

RESEARCH ARTICLE

Effect of micronutrient fortified fertiliser application on the growth and yield components of tomato plant in floodplain soils of Bangladesh

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Abstract: This study was conducted at farmers' fields in Chandina, Cumilla of Bangladesh covering soils of Old Meghna Estuarine Floodplain to find the effect of micronutrient application to tomato in floodplain soils. Randomized complete block design with 3 replications was used in the experiment where seven treatments including a control were tested. The treatments were formulated taking six micronutrients, i. e., Zn, B, Cu, Mn, Fe and Mo at the rate of 3, 2, 2, 3, 5 and 1 kg ha⁻¹, respectively. The treatments were designed following the additive element trial technique and N, P, K and S were applied at recommended rate equally to all plots. Fruit yield of tomato was affected significantly by the application of Zn alone but combine application of both Zn and B showed the highest responses. It was evident that the application of only Zn and B was sufficient to achieve a tomato fruit yield of 66.4 t ha⁻¹ that was similar to the highest yielding (67.5 t ha⁻¹) treatment (T7). The lowest yield (56.8 t ha⁻¹) was in the control treatment. Stover yield and plant height did not respond significantly while only Zn was found responsive for fruit yield, fruit clusters and number of fruits per plant. Similar to fruit yield, protein content and in all cases, nutrient uptake were affected by the application of both Zn and B. It was noted that the application of Zn and B influenced different growth and yield parameters while the other four micronutrients tested did not have any effect. However, the combine application of Zn, B, Cu, Mn, Fe and Mo was beneficial for plant growth.

Keywords: Bangladesh, floodplain soil, micronutrients, tomato.

INTRODUCTION

Bangladesh has an agro-based economy having a huge population with small arable land area. To feed its increasing population the arable land is being intensively used. Intensification of agricultural land use along with the cultivation of modern crop varieties have resulted in deterioration of soil fertility with an emergence of new nutrient deficiency, notably micronutrients. Cropping intensity of Bangladesh in 1983–1984 was 171 % which had become 194 % in 2015–2016 (BBS, 2017). Chronologically N, P, K, S, Zn and B deficiencies have arisen in Bangladesh soils (Islam, 2008). There is sporadic information of Cu, Mo and Mn deficiencies in crops (Bhuiyan *et al.*, 1998; Khanam *et al.*, 2000). On the other hand farmers of Bangladesh are not acquainted with the use of micronutrient containing fertilisers, which is a barrier for balanced fertilisation in crop production. Such situations produce a negative impact on crop production (Rijpma & Jahiruddin, 2004).

Continued use of micronutrients may lead to accumulation of excessive levels that will threaten food safety or quality. Thus, micronutrients play a great role in fertiliser programmes to achieve higher and sustainable crop yields. Unfortunately, micronutrients

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have received less attention in fertiliser management research, development and extension. Different research institutions and agricultural universities have conducted a number of field trials with micronutrients at different locations in Bangladesh. These researches mainly concentrated on cereal crops. Micronutrient trials have been conducted principally on rice (Jahiruddin *et al.*, 1994), wheat (Hossain, 2005) and maize (Alam *et al.*, 2000) among the cereal crops. Recently, a few field trials with micronutrients in vegetable cultivation have been conducted (Nasreen *et al.*, 2009). A large part of Bangladesh comprises floodplain soils, and the Old Meghna Estuarine Floodplain (AEZ 19) is one of the important Agro Ecological Zones of the country. Considering the above aspects, the present study was undertaken to evaluate the effect of micronutrient application on the growth and yield parameters of tomato in the soils of AEZ 19.

METHODOLOGY

Experimental site

The experiment was conducted at a farmer's field in the Gabura Village under Chandina Upazila of Cumilla District in Bangladesh in 2011 and 2012. There was coverage of AEZ 19 in the experimental field having Chandina soil series under Non-Calcareous Dark Grey Floodplain Soil type. The nutrient content and status of other parameters in the initial soil are presented in Table 1. BARI Tomato -2 variety was used in the study as it is a popular variety to cultivate in that region.

