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Effect of foliar application of zinc and boron on yield of tomato (*Lycopersicon esculentum* Mill.) cv. Azad T-6

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Abstract
Zinc and Boron play an important role chlorophyll synthesis, auxin synthesis, protein synthesis, water uptake and photosynthesis likewise, Boron also effect on production and quality of tomato, because it required by the crop plant for the cell division, nucleic acid synthesis uptake of calcium and transportation of carbohydrate. The deficiency of both element causes different types of disorder during the crop period, So keeping in the above view the present investigation on foliar application of zinc and boron at different concentration *i.e.* for the Zinc 0.0%, 0.25%, 0.50% & 0.75%;and for the Boron 0.0%, 0.20%, 0.40% & 0.60%.The foliar application of zinc at 0.75% and for the boron at 0.60% found best results and so the significant effect for improving the yield attributes *i.e.* number of fruits per plant, diameter of fruit, weight of fruit, fruit yield per plant & yield of fruit per hectare; So, for the optimum yield above dose of Zinc and Boron is recommended for the production of tomato.

Keywords: Tomato, zinc, boron, flowering, growth, yield etc.

Introduction
Tomato (*Lycopersicon esculentum* Mill.) is a member of Solanaceae family (2n=24) and is one of the most popular, nutritious and widely grown vegetable across the world. South America is origin place of tomato. Due to the excellent adaptability to wider range of soil and climatic conditions it is widely grown in many parts of the world. It is a self-pollinated crop and the number of the chromosome is 2n=2x=24. The total global area under tomato is 4815712 ha and the global production is 163029746 MT with a productivity of 33.9 MT/ha (NHB data base, 2020). In Uttar Pradesh, it is cultivated about an area of 20880 ha. with the production of 826320 MT and productivity is 39.57 MT/ha. In India, tomato occupies an area about 808500 ha with a production of 19696900 MT. The productivity of tomato in the country is 24.40 MT/HA (Horticulture at a glance, 2020). For harnessing the higher yield potential, supplementation of zinc and boron is essential. Amongst the vegetables, tomato is very responsible to the application of micronutrients. The zinc and boron improve the chemical composition of fruits and general condition of the plants and are known to acts as catalyst in promoting organic reaction taking place in plants. Zinc is essential for carbohydrates, protein metabolism and sexual fertilization. It is also essential for the synthesis of tryptophan which is the precursor of Indole Acetic Acid (IAA). Boron is essential for yield and quality of tomato. It helps in the development of cell wall, occurrence of cell division, formation of the vascular bundle, protein synthesis, root system development, fruit and seed formation and transport of sugar. Keeping the above points as entitled that Effect of foliar application of Zinc and Boron on yield of tomato (*Lycopersicon esculentum* Mill.) cv. Azad T-6 with objective as to find out suitable treatments of Boron and Zinc for maximum yield parameters of tomato.

Materials and Methods
The experiment was conducted at Vegetable Research Farm, Kalyanpur, Department of Vegetable Science, C. S. Azad University of Agriculture & Technology, Kanpur (U.P.) on Azad T-6 tomato variety. The treatment comprised combination of four levels of Boron (0%, 0.20%, 0.40% and 0.60%) and Zinc (0%, 0.25%, 0.50% and 0.75%). The experiment was carried out in Factorial Randomized Block Design with three replications. The gross plot size was 4.50m × 2.25m (10.125m^2). The seeds of tomato variety Azad T-6 were obtained from Vegetable Research Farm, Kalyan pur Kanpur. Seeds were sown on October month at Vegetable Research Farm, Kalyanpur Kanpur.

The recommended fertilizer dose of 120 kg N, 75 kg P and 60 kg K per ha was applied. Before applying chemical fertilizers, 2 baskets full of well decomposed FYM was applied to each plot before last ploughing. Seedlings were transplanted on November month, at a spacing of 45 x 30 cm and thus, in a plot, 25 seedlings were accommodated. After three week of planting tomato crop, treatment application of zinc and boron were applied as foliar spray. Other concentrations of zinc and boron (borax) solution were similarly prepared with mathematical calculation and applied for spraying.

a. **Experiment Details:** The treatment comprised combination of four levels of Boron (0%, 0.20%, 0.40% and 0.60%) and Zinc (0%, 0.25%, 0.50% and 0.75%).
b. **Statistical Analysis:** The experimental data recorded on each aspect on each treatment were statistically computed in factorial RBD as following procedure which is given by Panse and Sukhatme (1985). For calculating standard error of mean and critical difference (t) value was taken at 0.05 level of significance.
c. **Treatment application:** After three week of planting tomato crop, treatment application of zinc and boron were applied as spraying. For preparation of 0.25% zinc, 2.50 g zinc sulphate and 6g of slacked lime were dissolved in 5 liter distilled water. Other concentrations of zinc and boron (borax) solution were similarly prepared with mathematical calculation and applied for spraying.
d. **Climatic conditions:** Kanpur is characterized by sub-tropical climate with hot dry summer and cold winters. The annual rainfall is about 800-880 mm. The major portion of rain is received between July to September, with scattered shower in winter from the North-East monsoon. The maximum temperature ranges from 24 to 46 ˚C and minimum 7.0 to 24.8 ˚C with relative humidity from 32 to 98% in different months of the year.

