Original Research Article

Effect of foliar spraying of nano boron on quality parameters of tomato grown in polybags

ABSTRACT:

A polybag experiment was conducted during *kharif*, 2020 to know the effect of foliar application of nano boron on qualitative parameters of tomato. The experiment was laid out in a Completely Randomized Design (CRD) with thirteen treatments comprising different concentrations of nano boron (50, 100, 150, 200, 300, 400 and 500 ppm) boron (1g L^{-1}) and control (Without boron application). Each treatment was replicated thrice. The foliar application of nano boron was done at 30 and 45 DAT. Nano boron 500 ppm recorded minimum values for TSS (4.10 ^{o}Brix), pH (4.45), total sugars (2.45 %), reducing sugars (2.22 %), lycopene content (5.85 mg $100g^{-1}$) and maximum values for ascorbic acid (24.02 mg $100g^{-1}$), titrable acidity (0.52 %) and non-reducing sugars (0.23 %).

Keywords: Nano boron, TSS, pH, total sugars, reducing sugars, non-reducing sugars, lycopene content, ascorbic acid, titrable acidity and tomato.

INTRODUCTION:

Tomato (*Solanum lycopersicum* L.) is the main vegetable crop extensively grown all over the globe. In India, tomato occupies an area of 0.56 million hectares with a production of 16.13 million tonnes (NHB Database, 2020-21). In Telangana, tomato is cultivated in an area of 0.025 million hectares with a production of 0.88 million tonnes (NHB Database, 2020-21).

Tomato requires both major and micronutrients for its proper plant growth (Sainju *et al.,* 2003). Boron deficiency has been realized as the second most important micronutrient constraint in crops after zinc on a global scale (Ahmad *et al.,* 2012). In India, boron deficiency ranges from 1 to 84 percent with a mean of 33 percent (Gupta *et al.,* 2008). Boron in soil solution is present as boric acid and easily leached out of the soil due to its high solubility. Boron is involved in nucleic acid metabolism, carbohydrate and protein metabolism, indole acetic acid metabolism, cell wall synthesis, cell wall structure and membrane integrity. Sexual reproduction in a plant is more sensitive to low boron than vegetative growth. Boron is necessary for the translocation of sugars, increased reproduction and germination of pollens. Boron promotes the stigma receptivity by extending the pollination time and making the pollen viable, resulting in higher fertilization and fruit set. Boron application increase fruit sets per plant, increase individual fruit weight per plant and increase Brix % in tomatoes. B deficiency reduces the yield and quality of tomatoes. Fruit cracking is the most important physiological disorder caused due to boron deficiency. Tomato fruit cracking is effectively managed by boron application. The application of B increases the fruit firmness which increases the shelf life of tomato (Davis *et al*., 2003).

Nano fertilizers are a new generation of synthetic fertilizers which contain readily available nutrients on the nanoscale. Nano fertilizers are preferred largely due to their efficiency and environmentally friendly nature compared to conventional chemical fertilizers. The use of nano fertilizer is expected to maintain better soil fertility and provide greater crop yields. In view of the above, an attempt is being made to study the efficacy of foliar application of nano nutrients in tomato entitled "Effect of foliar application of nano boron on qualitative parameters of tomato (*Solanum lycopersicum* L.)".

MATERIAL AND METHODS:

The present investigation was carried out during *kharif,* 2020; at Agricultural College, Palem, Professor Jayashankar Telangana State Agricultural University. The nano particulates of Calcium were prepared in a nanotechnology laboratory at the Institute of Frontier Technology, Regional Agricultural Research Station, Tirupati. High-Resolution Transmission Electron Microscopy (HR-TEM) image analysis was carried out at the Indian Institute of Technology, Roorkee. The experiment was laid out in a Completely Randomized Design (CRD) with thirteen treatments comprising different concentrations of nano boron, boron and control and each treatment was replicated thrice. The foliar application of nano boron was done at 30 and 45 DAT. The treatment details are as follows

