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Influence of foliar application of zinc and boron on growth, yield and quality parameters of tomato (*Solanum lycopersicum* L.) cv. Kashi Aman

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Abstract

The present field experiment entitled “Influence of Foliar Application of Zinc and Boron on Growth, Yield and Quality Parameters of Tomato (*Solanum lycopersicum* L.) cv. Kashi Aman” was conducted during the *rabi* season of 2025-26 at the Vegetable Research Farm, Department of Horticulture, Rama University, Kanpur, Uttar Pradesh. The experiment was laid out in a Randomized Block Design with nine treatments and three replications. Treatments consisted of foliar sprays of zinc (0.25%, 0.5%, 0.75% and 1.0%) and boron (0.25%, 0.5%, 0.75% and 1.0%) applied at 30 and 45 days after transplanting, along with an untreated control.

Results showed that 0.75% zinc (T₃) was most effective for vegetative growth, recording the highest plant height (111.67 cm at 60 DAT and 121.30 cm at 90 DAT), number of branches per plant (5.58), chlorophyll content (55.43 SPAD units) and leaf area (50.73 cm²). However, 0.75% boron (T₇) proved superior for yield and quality attributes. It produced the maximum number of fruits per plant (29.50), average fruit weight (84.01 g), fruit yield per plant (1.70 kg) and total yield (472.13 q/ha). This treatment also recorded the highest total soluble solids (5.13 °Brix), lycopene content (6.07 mg/100 g), pericarp thickness (6.10 mm) and ascorbic acid content (20.70 mg/100 g) with the lowest fruit pH (4.20).

It is concluded that foliar application of 0.75% boron at 30 and 45 days after transplanting was the most promising treatment for achieving higher yield and superior fruit quality in tomato cv. Kashi Aman under Kanpur conditions. Application of 0.75% zinc was found most effective for improving vegetative growth. The study highlights the significant role of foliar micronutrient supplementation in enhancing productivity and quality of tomato.

Keywords: Tomato, Zinc, Boron, Foliar application, Growth, Yield, Fruit quality, Kashi Aman

Introduction

Tomato (*Solanum lycopersicum* L.) is one of the most economically important and nutritionally rich vegetable crops grown worldwide. It serves as a major source of vitamins (A and C), minerals, and bioactive compounds such as lycopene and ascorbic acid, which are known to promote human health and help reduce the risk of chronic diseases. In India, tomato plays a significant role in food security, rural employment, and income generation for small and marginal farmers. However, its productivity is often limited by widespread deficiencies of essential micronutrients, particularly zinc and boron, in intensive cropping systems.

Zinc is involved in key physiological processes including auxin biosynthesis, enzyme activation, chlorophyll formation, and protein metabolism. Boron, on the other hand, is crucial for cell wall development, pollen germination, fruit set, sugar translocation, and reproductive growth. Foliar application of these micronutrients has proven to be an effective and rapid method to correct deficiencies and enhance plant performance under field conditions. The present study was conducted to evaluate the effect of different concentrations of zinc and boron applied as foliar sprays on the growth, yield, and quality parameters of tomato cv. Kashi Aman during the *rabi* season of 2025-26 at Rama University, Kanpur. The main objective was to identify the most suitable concentration of each micronutrient for improving vegetative growth, fruit yield, and quality traits under the subtropical agro-climatic conditions of Uttar Pradesh.

Materials and Methods

The field experiment was conducted in open-field conditions at the Vegetable Research Farm, Department of Horticulture, Faculty of Agricultural Sciences and Allied Industries, Rama University, Kanpur (26°26' N latitude, 80°20' E longitude, 129.23 m above mean sea level) during the *rabi* season of 2025-26. The experiment was laid out in a Randomized Block Design with nine treatments and three replications. Treatments consisted of foliar sprays of zinc sulphate heptahydrate ($\text{ZnSO}_4 \cdot 7\text{H}_2\text{O}$) and borax ($\text{Na}_2\text{B}_4\text{O}_7 \cdot 10\text{H}_2\text{O}$) at four concentrations each (0.25%, 0.5%, 0.75% and 1.0%) along with an untreated control (T_9). Sprays were applied at 30 and 45 days after transplanting (DAT).

Tomato cv. Kashi Aman was used. Nursery was sown on 15 August 2025 and 30-day-old seedlings were transplanted on 18 September 2025 at 60 cm × 60 cm spacing. Plot size was 3 m × 3 m. The recommended dose of NPK (100:75:60 kg/ha) was applied as per standard practice. All other agronomic practices (irrigation, weeding, staking, plant protection) were followed uniformly.

