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Effect of foliar application of miconutrients on yield, quality and uptake of nutrients in tomato (*Lycopersicon esculentum*)

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ABSTRACT

A field experiment was conducted at R.B.S. College Research farm, Bichpuri, Agra (U.P.) to study the effect of foliar application of micronutrients on yield, quality and uptake of nutrients in tomato (Lycopersicon esculentum Mill). Nine treatments were evaluated in randomized block design with three replications. The results revealed that the three foliar application of 100 ppm each of B, Cu, Fe, Mn and 50 ppm Mo were at par and recorded significantly higher fruit and dry matter yield of tomato fruit over control. Foliar application of Zn and mixture of all the elements further increased the fruit yield by 17.2 and28.6 per cent, respectively over control. The maximum fruit yield and dry matter yield (29.66 and 1.49t ha^{-1} respectively) were recorded with foliar application of mixture of all the elements. Foliar application of micronutrients improved the quality parameters of tomato fruit and maximum acidity was recorded with copper. The amounts of ascorbic acid and total soluble solids were maximum with foliar application of zinc. The uptake of N, P, K and S by the crop also improved with foliar application of micronutrients and mixture of all the micronutrients resulted in highest uptake of these nutrients by tomato fruits. The uptake of micronutrients (Fe, Mn, Cu, Zn and B) by tomato fruits improved with their foliar application. But maximum values of these elements were recorded with foliar application of mixture prepared by the use of different micronutrients.

Keywords: Foliar application, micronutrients, quality, nutrient uptake, yield, tomato

INTRODUCTION

Tomato (*Lycopersicon esculentum Mill*) is one of the most popular and widely grown vegetables in the world ranking second in importance to potato in India. The fruits of tomato are eaten raw or cooked. It is cooked alone or mixed with other vegetables to prepare a variety of luscious and delicious dishes. Large quantities of fruits are used to produce soup, juice, ketchup and powder. Tomato is popular also because it supplies vitamin C and aids variety of colours and flavours to the food. Foliar feeding is a relatively new and controversial technique of feeding plants by applying liquid fertilizer directly to their leaves. Ferti-fortification, which involves fertilizing crops with micronutrients, gives immediate results by increasing the concentration of micronutrients in plant with an increase in yield. Foliar feeding results in rapid absorption and is less costly. Iron, Zn, Cu, Mn, Mo and boron can play an important role in increasing yield of vegetables. Timing of foliar micronutrient application is an important factor determining the effectiveness of the foliar applied fertilizers in increasing micronutrient concentration in vegetables. Since not much information is available on the effect of foliar application of micronutrients on vegetable crops in alluvial soils of western Uttar Pradesh, present study was , therefore, conducted to find out the effect of foliar feeding of micronutrients on yield, quality and uptake of nutrients in tomato fruits.

MATERIALS AND METHODS

The field experiment was conducted at R.B.S. College Research farm Bichpuri, Agra (U.P.). The soil was sandy loam in texture with normal soil reaction (pH 7.4) and electrical conductively 0.35 dSm^{-1}, low in organic carbon (4.8 g kg^{-1}) and available N (230 kg ha^{-1}) medium in available P (17.0 kg ha^{-1}) and K (140 kg ha^{-1}) and normalin DTPA-Zn (0.62 mg kg^{-1}), Fe (23 mg kg^{-1}), Mn (10 mg kg^{-1}) and Cu (2.1 mg kg^{-1}). The experiment was conducted in randomized block design with nine treatments viz. control, (T_0), 100 ppm boron (T_1), 100 ppm Zn (T_2), 50 ppm Mo(T_3), 100 PPM Cu (T_4), 100 ppm Fe (T_5), 100 ppm Mn (T_6), mixture of all the salts (T_7) and multiplex (T_8). All the micronutrients using boric acid, zinc sulphate, ammonium molybdate, copper sulphate, ferrous sulphate manganese

