

Optimization of Boron and Zinc on the growth and yield parameters of tomato (*Solanum lycopersicum L.*) in Nalanda district.

U.N.Umesh¹, Kumari Vibha Rani^{1*} and Jyoti Sinha¹

Subject Matter Specialist

¹Krishi Vigyan Kendra, Harnaut, Nalanda

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 highest 14.38 number of branches, the maximum 29.50 number of fruits per plant, highest fruit weight per plant 2.46 kg per plant with yield of 518.25 quintal per hectare 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 comparison 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 kg per plant with minimum yield of 450.50 quintal per hectare was recorded in control.

Key Words: Nitrogen, phosphorus, potash, zinc, boron, tomato, growth, yield

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 nutritional 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 occurring 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, ketchup, 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 nutritional value [7-8]. It is also used as flavouring agent.

The fruit quality of tomato is affected by various factors 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 deficiency in tomato. It also influence vegetative growth like higher vegetative growth, synthesis of pectin, 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 maintaining 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. Its 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 development of crop.

Zinc is also 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].

MATERIALS AND METHODS:

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%, available nitrogen 236 to 259 kg ha⁻¹, available phosphorous 24.25 to 34.40 kg ha⁻¹ available potassium 144 to 196 kg ha⁻¹, available Zinc 0.613 to 0.815 mg kg⁻¹ and available 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 available soil nutrients in tomato. The organic carbon, available nitrogen, available potassium, available zinc and available boron shows significant increase over farmers practice and pH, available phosphorus shows non significant increase 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 5 kg zinc plus 2 kg boron per hectare as basal dose).

This study was conducted on eight farmers field in different villages of Nalanda district 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, Available N by Subbiah and Asija 1956, Available P by Olsen's method, Available K by ammonium acetate method, available Zn by DTPA extraction method and available 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 5 kg/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 5 kg ha⁻¹ and boron 2 kg ha⁻¹ as basal dose in addition 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.

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	28.40	165.9	0.832	0.442
TO-2	7.20	0.567	262	28.65	167.9	0.765	0.465
TO-3	7.18	0.571	266	29.28	171.0	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

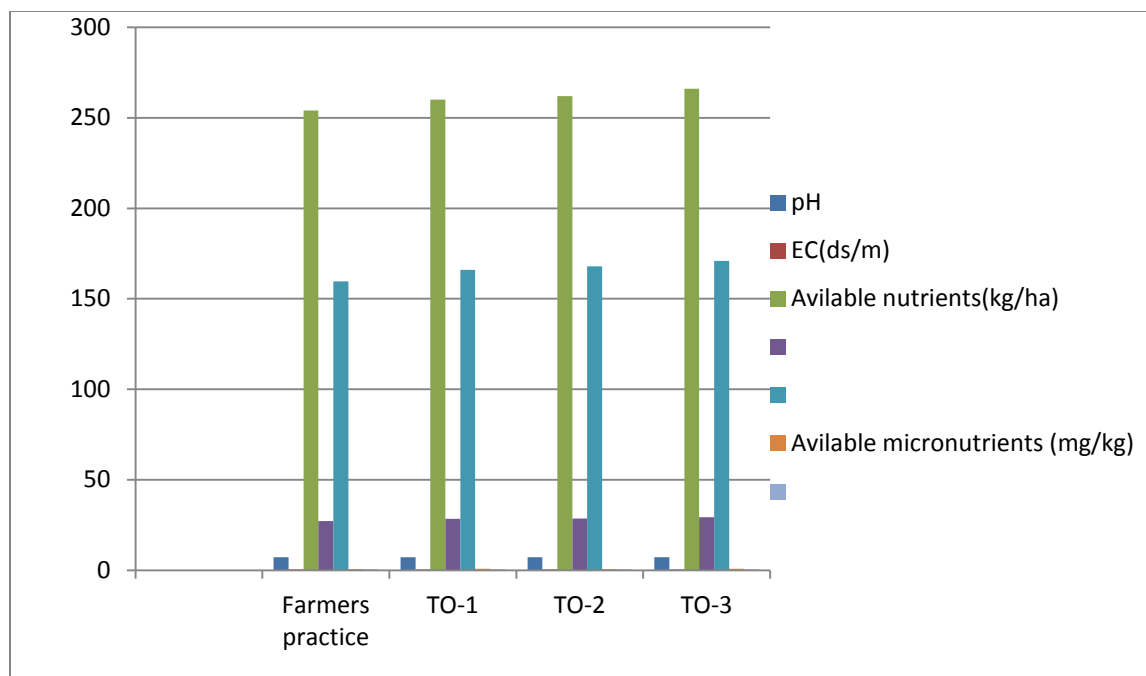


Figure1. Graphical representation of effect of boron and zinc on post-harvest soil properties of experimental plot field

RESULTS AND DISCUSSION:

The maximum 90.39 cm plant height, the highest 14.38 number of branches, higher 29.50 number 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 height, least number of branches 8.13, lesser number of fruits per plant 24.13, least average fruit weight 2.18 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.