T_1: Foliar spraying with boron @ 1 g L^{-1} (1000 ppm)
T_2: Foliar spraying with nano boron 50 ppm (0.05 g L^{-1})
T_3: Foliar spraying with nano boron 100 ppm (0.1 g L^{-1})
T_4: Foliar spraying with nano boron 150 ppm (0.15 g L^{-1})
T_5: Foliar spraying with nano boron 200 ppm (0.2 g L^{-1})
T_6: Foliar spraying with nano boron 300 ppm (0.3 g L^{-1})
T_7: Foliar spraying with nano boron 400 ppm (0.4 g L^{-1})
T_8: Foliar spraying with nano boron 500 ppm (0.5 g L^{-1})
T_9: Control (Without boron application)

Total Soluble Solids (^{O}Brix): The total soluble solids of the fruits were determined with the help of an Erma hand refractometer and expressed as ^{O}Brix (Ranganna, 1986).

pH : pH is the measurement of the logarithm of inverse ions in the solution.

$$pH = -\log(H^{+})$$

Where, H^{+}= hydrogen ion concentration (g lit^{-1})

The pH values were determined with the help of an electronic pH meter. The electronic pH meter was calibrated using 4 pH, 7 pH and 9 pH standard buffer solutions.

Ascorbic acid content (mg $100g^{-1}$): Ascorbic acid was estimated by the method outlined by Ranganna, (1986).

$$\text{Ascorbic acid (mg } 100g^{-1}) = \frac{\text{Titre x dye factor x volume made up x 100}}{\text{Aliquot of extract Taken for estimation} \times \text{weight of sample taken}}$$

$$\text{Dye factor} = \frac{0.5}{\text{Titre value}}$$

Titrable acidity (%): Estimation of titratable acidity was carried out by using the method given by Ranganna (1986).

$$\text{Titrable acidity (\%)} = \frac{\text{Titre value} \times \text{normality of alkali} \times \text{volume made} \times \text{equivalent weight of acid} \times 100}{\text{Weight of sample x Vol. of aliquot x 1000}}$$

Total Sugars (%): Total sugars were estimated by

$$\text{Total sugars (\%)} = \frac{\text{Factor x Volume made up x Dilution x 1000}}{\text{Titre value x weight of a sample}}$$

Reducing Sugars (%): The reducing sugars was determined by Lane and Eyon method described by Ranganna, 1986.

$$\text{Reducing sugars (\%)} = \frac{\text{mg of invert sugar} \times \text{dilution} \times 100}{\text{Titre} \times \text{weight of sample} \times 100}$$

Non-reducing sugars (%): The non-reducing sugar content in tomato was determined by subtracting the total sugars from the reducing sugars.

Non reducing sugars (%) = Total sugars (%) - Reducing sugars (%)

Lycopene content (mg 100g^{-1})

Milligrams of lycopene per 100gm sample, using the formula given by R.P. Srivastava and Kumar (2002)

O.D. of 1.0 = 3.1206 µg of lycopene / ml

$$\text{Lycopene (mg } 100g^{-1}) = \frac{3.1206 \times \text{OD of sample} \times \text{Vol. of made-up} \times \text{Dilution} \times 100}{\text{weight of sample} \times 1000}$$

RESULTS AND DISCUSSION:

Total soluble solids (^{o}Brix): It is evident from the data that (Table 1 and Fig. 1), among the treatments, nano boron 400 ppm was recorded lowest TSS (4.10 ^{o}Brix) which was statistically on par with nano boron 300 ppm (4.30 ^{o}Brix), while significantly highest TSS was recorded in nano boron 500 ppm (5.30 ^{o}Brix). Boron deficiency usually results in calcium deficiency. Calcium and boron deficiency results in faster fruit ripening. Thus, the un-treated fruits have higher sugar contents than the treated fruits which might be resulted in more total soluble solids in un-treated fruits. These results are in accordance with the findings of Islam *et al.* (2016) in cherry tomato and Naz *et al.* (2012) in tomato.

pH: All treatments had a significant influence on pH (Table 1 and Fig. 1). Among all the treatments, nano boron 400 ppm recorded the lowest pH (4.45) and it was on par with nano boron 300 ppm (4.50) and nano boron 200 ppm (4.52). Significantly highest pH recorded with nano boron 500 ppm (4.74) and Control (4.74). Lower concentrations of nano boron, such as nano boron 50 ppm (4.65), nano boron 100 ppm (4.62), nano boron 150 ppm (4.60) were statistically on par with each other in terms of pH. These results are similar to the findings of Davarpanah *et al.* (2016) in pomegranate.