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sulphate and multiplex were applied as foliar spray at an interval of 10 days. In all, three sprayingswere done on plants. The seedlings of tomato (var Rupali) were transplanted at the distance of 60 x 60 cm in first week of November in both years. The recommended dose of N 150 kg, P_2O_5 90 kg and K_2O 90 kg ha^{-1} were applied uniformly in each plot. The whole amount of P and K in the form of single superphosphate and muriate of potash, respectively and half amount of N as urea were applied before transplanting. Remaining half dose of N was applied at 30 days after transplanting. The fruit yield in each harvest was summed up to give total yield. The pieces of tomato fruits were oven dried to obtain dry matter yield. Total soluble solids were determined by Hand Refractometer Ascorbic acid in juice was determined as per method of Ranganna (1985). Total acid content was determined by titrating against 0.1 N NaOH solution using phenolphthalein as an indicator. Micro Kjeldahl method was used to determine the nitrogen content. The dry matter of tomato fruits was digested in diacid mixture (3:1 of HNO_3 : $HClO_4$) and analysed for P by molybdovanadate yellow colour method, K by flame photometer, S by turbidimetric method, micronutrient cations by atomic absorption spectrophotometer and boron by carmine method (Hatcher and Wilcox, 1950). The uptake of nutrients in fruits was worked out by multiplying content values with dry matter yield data. The data were analysed in randomized block design using standard procedures of ANOVA at 5% level of significance (Panse and Sukhatme, 1985).

RESULTS AND DISCUSSION

Data (Table 1) revealed that the marked improvement in the fruit yield could be achieved by foliar application of micronutrients over control. The treatment having mixture of micronutrients registered the maximum fruit (29.66 t ha^{-1}) and dry matter(1.49 t ha^{-1}) yield of tomato fruits. The increases in fruit and dry matter yield due to this treatment (T_7) were 28.6 and 27.3% over control, respectively. The mean yields of fruits showed significant superiority with T_7, T_5 (iron), T_2 (zinc),T_1(boron) and T_8 (multiplex) over the control in descending order. The variation in dry matter yield with different treatments was found to be significant and maximum yield was recorded with foliar application of mixture of all the micronutrients. However, the spraying of Zn, iron, multiplex and boron also proved significantly superior to control in respect of dry matter production. Increased yields due to micronutrients spraying may be attributed to enhanced photosynthetic activity resulting in to the increased production and accumulation of carbohydrate and favourable effect on vegetative growth and retention of flower and fruits which might have increased the number of fruits. Increased yield in response to foliar application of micro nutrients was also reported by Swati *et al.* (2011), Yadav *et al.* (2018) and Solanki *et al.* (2018).

Quality parameter

Foliar application of micronutrients improved the acidity in fruit over control and

Table 1: Effect of foliar application of micronutrients on yield and quality of tomato fruits (mean of 2 years)

Treatment	Yield (t ha^{-1})		Acidity (%)	Ascrobic acid (mg/100 g)	TSS (%)
	Fruit	Dry matter			
T_0 Control	23.05	1.17	0.83	24.8	4.45
T_1 Boron	26.20	1.31	0.88	27.7	4.63
T_2 Zinc	27.03	1.43	0.97	28.4	4.96
T_3 Molybdenum	24.61	1.21	0.93	25.2	4.65
T_4 Copper	24.23	1.26	0.98	25.9	4.88
T_5 Iron	27.21	1.41	0.88	25.8	4.73
T_6 Manganese	24.46	1.18	0.91	24.2	4.66
T_7 Mixture	29.66	1.49	0.94	28.2	4.85
T_8 Multiplex	26.00	1.38	0.88	25.8	4.76
SEm±	0.58	0.08	0.04	0.83	0.14
CD (P=0.05)	2.05	0.11	0.11	2.47	0.42

maximum value (0.98%) of acidity was recorded with copper followed by zinc and mixture of micronutrients. But the effect of foliar application of micronutrients was statistically at par with respect to acidity. Similar results were reported by Narayan *et al.* (2007). Significant influence was observed with the foliar application of micronutrients in increasing the amount of ascorbic acid content of tomato fruits. Foliar application of zinc exhibited the maximum increase in ascorbic acid content followed by mixture of micronutrients. This increase in ascorbic acid content might be due to synthesis of some metabolic intermediary substances that promoted greater synthesis of the precursor of ascorbic acid. Salam *et al.* (2010) and Yadav *et al.* (2018) reported efficacy of micronutrients in increasing the ascorbic acid content of tomato fruits.The amounts oftotal soluble solid ranged between 4.45 and 4.96 per cent and maximum TSS was recorded with foliar application of Zn followed by copper and mixture of all the micronutrients. Increase in TSS may be due to increased carbohydrate production during photosynthesis. These findings are in conformity with those of Yadav *et al.* (2018).