Results

Foliar application of zinc and boron significantly influenced all the studied parameters of tomato cv. Kashi Aman. The detailed results are presented below under three major categories: growth parameters, yield attributes, and quality parameters. Growth Parameters Treatment T_3 (0.75% Zn) recorded the maximum values for all vegetative growth characters. It produced the tallest plants with a height of 111.67 cm at 60 DAT and 121.30 cm at 90 DAT, which was significantly superior to the control (95.13 cm and 108.20 cm, respectively). The same treatment also gave the highest number of branches per plant (4.42 at 60 DAT and 5.58 at 90 DAT), leaf chlorophyll content (55.43 SPAD units), and leaf area (50.73 cm²) at 60 DAT (Tables 4.1-4.3). These results clearly indicate that 0.75% zinc was the most effective concentration for promoting vigorous vegetative growth. Yield Attributes Among the yield-related parameters, treatment T_7 (0.75% B) performed significantly better than all other treatments. It recorded the highest number of fruits per plant (29.50), average fruit weight (84.01 g), fruit yield per plant (1.70 kg), fruit yield per plot (42.49 kg), and total fruit yield (472.13 q/ha). This treatment was statistically superior to the control, which gave only 16.93 fruits per plant and 368.15 q/ha total yield. Treatment T_3 (0.75% Zn) ranked second in most yield attributes and was particularly effective for number of clusters per plant

and fruit length (Tables 4.4-4.8). Quality Parameters Foliar micronutrients also markedly improved fruit quality. Treatment T_7 (0.75% B) recorded the highest total soluble solids (5.13 °Brix), lycopene content (6.07 mg/100 g), and pericarp thickness (6.10 mm). Treatment T_3 (0.75% Zn) gave the highest ascorbic acid content (21.60 mg/100 g) and number of locules per fruit (4.10). Both T_3 and T_7 resulted in lower fruit pH and higher titratable acidity compared to the control (Tables 4.9-4.11). The untreated control (T_9) consistently recorded the lowest values for almost all quality traits. Overall, the results demonstrated that 0.75% zinc was most effective for vegetative growth, while 0.75% boron was superior for yield and quality improvement under the experimental conditions. Foliar application of zinc and boron significantly improved growth, yield, and quality of tomato cv. Kashi Aman. The superior performance of 0.75% zinc (T_3) for vegetative growth parameters can be attributed to zinc's well-established role in auxin (IAA) biosynthesis, activation of several key enzymes (including carbonic anhydrase), protein synthesis, and chlorophyll formation. Zinc also enhances cell division and elongation, leading to increased plant height, number of branches, leaf area, and chlorophyll content, as observed in the present study. These findings are in close agreement with earlier reports (Bhujel *et al.*, 2024; Banjade *et al.*, 2023; Ahmed *et al.*, 2023) [3, 2, 1]. Boron at 0.75% (T_7) proved to be the most effective treatment for yield and quality attributes. Boron plays a critical role in reproductive physiology, particularly in pollen germination, pollen tube growth, fruit set, and translocation of sugars and other photosynthates to developing fruits. The significant increase in number of fruits per plant, fruit size, fruit weight, and total yield under T_7 is therefore a direct result of improved reproductive efficiency and better source-to-sink relationship. The enhancement in quality traits such as TSS, lycopene, pericarp thickness, and ascorbic acid content may be due to boron's involvement in cell wall strengthening, membrane stability, and carbohydrate metabolism. These observations are supported by previous studies on tomato and related crops (Shahni and Bahadur, 2025; Haleema *et al.*, 2018; Xu *et al.*, 2021) [6, 5, 4].

The untreated control consistently recorded the lowest values for almost all parameters, confirming that the soils of the experimental site were deficient in available zinc and boron, and that foliar supplementation is an effective strategy to overcome these limitations under Kanpur conditions.

Table 1: Effect of foliar zinc and boron on growth parameters of tomato

Treatments	Plant Height (cm)		No. of Branches/Plant		Chlorophyll Content (SPAD)	Leaf Area (cm ²)
	60 DAT	90 DAT	60 DAT	90 DAT	60 DAT	60 DAT
T_1 (0.25% Zn)	100.07	112.87	3.50	4.50	47.67	40.57
T_2 (0.5% Zn)	106.97	118.13	4.17	5.37	52.17	47.90
T_3 (0.75% Zn)	111.67	121.30	4.42	5.58	55.43	50.73
T_4 (1% Zn)	103.30	116.47	3.50	4.50	51.03	44.53
T_5 (0.25% B)	97.00	111.73	3.33	4.33	45.87	46.53
T_6 (0.5% B)	104.07	115.83	3.58	4.67	48.67	45.33
T_7 (0.75% B)	108.73	120.23	4.38	5.50	54.37	49.73
T_8 (1% B)	98.87	113.67	3.33	4.33	48.70	43.53
T_9 (Control)	95.13	108.20	3.00	4.00	43.33	36.83
SEm±	0.75	2.80	0.31	0.86	0.59	0.95