Ascorbic acid (mg 100g^{-1}): Maximum ascorbic acid was registered in nano boron 400 ppm (24.02 mg 100g^{-1}) which was statistically on par with nano boron 300 ppm (23.58 mg 100g^{-1}). Whereas significantly minimum ascorbic acid was recorded in nano boron at 500 ppm (19.60 mg 100g^{-1}). Ascorbic acid was recorded with lower concentrations of nano boron such as nano boron 50 ppm (20.50 mg 100g^{-1}), nano boron 100 ppm (20.80 mg 100g^{-1}), nano boron 150 ppm (21.00 mg 100g^{-1}) were statistically on par with each other along with control (20.30 mg 100g^{-1}). The increased ascorbic acid with the foliar spraying of nano boron than the control might be due to the absorption of calcium which leads to improved membrane integrity, slowing biosynthesis and reducing respiration in tomato fruit. These results are in accordance with the findings of Islam *et al.* (2016) in cherry tomato.

Titrable acidity (%): The results indicated that foliar spraying of nano boron 400 ppm recorded the highest titrable acidity (0.50 %), while it was significantly lowest in nano boron 500 ppm (0.32 %). There was a non-significant difference was observed in lower concentrations of nano boron, such as nano boron 50 ppm (0.37 %), nano boron 100 ppm (0.37 %) on titrable acidity. These results are in accordance with the findings of Salam *et al.* (2010) in tomato

Total sugars (%): The data (Table 2 and Fig. 2) enunciated on total sugars as influenced by the foliar spraying of nano boron and boron revealed that, nano boron 400 ppm) recorded the lowest total sugars (2.45%) which was statistically on par with nano boron 300 ppm (2.54 %), while it was significantly highest in nano boron 500 ppm (3.27 %). There was a non-significant difference was observed in a lower concentration of nano boron such as nano boron 100 ppm (2.97 %) and nano boron 150 ppm (2.85 %) on total sugars (%).

Reducing sugars (%): Foliar application of boron and boron recorded a significant influence on reducing sugars (Table 2 and Fig. 2). Among all the treatments, nano boron 400 ppm recorded significantly lowest reducing sugars (2.22 %) and it was on par with nano boron 300 ppm (2.35 %), while it was significantly highest (3.18 %) in nano boron 500 ppm. Total sugars content affected by foliar spraying of nano boron might be due to its role in carbohydrate metabolism. Increases in total sugars were found in papaya, mandarin and mango fruits after foliar applications of boron (Babu and Yadav, 2005; Anees *et al.,* 2011). These results are in accordance with the findings of Naz *et al.* (2012) in tomato.

Non-reducing sugars (%): Nano boron 400 ppm recorded significantly highest non-reducing sugars (0.23 %), it was on par with nano boron 300 ppm (0.22 %) and nano boron 200 ppm (0.22 %), while it was significantly lowest in nano boron 500 ppm (0.09 %).

Lycopene content (mg $100g^{-1}$): The observations from table 2 confirm that, nano boron 400 ppm recorded the lowest value of lycopene content (5.85 mg $100g^{-1}$) which was statistically on par with nano boron 300 ppm (6.05 mg $100g^{-1}$) and nano boron 200 ppm (6.13 mg $100g^{-1}$) Whereas nano boron 500 ppm recorded significantly highest lycopene content (7.03 mg $100g^{-1}$). There was a non-significant difference was observed in lower concentrations of nano boron, such as nano boron 50 ppm (6.83 mg $100g^{-1}$), nano boron 100 ppm (6.64 mg $100g^{-1}$) and nano boron 150 ppm (6.59 mg $100g^{-1}$). Fruits developed from nano boron treatments had less amount of lycopene. Reasons for less amount of lycopene might be boron and Ca affect the ethylene generating cycle, which affects the lycopene synthesis during the ripening process (Njoroje *et al.,* 1998).