Table 2: Effect of foliar application of micronutrients on uptake of nutrients by tomato fruits (mean of 2 years)

Treatment	Major nutrients (kg ha^{-1})				Micronutrients (g ha^{-1})				
	N	P	K	S	Zn	Fe	Cu	Mn	B
T_0	34.2	6.6	12.1	5.7	33.4	64.3	9.6	20.6	34.5
T_1	40.9	6.9	16.1	6.5	34.9	67.8	9.8	23.1	49.0
T_2	46.7	8.2	16.3	6.6	40.5	68.0	10.2	23.6	39.5
T_3	45.5	6.5	16.8	7.3	30.0	67.6	9.7	20.9	34.9
T_4	43.1	7.9	18.6	7.6	36.0	67.0	15.0	22.4	37.9
T_5	44.6	8.5	19.2	7.6	36.4	80.0	10.1	23.4	40.2
T_6	44.0	8.3	15.3	6.8	36.2	70.0	9.4	26.0	39.5
T_7	49.8	9.7	21.8	8.6	46.3	87.0	17.2	26.3	53.0
T_8	46.4	8.2	20.1	7.8	40.0	80.0	16.8	24.2	48.2
SEm±	1.45	0.32	0.37	0.31	1.28	2.04	0.39	0.51	1.13
CD (P=0.05)	4.48	0.98	1.13	0.94	3.88	6.26	1.21	1.56	3.46

Uptake of nutrients

Nitrogen uptake by tomato fruits increased significantly by foliar application of micronutrients. The uptake of nitrogen varied from 34.2 kg ha^{-1} at control to 49.8 kg ha^{-1} with foliar application of mixture. Foliar application of Zn and multiplex proved more efficient in improving N uptake compared to other micronutrients. The increase in N uptake may be attributed to increased dry matter yield as well as N content in fruits. Similar results were reported by Bhatt and Srivastava (2005), Patil *et al.* (2008). The foliar application of mixture (T_7) proved to be most effective in improving the absorption of phosphorus by tomato fruits. Most of the micronutrients proved superior in improving the phosphorus uptake by fruits. This increase may be due to twin effect of the increased P content and the increased tomato fruit yield (Bhatt and Srivastava, 2005). Potassium uptake by tomato fruits increased by three foliar sprays of micronutrients over unsprayed treatment. Significantly higher K uptake in fruit was observed by foliar application of micronutrients mixture than the other treatments. The increase in K uptake may be due to combined effect of increased concentration and dry matter yield as a result of three sprayings of micronutrients (Bhatt and Srivastava 2005). Foliar application of mixture of micronutrients resulted in significantly higher uptake of sulphur in fruits. However, alone spraying of most of the micronutrients increased the sulphur uptake by fruits over control. Similar results were reported by Swati *et al.* (2011) and Solanki *et al.* (2018).

Zinc uptake by tomato fruits ranged between 33.4 and 46.3 g ha^{-1}. Foliar applications of mixture of micronutrients and zinc alone were rated best in respect of Zn uptake by fruits (Patnaik *et al.*2001). Increase in zinc uptake in garlic by foliar application of zinc, boron and molybdenum was also reported by Selvaraj *et al.* (2002) and Salam *et al.* (2010). The foliar application of most of the micronutrients

markedly improved the iron uptake by fruits over control. The mixture of micronutrients (T_7) led to the significantly higher uptake of iron compared to other treatments being at par with foliar application of iron. The foliar application of other micronutrients was helpful in further boosting the iron uptake over foliar application of iron alone (Selvaraj *et al.* 2002). All the treatments proved significantly superior to control in respect of Mn uptake by tomato fruit. Manganese uptake by fruits ranged from 20.6 g ha^{-1} at control to 26.3 g ha^{-1} with foliar application of micronutrient mixture (T_7). Foliar application of Mn (T_6) and T_7 treatments were statistically at par with respect to Mn uptake by the fruits (Bhatt and Srivastava 2005). The maximum utilization of copper (17.2 g ha^{-1}) was reported with foliar application of mixture followed by copper spraying. The minimum value of copper uptake was reported under control. Foliar application of mixture (T_7) increased the boron uptake by the fruits over control. Spraying of boron (T_1) was equally effective in improving its uptake by fruits. Similar results were reported by Solanki *et al.* (2018).

From the results, it may be concluded that the foliar application of micronutrient mixture resulted in better yield, quality and uptake of nutrients by tomato fruits. Hence three foliar application of mixture of B, Zn, Cu, Fe and Mn each @ 100 ppm and Mo@ 50 ppm at an interval of 10 days from 40 days after transplanting of tomato could be recommended. Use of multiples also proved beneficial in respect of yield quality and utilization of nutrients in tomato.

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