Table 1: Nutrient content and status of other parameters in initial soil

Characteristics	Status of plant nutrients and other soil parameters
Organic matter (%)	1.68
pH	6.1
Total N (%)	0.10
Available P (mg kg ⁻¹)	14.8
Exchangeable K (cmolc kg ⁻¹)	0.07
Exchangeable Ca (cmolc kg ⁻¹)	3.95
Exchangeable Mg (cmolc kg ⁻¹)	2.73
Available S (mg kg ⁻¹)	7.5
Available Zn (mg kg ⁻¹)	0.79
Available B (mg kg ⁻¹)	0.28
Available Cu (mg kg ⁻¹)	2.28
Available Fe (mg kg ⁻¹)	257
Available Mn (mg kg ⁻¹)	8.9

Treatments

A total of seven treatments were tested in the study among which six were micronutrient containing fertiliser treatments and one control. The treatments were T₁ (Control), T₂ (Zn), T₃ (Zn + B), T₄ (Zn + B + Cu), T₅ (Zn + B + Cu + Mn), T₆ (Zn + B + Cu + Mn + Fe) and T₇ (Zn + B + Cu + Mn + Fe + Mo). Micronutrients were added as ZnSO₄·7H₂O, H₃BO₃, CuSO₄·5H₂O, MnCl₂, FeSO₄·7H₂O and Na₂MoO₄ at the rate of 3 kg Zn, 2 kg B, 2 kg Cu, 3 kg Mn, 5 kg Fe and 1 kg Mo per ha. Urea, TSP, MoP and gypsum were applied at recommended doses equally to all plots and the doses were 100, 30, 60 and 10 kg ha⁻¹ for N, P, K and S, respectively (BARC, 2005).

Experimental design and layout

Randomised complete block design with three replications was used in the study where each of the plots measured 4 m × 5 m in size. Each plot was surrounded by 40 cm wide and 10 cm high earthen bunds. One meter wide and 10 cm deep irrigation channel was made in-between two blocks. The layout of the experiment and randomisation was done in accordance with the standard statistical methods.

Transplanting seedling and intercultural operations

Thirty-day old tomato seedlings from nursery bed were transplanted in the main field maintaining 60 cm × 40 cm spacing. The transplanted seedlings were nursed properly and watered in the morning and evening for three days. Subsequently, irrigation, weeding and plant protection measures (e.g., pesticide application) were done as and when necessary.

Data recorded

The tomato fruits were harvested when they attained an edible stage. A 6 m² area in each plot was selected to harvest fruits and stover (crop residue). The weights of fruits were measured just after harvest. The stover yield was expressed on sundry basis. Data on the growth and yield contributing characters were recorded from 10 randomly selected representative plants from outside the harvested area within a plot, as described by Gomez and Gomez (1984). The growth and yield components on which data were recorded were plant height (cm), number of fruit clusters per plant, number of fruits per plant, total fruit yield per plant (kg), fruit yield (t ha⁻¹) and stover yield (t ha⁻¹).

Collection and preparation of plant samples for chemical analysis

Plant samples (fruit and stover) were collected at the time of harvesting. The stover samples were air dried immediately after collection and the dry samples were chopped off into smaller pieces. The collected plant samples were then oven dried at 65 °C for 24 h. To obtain a homogenous powder, the samples were finely ground by using a grinding-mill to pass through a 60-mesh sieve. The samples were stored in desiccators for the determination of N, P, K, S, Zn and B contents.

The processed plant samples were chemically analysed for the determination of N, P, K, S, Zn and B concentrations following the methods stated in Table 2.

Nutrient uptake was calculated from the yield and nutrient concentration data using the following formulae:

For N, P, K and S:

$$\text{Nutrient uptake (kg ha}^{-1}\text{)} = \text{Nutrient content in plant sample (\%)} \times \text{Oven dry yield (kg ha}^{-1}\text{)}/100$$

For Zn and B:

$$\text{Nutrient uptake (g ha}^{-1}\text{)} = \text{Nutrient content in plant sample (\mu g g}^{-1}\text{)} \times \text{Oven dry yield (kg ha}^{-1}\text{)}/1000$$

Protein concentrations of the main produce were estimated from N concentration of the respective produce by using the following formula

$$\% \text{ Protein} = \% \text{ N of the produce} \times 6.25 \text{ (FAO/WHO/UNU, 1985)}$$

Table 2: Methods used for plant analysis

Elements	Analytical methods
N	Micro-Kjeldahl method (Bremner & Mulvaney, 1982)
P	Colorimetric method: determined using molybdovanadate solution (Yoshida <i>et al.</i> , 1976).
K	Directly by flame photometer (Yoshida <i>et al.</i> , 1976).
S	Turbidimetric method: determined by developing turbid using BaCl ₂ (Chapman & Pratt, 1961).
Zn	Determined directly by atomic adsorption spectrophotometer (Yoshida <i>et al.</i> , 1976).
B	Determined in terms of colour by spectrophotometer following azomethine-H method (Keren <i>et al.</i> , 1996).