CONCLUSION: foliar spraying of nano boron significantly influenced the TSS, pH, total sugars, reducing sugars, lycopene content ascorbic acid and titrable acidity of tomato. Nano boron 500 ppm recorded minimum values for TSS, pH, total sugars, reducing sugars, lycopene content and maximum values for ascorbic acid, non-reducing sugars and titrable acidity.

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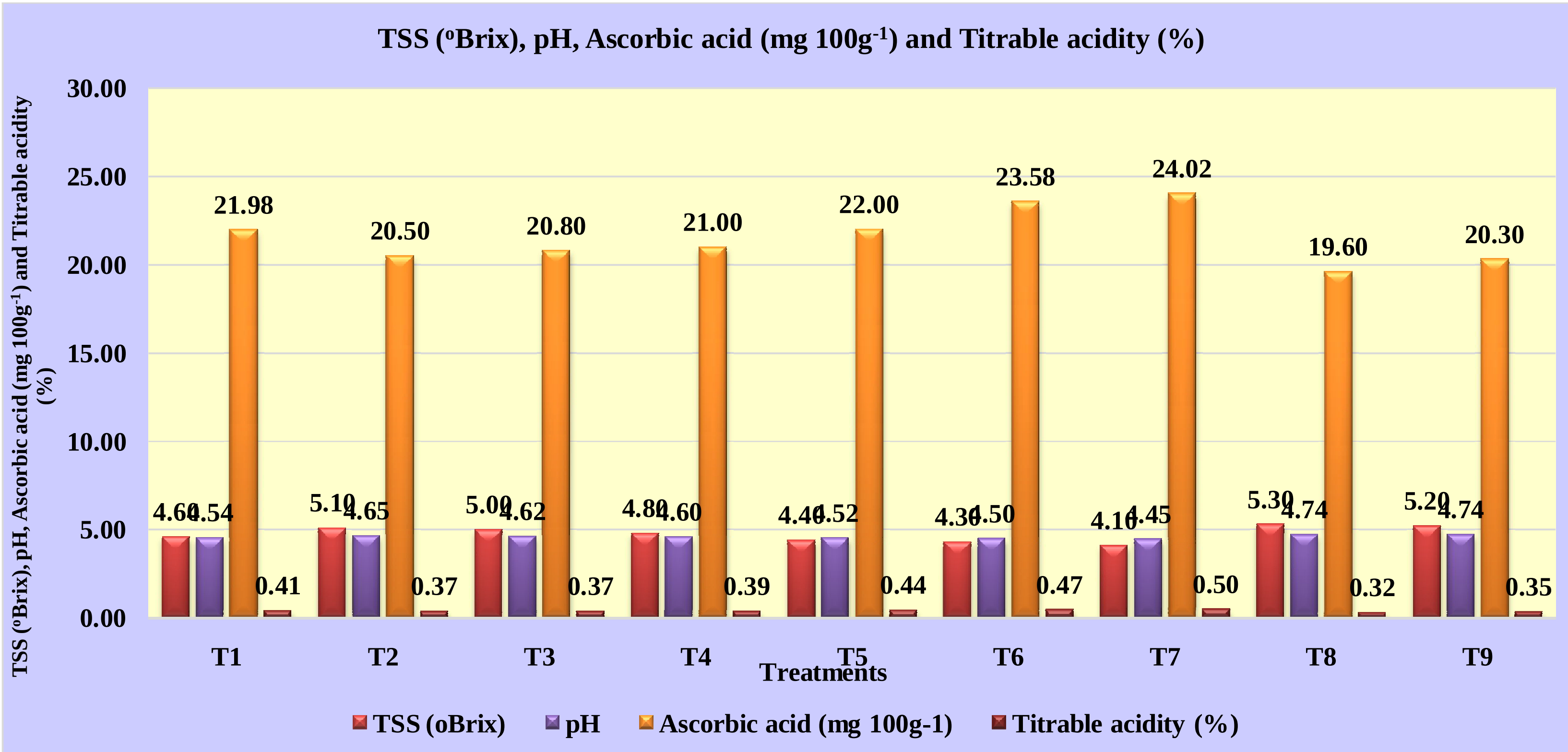
Table 1. Effect of foliar spraying of nano boron on TSS (^{o}Brix), pH, ascorbic acid (mg 100g^{-1}) and titrable acidity (%) of tomato grown in polybags