Yield attributes

1. **Number of fruits per plant:** Several pickings were required as all the fruits did not mature at a time. In each picking, fruits were counted at after last picking; the average number of fruits per plant was calculated.
2. **Diameter of fruit (cm):** The diameter of fruit was measured in centimeter (cm) from the middle of the fruit with the help of a *Vernier Callipers*. The diameter of all the fruit of 3 sampled plants was taken and mean was worked out.
3. **Weight of fruit (g):** The weights of randomly selected fruits were pooled and average fruit weight was calculated in gram.
4. **Fruit Yield per plant (g):** Fruit yield per plant was observed by total harvested fruits. Harvesting is done in morning time. Data were showed in g/plant.
5. **Fruit Yield per Hectare (q):** On the basis of fruit yield per plant, the fruit yield per plot was observed and the fruit yield per hectare was determined in quintal.

Results and Discussion

1. Number of fruits per plant

The maximum number of fruit per plant with the application of zinc was observed 27.86 with Zn_3 (0.75%) and minimum number of fruits per plant was 24.95 recorded with Zn_0 (0.0%). Boron also influenced the number of fruits per plant and maximum 27.46 recorded with B_3 (0.60%) and minimum number of fruits per plant was 25.86 recorded with B_0 (0.0%). More number of fruits was obtained with the increased dose of zinc and boron. This may be attributed to enhanced photosynthesis activity and increased production and accumulation of carbohydrates and favourable effect on vegetative growth and increase in flowering and fruiting, which increased number of fruits per plant. Similar results were reported by several workers like Vasil *et al.* (1997) [1], Yadav *et al.* (2001) [2], Babu (2002) [3], Sahin *et al.* (2015) [4] and Bibi Haleema *et al.* (2017) [5].

Zn \ B	B_0 (0%)	B_1 (0.20%)	B_2 (0.40%)	B_3 (0.60%)	Mean
Zn_0 (0%)	22.150	24.870	26.650	26.650	24.950
Zn_1 (0.25%)	26.720	26.860	26.170	27.170	26.933
Zn_2 (0.50%)	27.120	27.350	27.750	27.750	27.430
Zn_3 (0.75%)	27.450	27.750	27.300	28.300	27.863
Mean	25.860	26.700	27.140	27.467	
	Zn		B		Zn x B
S.E. (Diff.)	0.550		0.550		1.100
CD at 5%	1.124		1.124		N.S.

2. Diameter of fruit (cm)

Zinc and boron treatment showed significant variation with diameter of fruit and their interactive effects were also found significant. Maximum diameter of fruits were recorded in Zn_3 (6.67cm), Zn_2 (6.57cm) followed by Zn_1 (6.45cm), whereas minimum diameter of fruits observed in Zn_0 (5.98 cm). Boron also influenced the diameter of fruits and maximum diameter were recorded with B_3 (6.58cm), B_2 (6.50 cm) followed by B_1 (6.40 cm). The minimum diameter of fruits was recorded with B_0 (6.20 cm). Similar results were reported by several workers like Ali *et al.* (2013) [6] and Harris *et al.* (2015) [7].

Zn \ B	B_0 (0%)	B_1 (0.20%)	B_2 (0.40%)	B_3 (0.60%)	Mean
Zn_0 (0%)	5.310	5.960	6.260	6.390	5.980
Zn_1 (0.25%)	6.410	6.440	6.470	6.510	6.457
Zn_2 (0.50%)	6.500	6.560	6.590	6.650	6.575
Zn_3 (0.75%)	6.580	6.650	6.700	6.780	6.678
Mean	6.200	6.403	6.500	6.580	
	Zn		B		Zn x B
S.E. (Diff.)	0.134		0.134		0.267
CD at 5%	0.273		0.273		N.S.