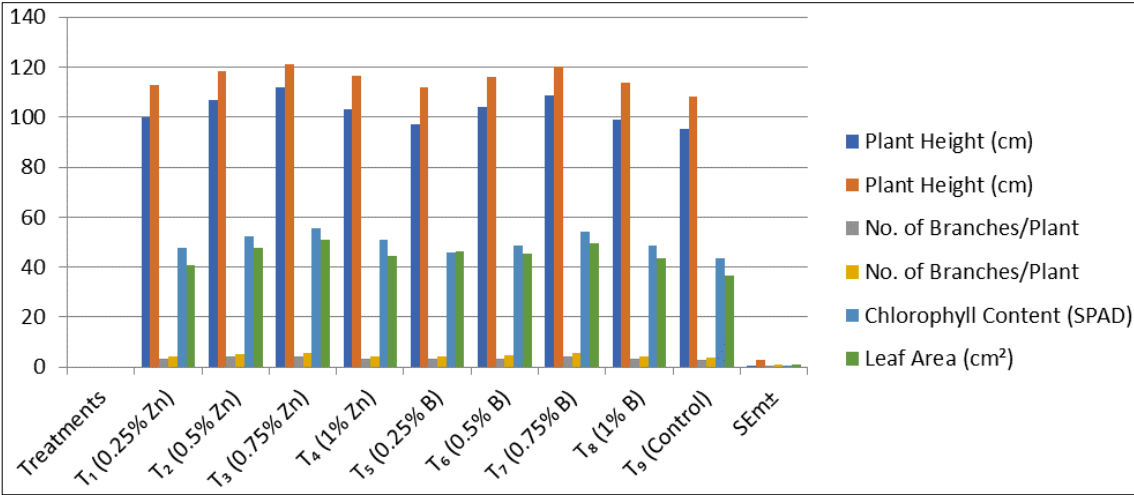


Fig 1: Effect of foliar zinc and boron on growth parameters of tomato

Table 2: Effect of foliar zinc and boron on yield and quality parameters of tomato

Treatments	Fruits/Plant	Avg. Fruit Wt (g)	Yield/Plant (kg)	Total Yield (q/ha)	TSS (°Brix)	Ascorbic Acid (mg/100g)	Lycopene (mg/100g)	Pericarp (mm)
T ₁	17.43	73.27	1.44	400.19	4.50	16.77	5.01	5.47
T ₂	22.43	79.77	1.51	418.43	4.77	17.70	5.81	5.63
T ₃	27.90	82.91	1.63	451.58	4.87	21.60	5.52	5.97
T ₄	18.30	77.60	1.46	406.76	4.80	18.23	5.56	5.87
T ₅	17.10	72.80	1.38	384.45	4.53	15.73	4.69	5.27
T ₆	24.17	80.87	1.59	442.41	4.87	18.10	6.00	5.73
T ₇	29.50	84.01	1.70	472.13	5.13	20.70	6.07	6.10
T ₈	20.10	79.23	1.49	414.26	4.40	17.37	5.29	5.40
T ₉ (Control)	16.93	70.03	1.33	368.15	4.03	15.37	4.55	4.63
SEm±	0.51	0.80	0.04	10.99	0.18	0.57	0.24	0.12
CD at 5%	1.55	2.41	0.12	33.24	0.56	1.72	0.71	0.37

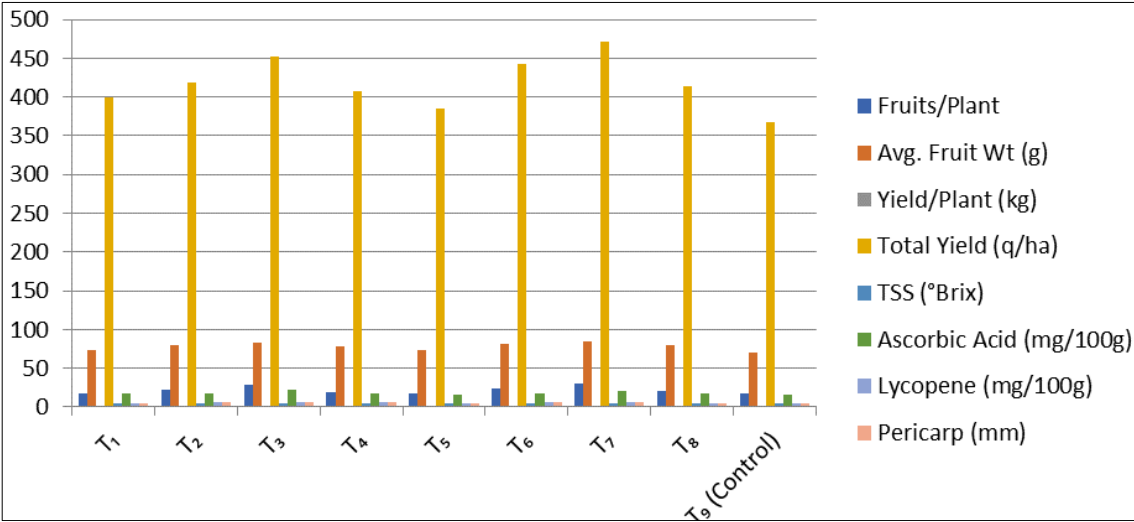


Fig 2: Effect of foliar zinc and boron on yield and quality parameters of tomato

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