Data analysis

The collected data were compiled and tabulated in proper form, which was subjected to statistical analyses following standard methodology and the mean differences were adjudged by Duncan's Multiple Range Test (Gomez & Gomez, 1984).

RESULTS AND DISCUSSION

The effects of treatment were examined in respect of growth and yield components, fruit and stover (crop residue) yields, protein and zinc concentrations of fruits, and nutrient uptake by fruit and stover.

Growth and yield components

Plant height recorded at final harvest did not respond to the treatments (Table 3). Treatment T₇ produced the tallest plants (72.7 cm) and T₁ (control) the shortest (64.1 cm). Different micronutrient treatments affected the number of fruit clusters per plant, number of fruits per plant and fruit yield per plant significantly, which is shown in

Table 3. The highest number of fruit clusters and fruits per plant were observed (19.2 and 51.0, respectively) in T₃ treatment, which was statistically similar to those of all the other treatments except the control. Again, fruit yield per plant (2.23 kg) was also the highest in the same treatment (T₃). The lowest (2.07 kg) was found in control treatment. Each of the yield attributes have been significantly affected by the micronutrients although in most cases Zn was found to be the most influential element. It might be due to numerous roles of zinc in crop physiology. Some such important functional roles include the metabolism of auxins and nitrogen, enhancing enzyme activities (e.g. dehydrogenase, proteinases and peptidases) and synthesis of cytochrome c (Obata *et al.*, 1999; Havlin *et al.*, 2010). Zinc is also an important nutrient in the reproduction process of plant. Formation of male and female reproductive organs and the pollination process are disturbed due to zinc deficiency (Brown *et al.*, 1993). In each case, application of B with Zn gave slightly improved results, but it was not statistically significant. In an experiment, application of 2 kg B ha⁻¹ resulted in maximum number of flower clusters per tomato plant (Naz *et al.*, 2012).

Table 3: Effects of micronutrients on the yield and yield components of tomato

Treatments	Plant height (cm)	Fruit clusters per plant (no.)	Fruits per plant (no.)	Fruit yield per plant (kg)	Fruit yield (t ha ⁻¹)	Stover yield (t ha ⁻¹)
T1: Control	64.1	17.6b	39.2b	2.07b	56.8c	2.66
T2: Zn	71.3	19.0a	47.0a	2.18a	61.6b	3.23
T3: Zn + B	71.7	19.2a	51.0a	2.23a	66.4a	3.42
T4: Zn + B + Cu	68.9	18.3ab	47.1a	2.22a	65.2ab	3.31
T5: Zn + B + Cu + Mn	69.1	18.3ab	47.6a	2.20a	66.7a	3.33
T6: Zn + B + Cu + Mn + Fe	72.1	19.1a	48.2a	2.22a	66.4a	3.39
T7: Zn + B + Cu + Mn + Fe + Mo	72.7	19.1a	50.4a	2.22a	67.5a	3.45
CV (%)	4.72	3.12	4.77	2.00	3.28	8.44
Significance level	NS	*	**	**	**	NS
SE (±)	1.91	0.34	1.30	0.03	1.22	0.16

Means followed by the same letter in a column are not significantly different at 5 % level by DMRT.

SE (±) = standard error of means; CV = coefficient of variation; * = significant at 5 % level; ** = significant at 1 % level; NS = not significant

Yield

Fruit yield of tomato significantly responded to the application of different micronutrients, while differences in stover yield between any two treatments was not significant (Table 3). The highest fruit yield (67.5 t ha⁻¹) was noted in T₇ treatment, which was statistically similar to the fruit yields of other treatments except T₁ and T₂. The lowest fruit yield (56.8 t ha⁻¹) was found in control treatment. A higher yield was observed with combined application of Zn and B fertilisers (T₃ treatment). There were no additive effects due to the application of other four micronutrients. Application of Zn induced the highest yield in tomato (Arora *et al.*, 1990) and application of B fertiliser increased the yield of tomato (Sobulo, 1975; Chude & Oyinlola, 2001).