3. Weight of fruit (g)

Maximum significant weight of fruit was recorded in Zn_3 (50.69 g), Zn_2 (49.90 g) and followed by Zn_1 (49.02 g), whereas minimum weight of fruit was observed in Zn_0 (45.39g). Significantly maximum fruit weight was recorded with B_3 (49.97g) and B_2 (49.37g) followed by B_1 (48.60 g), while minimum weight of fruit was recorded with B_0 (47.06g). Weight of fruits was positively influenced by Zn and B. By these micronutrients constructive cellular mechanism and respiration are accelerated which caused aggressive carbohydrates and protein synthesis, enhanced mobilization of food and minerals towards diameter and other growth character of fruit. These activities might be increased more weighted fruits ultimately. Findings are in agreement with reports of Yadav *et al.* (2006) [8], Kesani *et al.* (2013) [9] and Sultana *et al.* (2016) [10] in tomato.

Zn \ B	B_0 (0%)	B_1 (0.20%)	B_2 (0.40%)	B_3 (0.60%)	Mean
Zn_0 (0%)	40.310	45.240	47.520	48.510	45.395
Zn_1 (0.25%)	48.660	48.890	49.120	49.420	49.023
Zn_2 (0.50%)	49.340	49.800	50.010	50.480	49.908
Zn_3 (0.75%)	49.950	50.480	50.860	51.470	50.690
Mean	47.065	48.602	49.377	49.970	
	Zn		B		Zn x B
S.E. (Diff.)	0.596		0.596		1.192
CD at 5%	1.218		1.218		2.436

4. Fruit yield per plant (g)

Zinc and boron significantly influenced fruit yield of tomato. Interaction of Zn and B was found to be significant. Maximum fruit yield was recorded in Zn_3 (1378.34g), Zn_2 (1356.94g) followed by Zn_1 (1332.34g), while minimum fruit yield was observed in Zn_0 (1234.26 g).

Boron also influenced fruit yield and maximum yield per plant was recorded with B_3 (1358.80g) and B_2 (1342.60g) followed by B_1 (1321.20g), and minimum fruit yield per plant was recorded with B_0 (1279.28g). Higher yield was obtained due to increased number of fruits per plant, diameter of fruits and weight of an individual fruit. Workers like Haque *et al.* (2011) [11] and Kumari (2012) [12] reported similar yield in tomato.

Zn \ B	B_0 (0%)	B_1 (0.20%)	B_2 (0.40%)	B_3 (0.60%)	Mean
Zn_0 (0%)	1095.750	1230.310	1292.640	1318.360	1234.265
Zn_1 (0.25%)	1321.830	1328.750	1334.690	1344.090	1332.340
Zn_2 (0.50%)	1341.610	1352.990	1360.410	1372.780	1356.947
Zn_3 (0.75%)	1357.940	1372.780	1382.670	1399.990	1378.345
Mean	1279.283	1321.208	1342.603	1358.805	
	Zn		B		Zn x B
S.E. (Diff.)	5.371		5.371		10.742
CD at 5%	10.971		10.971		21.942

5). Fruit yield per hectare (q)

Significantly maximum fruit yield per hectare was recorded in Zn_3 (478.32q), Zn_2 (470.89q) followed by Zn_1 (462.35q) and minimum fruit yield was observed in Zn_0 (428.32q).

Boron also influenced fruit yield significantly and maximum yield per hectare was recorded with B_3 (471.53q) and B_2 (465.91q) followed by B_1 (458.49q). The minimum fruit yield was recorded with B_0 (443.94q). Fruit yield per hectare was increased due to micronutrients Zn and B which acts positive role to hasten different yield attributes which are ultimately promoted fruit yield. Findings are in accordance with the reports of Babu (2002) [13], Das and Patro (1989) [14], Mishra *et al.* (2012) [15] and Mushtaq *et al.* (2016) [16] in tomato.

B Zn	B_0 (0%)	B_1 (0.20%)	B_2 (0.40%)	B_3 (0.60%)	Mean
Zn_0 (0%)	380.250	426.950	448.580	457.500	428.320
Zn_1 (0.25%)	458.700	461.110	463.170	466.430	462.353
Zn_2 (0.50%)	465.570	469.520	472.090	476.390	470.892
Zn_3 (0.75%)	471.240	476.390	479.820	485.830	478.320
Mean	443.940	458.492	465.915	471.538	
	Zn		B		**Zn x B**
S.E. (Diff.)	4.170		4.170		8.340
CD at 5%	8.519		8.519		17.038

Conclusion

An experiment was conducted during *rabi* season at Vegetable Research Farm, Kalyanpur Kanpur, Uttar Pradesh. With the summary of results, it can be concluded that number of fruits per plant, diameter of fruit, weight of fruit, fruit yield per plant, fruit yield per hectare, were significantly increased with the application of at zinc 0.75%, boron at 0.60%. From above scenario of result, Zn_3 (0.75%) and B_3 (0.60%) produced maximum significant values of yield attributes of tomato. For obtaining optimum yield of tomato fruit spraying with 0.75% zinc and 0.60% boron is recommended.

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