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Optimization of Boron and Zinc on the Growth and Yield Parameters of Tomato (*Solanum lycopersicum* L.) in Nalanda District

U. N. Umesh [a#], Kumari Vibha Rani [a*#] and Jyoti Sinha [a#]

[a] Krishi Vigyan Kendra, Harnaut, Nalanda, India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The field experiment was carried out to overcome the poor growth and yield of tomato due to imbalance use of fertilizer and micronutrient deficiency. The objective to conduct this experiment was soil application of micronutrients alongwith nitrogen, phosphorus and potash for growth and yield enhancement. The maximum 90.39 cm plant height,the heighest 14.38 number of branches,the maximum 29.50 number of fruits per plant, heighest fruir weight per plant 2.46 kg per plant with yield of 518.25 quintal per heactare in case of technology option three application of 120.80.80 kg N:P:K ha^{-1} alongwith 10kg zinc and 1 kg boron per hectare as basal dose in comparision to other treatments. The lowest 80.45 cm plant height, least number of branches per plant 8.13,lesser number of fruit per plant 24.13, least fruit weight 2.18 kgper plant with minimum yield of 450.50 quintal per hectare was recorded in control.

Keywords: Nitrogen; phosphorus; potash; zinc; boron; tomato; growth; yield.

[#] *Subject Matter Specilist;*
**Corresponding author: E-mail: kumarivibhaa1@gmail.com;*

1. INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is the second most important vegetable crop next to potato (*Solanum tuberosum L*.) belongs to the family Solanaceae. The approx production was 182.3 million tonnes of tomato fruit from 4.85 million hectare each year [1]. Asia contributes about 61.1% of global tomato production. The major tomato consuming countries are India, China, North Africa, The middle east, The US and Brazil with consumption of 61.9 to 198.9 kg per capita [1]. Bihar contributes 5.28% with production of 964 thousand tonnes in overall production of the country (Source: State directorate of horticulture). Tomato is rich in nutrional value due to various bioactive compounds, vitamins, carotenoids and phenolic compounds [2-4]. It is rich source of lycopene in daily diet of human being [5]. It also have the naturally occuring antioxidants, vitamin C and E, large amounts of metabolites such as sucrose, hexoses, citrate,malate and ascorbic acid [3,4,6]. The demand of tomato consumption is increasing day by day to its raw use and in various products such as soups, ketch up, sauce, marmalade, chutney and juice etc.It is used extensively in canning industry for canned products. It is consumed to meet the requirement of vitamin A,B, and C, carotenoids, lycopene and minerals (calcium) up to some extent due to its good nutrional value [7-8]. It is also used as flavouring agent.

The fruit quality of tomato is affected by various factores such as plant growing conditions, scarcity of water resources, soil salinization and abiotic stresses [9-12]. Boron is an important element to enhance the yield and quality of tomato. It affects directly and indirectly in improving quality and enhancing yield by checking various types of physiological disorders and different types of diseases [13]. It affects various parameters in terms of quality like shape and size, color, firmness, smoothness, shelf life and chemical composition. The same results was also reported by [14] in case of boron difficiency in tomato.It also influence vegetative growth like higher vegetative growth, synthesis of pictin ,imbalance in water relation in plant,affects metabolism of protein, resynthesis of adenosine triphosphate(ATP) and affects translocation of sugar at flowering and fruiting stages [15]. Boron plays an important role in various plant functions and maintaing quality of produce such as hormone movement in plants, active absorption of salt, fruit set and flowering process in plants, pollen germination, metabolism of nitrogen and carbohydrates etc. It deficiency leads to lesser growth of roots, brittle leaves and necrotic spots on shoot apex. As per findings of [16] the quality parameters of tomato is affected by boron application. It improves overall growth and devlopment of crop.

Zinc is also an another important micronutrient for increasing dry biomass ,fruit yield, number of fruits and fresh weight of fruits as per findings of [17]. The other basic function of zinc in plants are metabolism of proteins, phosphates and carbohydrates and also synthesis of auxins, RNA and ribosome formations as per findings of [18].

2. MATERIALS AND METHODES

2.1 Soil Properties of the District and Initial and Final Value of Soil Properties of Farmers Field

The initial value of soil properties of the experimental plot (farmers field) varies in the range of pH from 7.08 to 7.33, EC 0.018 to 0.038 deci simon per meter, organic carbon 0.543 to 0.620%, avilable nitrogen 236 to 259 kg ha-^{1}, avilable phosphorous 24.25 to 34.40 kg ha-^{1} avilable potassium 144 to 196kg ha-^{1}, avilable Zinc 0.613 to 0.815 mg kg-1 and avilable boron 0.363 to 0.519 mg kg-^{1}.