There was an increasing trend observed in the yield of tomato from T₁ to T₃ treatment and it dropped slightly in T₄ (Zn + B + Cu) treatment. It might be due to the lower uptake of Zn resulting from the antagonistic relation between Zn and Cu. A previous study stated that higher concentrations of copper in the soil solution relative to zinc can reduce the availability of zinc to a plant (and *vice versa*) due to competition for the same sites for absorption into the plant root (Mousavi *et al.*, 2012). This could occur after the application of a copper fertiliser. In another experiment, it was shown that Zn concentration decreased significantly at higher levels of Cu (2.0 and 2.5 mg kg⁻¹) in leaves and remained unaffected in the grain and straw of wheat (Kumar *et al.*, 2009). Some confusing reports are also available in literature regarding the Zn-Cu relationship. *Amaranthus cruentus* plant can accumulate higher concentrations of Cu and Zn if the cultivated soil

contains moderately higher Cu and Zn levels (Ondo *et al.*, 2012). Antagonist effects were observed between Cu and Zn supplementation and other metals in roots. In stems, synergistic effects were observed.

Protein and zinc concentrations of fruit

A significant variation was observed in protein and zinc concentrations of tomato fruit as an effect of the micronutrient treatments (Table 4). The highest protein

Table 4: Effects of micronutrients on protein and zinc concentrations of tomato fruit

Treatments	Protein (%)	Zinc (µg g ⁻¹)
T ₁ : Control	0.70c	1.35b
T ₂ : Zn	0.75b	1.95a
T ₃ : Zn + B	0.86a	1.91a
T ₄ : Zn + B + Cu	0.82a	1.89a
T ₅ : Zn + B + Cu + Mn	0.81a	1.99a
T ₆ : Zn + B + Cu + Mn + Fe	0.83a	1.92a
T ₇ : Zn + B + Cu + Mn + Fe + Mo	0.85a	2.01a
CV (%)	3.22	7.97
Significance level	**	**
SE (±)	0.02	0.09

Protein and zinc concentrations of tomato fruit were expressed as fresh weight basis.

Means followed by the same letter in a column are not significantly different at 5 % level by DMRT.

SE (±) = standard error of means; CV = coefficient of variation; ** = significant at 1 % level

concentration (0.86 %) was observed in T₃ treatment, which was statistically similar to the other treatments (T₂-T₆). The highest zinc concentration (2.01 µg g⁻¹) was found in T₇ treatment and it was also statistically similar to all other treatments except the control. The lowest concentrations of protein and zinc were observed in the control treatment. Considering nutritional aspects, protein and zinc contents of vegetables and cereal grains are a matter of concern in the present situation. Recently, research has been oriented to explore the use of Zn fertilisers to increase Zn concentrations beyond what is needed for the maximum yield, to enrich the edible portions of crops for human health benefits (Genc *et al.*, 2005; Broadly *et al.*, 2007; Ortiiz-Monasterio *et al.*, 2007; Cakmak, 2008). The protein content of tomato fruit increased with the application of zinc. Zinc deficiency is considered to restrict RNA synthesis, which in turn inhibits protein synthesis (Katyal & Randhawa, 1983). Combined application of Zn and B was needed

to achieve the highest protein concentration while application of only Zn was sufficient to have the highest Zn concentration in the tomato fruit. The protein content of tomato fruit has been influenced positively by the zinc concentration of the same (Figure 1).

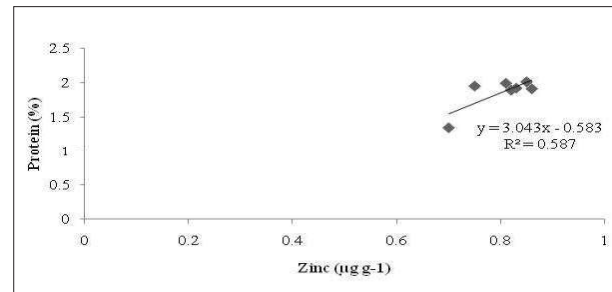


Figure 1: Relationship between Zn concentration and protein content of tomato fruit