Treatments	**TSS (^{o}Brix)**	**pH**	**Ascorbic acid (mg 100g^{-1})**	**Titrable acidity (%)**
T_1: Foliar spraying with boron @ 1 g L^{-1}	4.60	4.54	21.98	0.41
T_2: Foliar spraying with nano boron 50 ppm	5.10	4.65	20.50	0.37
T_3: Foliar spraying with nano boron 100 ppm	5.00	4.62	20.80	0.37
T_4 : Foliar spraying with nano boron 150 ppm	4.80	4.60	21.00	0.39
T_5 : Foliar spraying with nano boron 200 ppm	4.40	4.52	22.00	0.44
T_6 : Foliar spraying with nano boron 300 ppm	4.30	4.50	23.58	0.47
T_7 : Foliar spraying with nano boron 400 ppm	4.10	4.45	24.02	0.50
T_8 : Foliar spraying with nano boron 500 ppm	5.30	4.74	19.60	0.32
T_9 : Control (Without boron application)	5.20	4.74	20.30	0.35
SEm±	**0.07**	**0.03**	**0.36**	**0.01**
CD (P=0.05)	**0.22**	**0.08**	**1.07**	**0.03**

Table 2. Effect of foliar spraying of nano boron on total sugars (%), reducing sugars (%), non-reducing sugars (%) and lycopene content (mg 100g^{-1}) of tomato grown in polybags

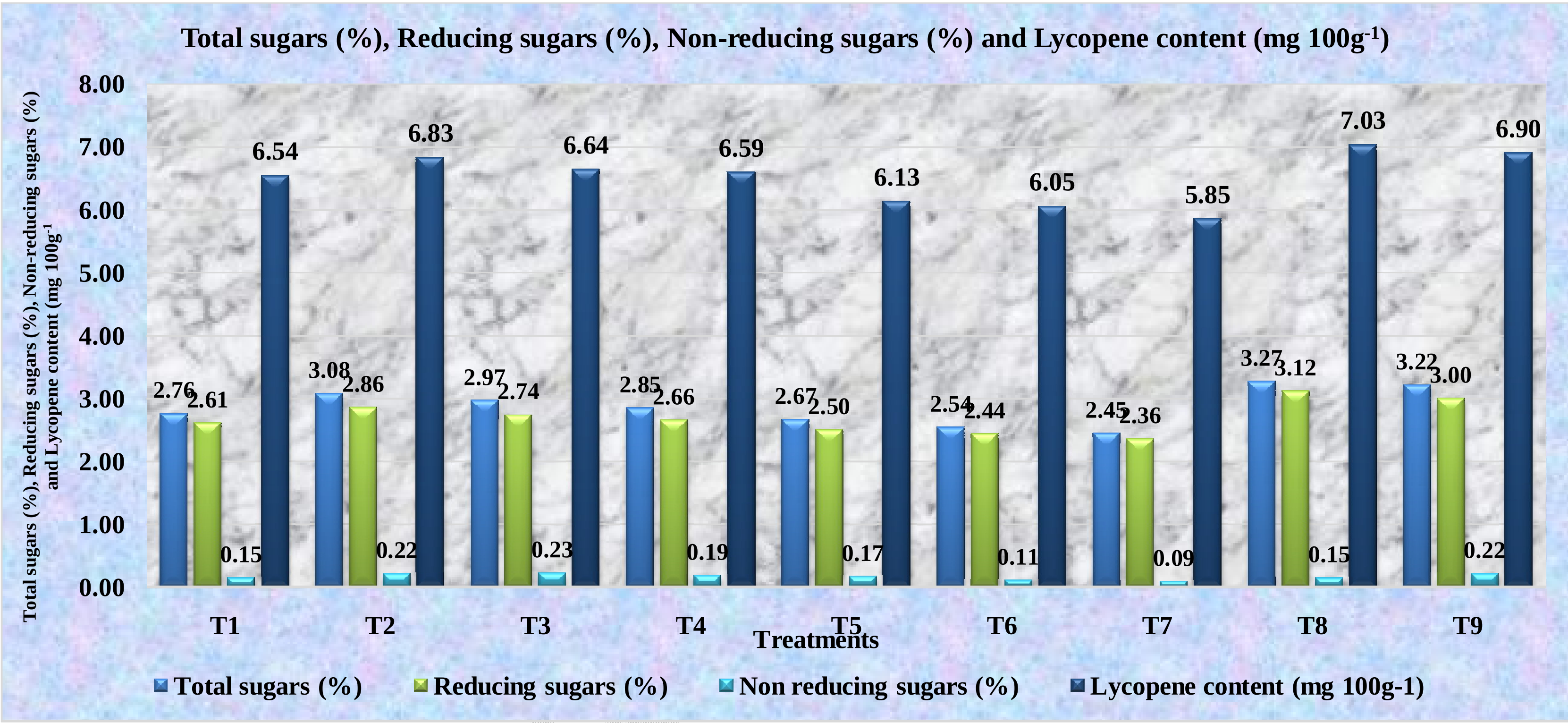
Treatments	**Total sugars (%)**	**Reducing sugars (%)**	**Non-reducing sugars (%)**	**Lycopene content (mg 100g^{-1})**
T_1: Foliar spraying with boron @ 1 g L^{-1}	2.76	2.57	0.19	6.54
T_2: Foliar spraying with nano boron 50 ppm	3.08	2.93	0.15	6.83
T_3: Foliar spraying with nano boron 100 ppm	2.97	2.82	0.15	6.64
T_4 : Foliar spraying with nano boron 150 ppm	2.85	2.68	0.17	6.59