The post harvest soil properties of experimental plot (farmers field) as per Table 1 shows that effect of soil application of zinc and boron on avilable soil nutrients in tomato. The organic carbon, avilable nitrogen, avilable pottasium, avilable zinc and avilable boron shows significant increase over farmers practice and ph, avilable phosphorus shows non significant incrase over the farmer practices. The highest boron and zinc was recorded in technology option two(farmers practice, N:P:K @ 120:80:80 kg ha^{-1} and 5kg zinc plus 2 kg boron per hectare as basal dose).

This study was conducted on eight farmers field in different villages of Nalanda distric in state Bihar in India for improving growth, enhancing yield and productivity of tomato. The design used for this experiment are randomized block design. The soil samples from different farmers plots were collected and tested for pH by 1:2 soil water suspension through pH meter, EC by 1:2 soil water suspension through EC meter, organic carbon by wet digestion method, Avilable N by Subbiah and Asija 1956, Avilable P by Olsen's

method, Avilable K by ammonium acetate method ,avilable Zn by DTPA extraction method and avilable Boron by azomethine-H method after selection of plot for experiment. The analysed result of soil properties is mentioned in soil details. After raising of tomato seedlings the twenty five days old seedlings were transplanted in the field with application of N:P:K @ 120:80:80 kg ha^{-1} in farmers practice. In technology option one we applied zinc 5kg/ha and one kg boron ha-1, in technology option two zinc 10 kg ha^{-1} and boron 1 kg ha^{-1} and in technology option three zinc 5kg ha-1 and boron 2kg ha^{-1} as basal dose in addittion to farmers practice. The gap filling was done after 10 to 12 days in case seedling damage. After transplanting data on different parameters are recorded at regular interval such as Plant height (cm), number of branches per plant, number of fruits per plant, fruit weight per plant (kg) and yield (Q/ha). After completion of harvesting the sampling of different experimental plots were done. The results of soil testing is mentioned in Table 1.

3. RESULTS AND DISCUSSION

The maximum 90.39 cm plant height ,the highest 14.38 number of branches, higher 29.50number of fruits per plant, the maximum 2.46 kg average weight of fruit per plant and maximum 518.25 quintal per hectare yield was recorded in case of application of 120:80:80 kg N:P:K ha^{-1}, 10kg Zn ha^{-1} and 1kg B ha^{-1} as compared to other treatments. The lowest 80.45 cm plant hight, least number of branches 8.13, lesser number of fruits per plant 24.13, least average fruit weight2.18 kg $plant^{-1}$ and minimum yield 450.50 q ha^{-1} was recorded in case of technology option one(farmers practice) as per Table 2.

Table 1. Effect of boron and zinc on post-harvest soil properties of experimental plot field

Technology option	pH	EC (ds/m)	Avilable nutrients (kg/ha)			Avilable micronutrients (mg/kg)	
			N	P2O5	K2O	Zn	B
Farmers practice	7.22	0.563	254	27.13	159.6	0.668	0.439
TO-1	7.21	0.566	260	28.4	165.9	0.832	0.442
TO-2	7.2	0.567	262	28.65	167.9	0.765	0.465
TO-3	7.18	0.571	266	29.28	171	0.793	0.473
SEm+-	0.02	0.002	2.25	0.58	2.65	0.004	0.008
C.D(P=0.05)	NS	0.006	6.78	NS	7.96	0.011	0.024

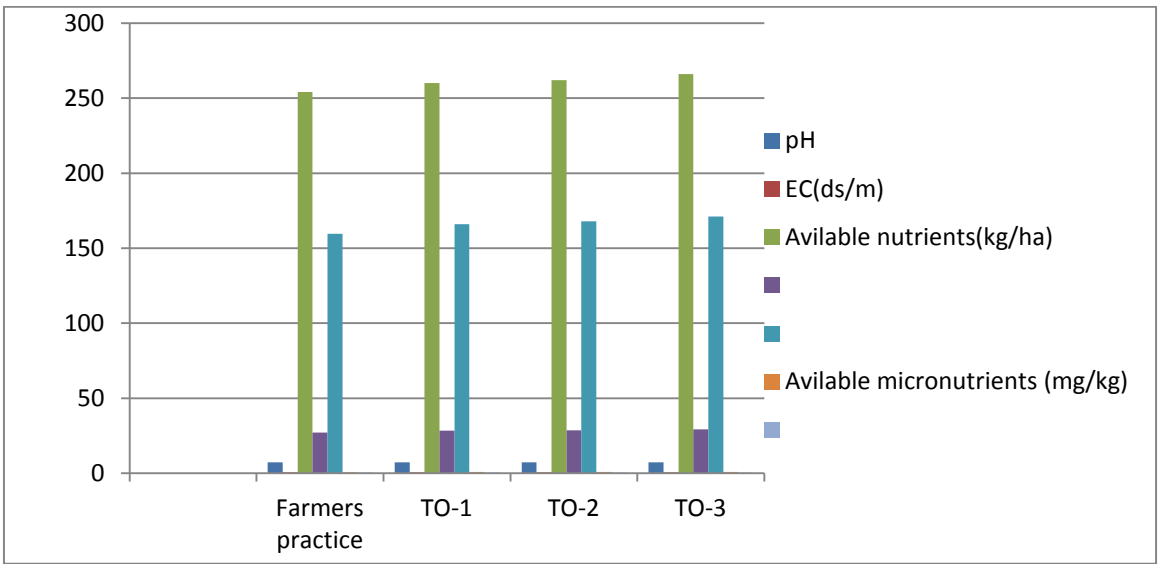

Fig. 1. Graphical representation of effect of boron and zinc on post-harvest soil properties of experimental plot field