Table 5: Effects of micronutrients on the nutrient concentration of tomato

Treatments	N (%)		P (%)		K (%)	
	Fruit	Stover	Fruit	Stover	Fruit	Stover
T ₁ : Control	0.112c	1.00c	0.017	0.301	0.085c	2.99c
T ₂ : Zn	0.120b	1.12b	0.016	0.284	0.094b	3.30b
T ₃ : Zn + B	0.138a	1.23a	0.016	0.289	0.101a	3.36a
T ₄ : Zn + B + Cu	0.131a	1.18ab	0.017	0.285	0.102a	3.39a
T ₅ : Zn + B + Cu + Mn	0.130a	1.19ab	0.016	0.291	0.104a	3.45a
T ₆ : Zn + B + Cu + Mn + Fe	0.133a	1.21a	0.016	0.288	0.102a	3.39a
T ₇ : Zn + B + Cu + Mn + Fe + Mo	0.136a	1.27a	0.017	0.296	0.104a	3.45a
CV (%)	3.22	3.61	3.86	3.77	3.63	2.53
Significance level	**	**	NS	NS	**	**
SE (±)	0.003	0.02	0.001	0.006	0.002	0.05

Treatments	S (%)		Zn (µg g ⁻¹)		B (µg g ⁻¹)	
	Fruit	Stover	Fruit	Stover	Fruit	Stover
T ₁ : Control	0.010b	0.416c	1.35b	32.3b	1.13b	28.2b
T ₂ : Zn	0.011a	0.536b	1.95a	45.7a	1.16b	29.9b
T ₃ : Zn + B	0.011a	0.570ab	1.91a	45.0a	1.39a	37.1a
T ₄ : Zn + B + Cu	0.012a	0.588ab	1.89a	45.3a	1.53a	38.0a
T ₅ : Zn + B + Cu + Mn	0.012a	0.608a	1.99a	44.5a	1.47a	37.2a
T ₆ : Zn + B + Cu + Mn + Fe	0.012a	0.594ab	1.92a	45.3a	1.54a	38.1a
T ₇ : Zn + B + Cu + Mn + Fe + Mo	0.012a	0.607a	2.01a	46.2a	1.55a	38.6a
CV (%)	6.27	6.12	7.97	6.88	6.36	6.16
Significance level	*	**	**	**	**	**
SE (±)	0.004	0.019	0.086	1.73	0.051	1.26

Nutrient concentration of tomato fruit was expressed as fresh weight basis

Means followed by the same letter in a column are not significantly different at 5 % level by DMRT

SE (±) = standard error of means; CV = coefficient of variation; * = significant at 5 % level; ** = significant at 1 % level;

NS = non-significant

Nutrient uptake

The concentrations of N, K, S, Zn and B in both tomato fruit and stover responded significantly to the treatments except for P concentration (Table 5). The nutrient uptake as calculated from the yield and nutrient concentration data are presented in Table 6.

Significant uptake of N, K, S, Zn and B by tomato with respect to the application of Zn and B was observed. The other micronutrients did not play a positive role in the nutrient uptake by the crop. Uptake of N by tomato fruit and stover was significantly influenced by the treatments. The fruit N uptake ranged from 63.4 to 91.7 kg ha⁻¹ where the highest N uptake was observed in T₇ treatment, which was statistically similar to the uptake results of T₃-T₆ treatments. The stover N uptake ranged from 26.5 kg ha⁻¹ in the control to 43.7 kg ha⁻¹ in T₇ treatment. Obviously, the highest total uptake of N (135 kg ha⁻¹) resulted from T₇ treatment, which was

statistically similar to the uptake of T₃ and T₆ treatments. Fruit P uptake ranged from 9.6 kg ha⁻¹ in T₂ to 11.3 kg ha⁻¹ in T₇ treatment, whereas 8.07 kg ha⁻¹ was noted in the control and 10.3 kg ha⁻¹ in T₇ treatment in case of stover P uptake. For both fruit and stover, the highest K uptake (70.2 and 119 kg ha⁻¹, respectively) was obtained from T₇ treatment, which was statistically similar to those of all other treatments except T₁ and T₂. Similarly, the highest total K uptake (189 kg ha⁻¹) was also found in T₇ treatment and it was statistically similar to those of T₃, T₅ and T₆. The lowest uptake was found in T₁ treatment. The highest fruit S uptake (8.01 kg ha⁻¹) was recorded in T₅ treatment whereas for stover and total S, the highest uptake (20.9 and 28.9 kg ha⁻¹, respectively) was recorded in T₇ treatment. The lowest S uptake was found in control treatment. In each case, the S uptake was similar to each other except T₁ and T₂. Fruit, stover and total Zn uptake ranged from 78 to 136, 87 to 160 and 164 to 296 g ha⁻¹, respectively. In all cases, the highest uptake was recorded in T₇ treatment, which was statistically similar to all

