormones synthesis which resulted in more shoot and root growth which finally increased uptake of nitrogen in plant. Nitrogen uptake by plant remained non-significant with micronutrients (Table 2).

Maximum phosphorus uptake by plant (44.42 kg/ha) was recorded with N_5 (50% RDF + 50% N from FYM + Bio NPK) which was at par with N_6 (50%

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Table 1: Effect of INM and micronutrients on quality and yield of tomato (Pooled of two years)

Code	Treatment	Titrable acidity (%)	TSS (oBrix)	Vitamin-C (mg/100g)	Lycopene (mg/100g)	Fruit yield per hectare (t)
Micronutrient (M)						
M_1	Zinc @100 ppm	0.92	5.18	32.19	2.85	35.68
M_2	Boron @ 100 ppm	0.91	5.20	32.40	2.89	39.55
	S.Em.±	0.01	0.03	0.33	0.03	0.62
	CD at 5 %	0.01	NS	NS	NS	1.77
INM (N)						
N_1	100% RDF	0.89	4.91	30.58	2.64	32.14
N_2	75% RDF + 25% N from FYM + Bio NPK	0.92	5.15	32.59	2.79	36.33
N_3	75% RDF + 25% N from Vermicompost + Bio NPK	0.91	5.17	32.68	2.96	37.65
N_4	75% RDF + 25% N from Castor cake + Bio NPK	0.91	5.15	31.25	2.83	36.41
N_5	50% RDF + 50% N from FYM + Bio NPK	0.93	5.30	32.22	2.93	42.57
N_6	50% RDF + 50% N from Vermicompost + Bio NPK	0.94	5.38	34.93	3.08	39.75
N_7	50% RDF + 50% N from Castor cake + Bio NPK	0.92	5.27	31.81	2.85	38.47
	S.Em.±	0.00	0.06	0.62	0.05	1.17
	CD at 5 %	0.01	0.17	1.76	0.14	3.31
	Year	Sig.	NS	Sig.	NS	Sig.
	Sig. interaction	-	-	-	-	-
	CV %	1.10	3.94	6.65	5.89	10.74

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RDF + 50% N from Vermicompost + Bio NPK). This might be due to application of FYM with Bio-NPK which increased nutrient absorbance by making more available nutrients in the soil. More nutrient content is responsible for higher rate of photosynthesis which increased dry matter of the plant and finally nutrient uptake is increased. Same result obtained by Avhad *et,al.* (2016), Kumari and Tripathi (2018), Tekale *et,al.* (2017). Phosphorus uptake by plant remained non-significant with micronutrients (Table 2).

Potash uptake by plant was influenced significantly by different treatment of INM. Maximum potash uptake by plant (54.95 kg/ha) was recorded with N_5 (50% RDF + 50% N from FYM + Bio NPK). This might be due to application of FYM with Bio-NPK which increased nutrient absorbance by making more available nutrients in the soil. More nutrient content is responsible for higher rate of photosynthesis which increased dry matter of the plant and finally nutrient uptake is increased. Same result obtained by Avhad *et.al.* (2016), Kumari and Tripathi (2018), Tekale *et,al.* (2017) in tomato. Potash uptake by plant remained non-significant with micronutrients (Table 2). Interaction effect of different treatments of INM and micronutrients remained non-significant for nutrient uptake by plant of tomato.

The data in table 5 clearly indicated that the treatment combination M_1N_5 *i.e.* Zinc @ 100 ppm and 50% RDF + 50% N from FYM + Bio NPK recorded maximum microbial count (6.2×10^7 and 7.5×10^7) while the lowest microbial count (4.9×10^6 and 5.3×10^6) recorded with M_2N_1 *i.e.* Boron @ 100 ppm and 100% RDF.

Maximum available N_2O (271.77 kg/ha) was recorded with N_5 (50% RDF + 50% N from FYM + Bio NPK). Maximum available P_2O_5 (51.08 kg/ha) found with treatment N5 (50% RDF + 50% N from FYM + Bio NPK). Maximum available K_2O (257.13 kg/ha) found with treatment N_5 (50% RDF + 50% N from FYM + Bio NPK). Maximum organic carbon (0.45%) found with treatment N_5 (50% RDF + 50% N from FYM + Bio NPK). Minimum electrical conductivity (1.13 dS/m) found with treatment N_5 (50% RDF + 50% N from Vermicompost + Bio NPK) and N_2 (75% RDF + 25% N from FYM + Bio NPK). Minimum pH (7.76) found with

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Table 2: Effect of INM and micronutrients on nutrient content and uptake by plant of tomato (Pooled of two years)

Code	Treatment	N content in plant (%)	P content in plant (%)	Kcontent in plant (%)	Nitrogen uptake by plant (kg/ha)	Phosphorus uptake by plant (kg/ha)	Potash uptake by plant (kg/ha)
Micronutrient (M)							
M_1	Zinc @100 ppm	1.64	0.65	1.32	119.71	39.90	45.94
M_2	Boron @ 100 ppm	1.65	0.63	1.32	117.55	38.38	47.22
	S.Em.±	0.01	0.01	0.01	0.56	0.57	0.48
	CD at 5 %	NS	NS	NS	1.60	NS	NS
INM (N)							
N1	100% RDF	1.59	0.60	1.24	109.00	34.75	38.68
N2	75% RDF + 25% N from FYM + Bio NPK	1.61	0.65	1.34	121.67	40.50	47.79
N3	75% RDF + 25% N from Vermicompost + Bio NPK	1.63	0.65	1.34	120.33	37.58	44.93
N4	75% RDF + 25% N from Castor cake + Bio NPK	1.62	0.63	1.31	115.33	36.17	42.26
N5	50% RDF + 50% N from FYM + Bio NPK	1.72	0.68	1.38	125.75	44.42	54.95
N6	50% RDF + 50% N from Vermicompost + Bio NPK	1.68	0.65	1.33	119.50	42.25	50.06
N7	50% RDF + 50% N from Castor cake + Bio NPK	1.65	0.63	1.32	118.83	38.33	47.38
	S.Em.±	0.01	0.01	0.01	1.05	1.06	0.89
	CD at 5 %	0.02	0.04	0.03	2.99	3.02	2.54
	Year	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.
	Sig. interaction	-	-	-	-	-	-
	CV %	1.84	7.71	2.36	3.08	9.40	6.65

treatment N_5 (50% RDF + 50% N from Vermicompost + Bio NPK). Improvement in soil parameters might be due to application of organic manures with Bio-NPK which makes more nutrients available and also improve soil physical and chemical properties.

Conclusion

Thus it can be concluded that application of INM treatments, i.e. N_6 (50% RDF + 50% N from vermicompost + Bio NPK) improved TSS, lycopene, Vitamin-C and titrable acidity while zinc and boron do not affect quality parameters except titrable acidity. Further, N_5 (50% RDF + 50% N from FYM + Bio NPK) recorded maximum N, P and K uptake by plant. This treatment improved soil parameters and microbial count. Interaction effect found non-significant for quality parameters, nutrient uptake and soil parameters.

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