Table 2. Effect of boron (B) and zinc(Zn) on growth and yield of tomato

Treatments	Plant height(cm)	Number of brances per plant	Number of fruits per plant	Fruit weight per plant(kg)	Yield (Q/ha)
(Farmers practice,120:80:80 kg/ha)	80.45	8.13	24.13	2.18	450.50
(Farmers practice+5 kg zinc+1kg boron/ha as basal dose)	83.40	10.88	26.25	2.24	491.13
(Farmers practice+10 kg zinc+1kg boron/ha as basal dose)	90.39	14.38	29.50	2.46	518.25
(Farmers practice+5 kg zinc+2kg boron/ha as basal dose)	86.38	12.00	27.13	2.33	497.88
SE(d)	0.335	0.222	0.747	0.077	8.183
Cd	0.693	0.458	1.542	0.160	16.889

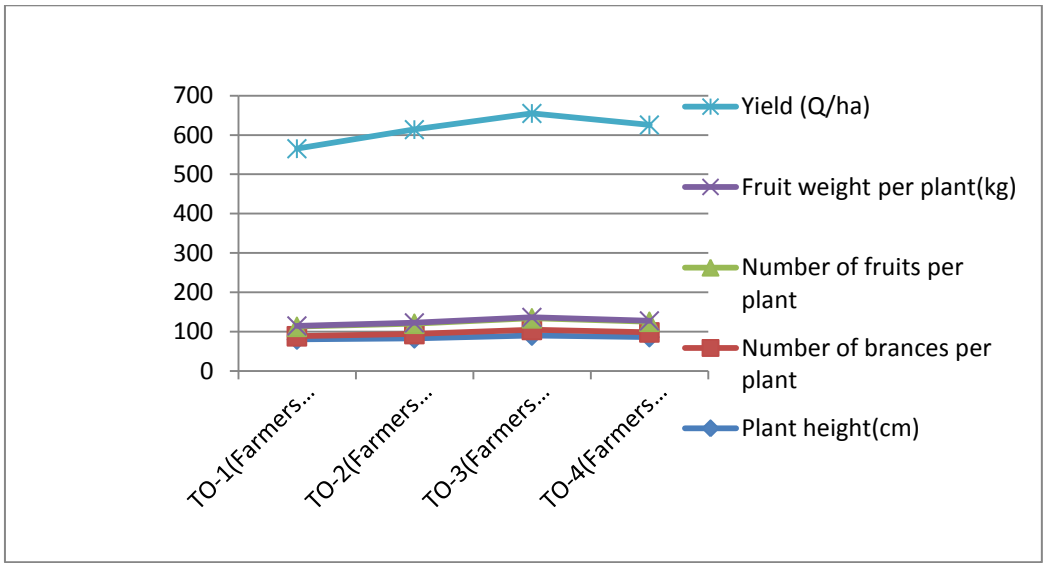

Fig. 2. Graphical representation of Effect of boron (B) and zinc(Zn) on growth and yield of tomato

As per findings of [19-21] the higher plant height , maximum average fruit weight ,number of fruits per plant and highest yield was recorded in case of boron and zinc application in soil. As per report of [22,23] the positive effect of micronutrient (zinc) on higher number of fruit set and increasing the weight of brinjal in case of increasing the level of zinc. As per findings of [24] the increase in fruit yield and fruits per cluster was recorded in case of 0.2%, 0.5% zinc sulphate application. The increase in number of fruits per plant, fruit weight and total yield in brinjal crop was also reported by [25] in case of soil application of zinc. The similar result was also found by [26]. The combined application of boron and zinc leads to increase in plant height in tomato was reported by [15,27,28] also reported increase in number of leaves in tomato and french bean by application of boron. [29] also reported increase in plant height by combined application of boron and zinc.

4. CONCLUSION

The micronutrients plays an imporantant role in plant growth and yield of crop. Application of micronutrients along with macronutrients for better growth and yield of the crop. Micronutrients are such type of nutrients that are required in trace amount. If deficienciye of micronutrients occure plants shows deficiency symptom and various types of physilogical disorder in it. The maximum 518.25 quintal per hectare yield with heighest 90.39 cm plant height and more number of branches 14.38 was recorded in case of application of 120:80:80 kg N:P:K ha^{-1} with 10 kg zinc and 1 kg boron per hectare as basal dose.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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