Table 6: Effects of micronutrients on the nutrient uptake of tomato

Treatments	N uptake (kg ha ⁻¹)			P uptake (kg ha ⁻¹)			K uptake (kg ha ⁻¹)		
	Fruit	Stover	Total	Fruit	Stover	Total	Fruit	Stover	Total
T ₁ : Control	63.4c	26.5d	90e	9.8bc	8.07c	17.8c	48.5c	80c	128d
T ₂ : Zn	74.2b	33.3c	107d	9.6c	8.42bc	18.0c	57.7b	98b	155c
T ₃ : Zn + B	91.5a	42.0ab	133ab	10.9ab	9.90a	20.8ab	67.1a	115a	182ab
T ₄ : Zn + B + Cu	85.3a	39.2b	125c	10.9ab	9.46ab	20.4b	66.5a	112a	179b
T ₅ : Zn + B + Cu + Mn	86.8a	39.7ab	127bc	10.8ab	9.69a	20.5ab	69.1a	115a	184ab
T ₆ : Zn + B + Cu + Mn + Fe	88.6a	41.1ab	130abc	10.9ab	9.80a	20.7ab	68.0a	115a	183ab
T ₇ : Zn + B + Cu + Mn + Fe + Mo	91.7a	43.7a	135a	11.3a	10.3a	21.5a	70.2a	119a	189a
CV (%)	4.01	5.84	3.31	5.81	6.48	2.70	4.76	5.13	3.00
Significance level	**	**	**	*	**	**	**	**	**
SE (±)	1.92	1.28	2.31	0.36	0.35	0.31	1.75	3.19	2.97

Treatments	S uptake (kg ha ⁻¹)			Zn uptake (g ha ⁻¹)			B uptake (g ha ⁻¹)		
	Fruit	Stover	Total	Fruit	Stover	Total	Fruit	Stover	Total
T ₁ : Control	5.50c	11.0c	16.5c	78b	87c	164d	64b	74b	138c
T ₂ : Zn	6.85b	15.9b	22.7b	120a	135b	255c	71b	89b	160b
T ₃ : Zn + B	7.29ab	19.5a	26.7a	127a	155ab	282ab	92a	127a	219a
T ₄ : Zn + B + Cu	7.70ab	19.5a	27.2a	123a	150ab	274bc	100a	126a	226a
T ₅ : Zn + B + Cu + Mn	8.01a	20.3a	28.3a	133a	149ab	281ab	98a	124a	222a
T ₆ : Zn + B + Cu + Mn + Fe	7.74ab	20.1a	27.9a	128a	155ab	282ab	102a	129a	231a
T ₇ : Zn + B + Cu + Mn + Fe + Mo	7.90ab	20.9a	28.9a	136a	160a	296a	105a	133a	238a
CV (%)	7.56	8.44	6.04	8.93	8.81	4.13	7.49	7.38	5.20
Significance level	**	**	**	**	**	**	**	**	**
SE (±)	0.32	0.89	0.89	6.22	7.20	6.25	3.91	4.88	6.16

Means followed by the same letter in a column are not significantly different at 5 % level by DMRT.

SE (±) = standard error of means; CV = coefficient of variation; * = significant at 5 % level; ** = significant at 1 % level

other treatments except T₁ for fruit Zn, and T₁ and T₂ for stover Zn. In case of total uptake, effects of all the treatments were similar to each other except T₁, T₂ and T₄. The lowest uptake was always found in the control treatment. Uptake of fruit, stover and total B ranged from 64 to 105, 74 to 133 and 138 to 238 g ha⁻¹, respectively. In each case, the highest B uptake was associated with T₇ treatment, which was statistically similar to those of all other treatments except T₁ and T₂. The lowest uptake was recorded in T₁ treatment for all fractions. The uptake of Zn and B by tomato increased with higher B levels (Smit & Combrink, 2004). Another study indicated that in tomato, soil-applied B increased uptake and tissue concentrations of N, K and B (Davis *et al.*, 2003).

CONCLUSION

The application of Zn and B influenced different growth and yield parameters while the other four micronutrients tested: i.e. Cu, Mn, Fe and Mo, did not have any effect. The application of micronutrient package having Zn, B, Cu, Mn, Fe and Mo is beneficial for better plant growth. Fruit yield of tomato was affected significantly by the application of only Zn but combined application of both Zn and B showed the highest responses by tomato. Only Zn was found responsive for fruit yield per plant, fruit clusters per plant and number of fruits per plant. Similar to fruit yield, protein concentration and almost all nutrient uptake were affected by the application of both Zn and B.

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