T_5 : Foliar spraying with nano boron 200 ppm	2.67	2.45	0.22	6.13
T_6 : Foliar spraying with nano boron 300 ppm	2.54	2.32	0.22	6.05
T_7 : Foliar spraying with nano boron 400 ppm	2.45	2.22	0.23	5.85
T_8 : Foliar spraying with nano boron 500 ppm	3.27	3.18	0.09	7.03
T_9 : Control (Without boron application)	3.22	3.11	0.11	6.90
SEm±	**0.06**	**0.04**	**0.002**	**0.11**
CD (P=0.05)	**0.17**	**0.13**	**0.007**	**0.33**



T_1 : Foliar spraying with boron @ 1 g l^{-1}
T_2 : Foliar spraying with nano boron 50 ppm
T_3 : Foliar spraying with nano boron 100 ppm
T_4 : Foliar spraying with nano boron 150 ppm
T_5 : Foliar spraying with nano boron 200 ppm
T_6 : Foliar spraying with nano boron 300 ppm
T_7 : Foliar spraying with nano boron 400 ppm
T_8 : Foliar spraying with nano boron 500 ppm
T_9 : Control (Without boron application)

Fig. 1. **Effect of foliar spraying of nano boron on TSS (ºBrix), pH, ascorbic acid (mg 100g^{-1}) and titrable acidity (%) of tomato grown in polybags**



T_1 : Foliar spraying with boron @ 1 g l^{-1}

T_2 : Foliar spraying with nano boron 50 ppm

T_3 : Foliar spraying with nano boron 100 ppm

T_4 : Foliar spraying with nano boron 150 ppm

T_5 : Foliar spraying with nano boron 200 ppm

T_6 : Foliar spraying with nano boron 300 ppm

T_7 : Foliar spraying with nano boron 400 ppm

T_8 : Foliar spraying with nano boron 500 ppm

T_9 : Control (Without boron application)

Fig. 2. **Effect of foliar spraying of nano boron on total sugars (%), reducing sugars (%), non-reducing sugars (%) and lycopene content (mg 100g^{-1}) of tomato grown in polybags**