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.

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

Treatments	Plant	Number of	Number of	Fruit weight	Yield (Q/ha)
------------	-------	-----------	-----------	--------------	--------------

	height(cm)	brances per plant	fruits per plant	per plant(kg)	
(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

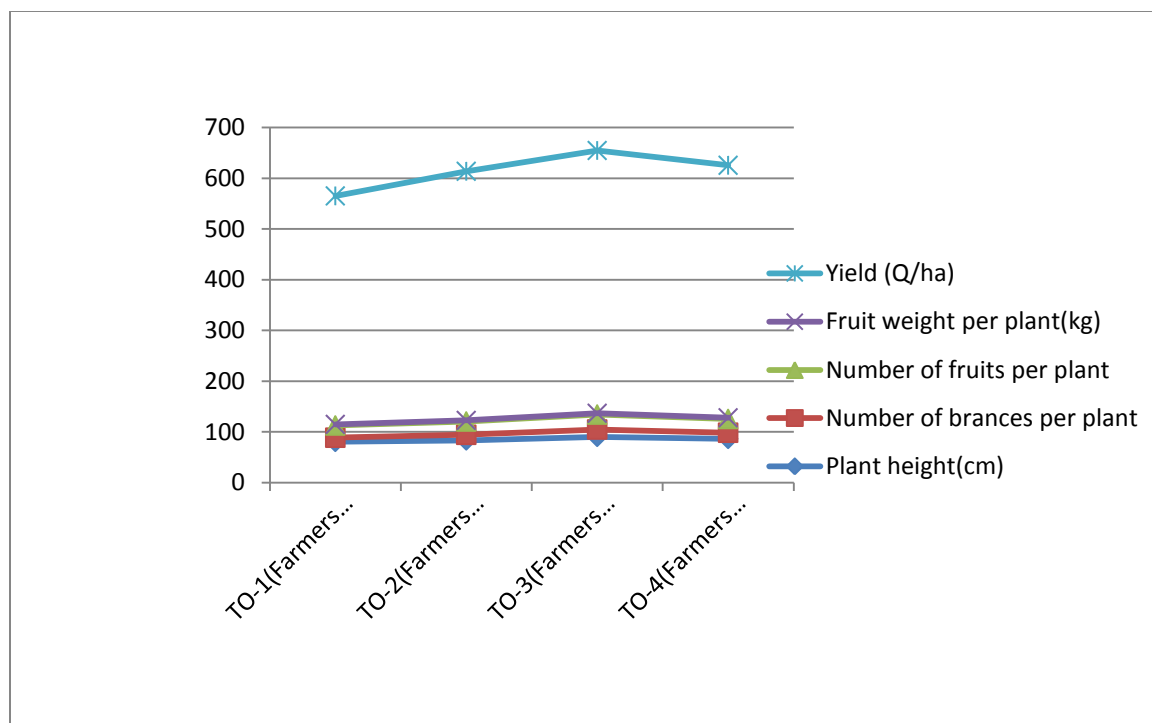


Figure 2. Graphical representation of Effect of boron(B) and zinc(Zn) on growth and yield of tomato.

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 physiological 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.

REFERENCES:

- 1.FAOSTAT(2019). Available at :<http://www.fao.org/faostat/en/#home>.
- 2.Liu Z., Alseekh S., Brotman Y.,Zheng Y., Feiz., Tieman D.M.,et al.(2016). Identification of a solanum pennellii chromosome 4 fruit flavour and nutrional quality- associated metabolite QTL.Front.Plant Sci.7,1671.10.3389/fpls.2016.01671.
- 3.Marti R.,Rosello S., Cebolla-Cornejo J.(2016). Tomato as a source of carotenoids and polyphenols targeted to cancer prevention.Cancers(Basel)8,E58.10.3390/CANCERS 8060058.
- 4.Li Y., Wang H., Zhang Y., Martin C.(2018b). Can the world's favorite fruit,tomato,provide an effective biosynthetic chassis for high-value metabolites plant cell rep.37,1443-1450.10.1007/s00299-018-2283-8.

5. Viuda-Martos M., Sanchez-Zapata E., Sayas-Barbera E., Sendra E., Perez-Alvarez J.A., Fernandez-Lopez J. (2014). Tomato and tomato byproducts. Human health benefits of lycopene and its application to meat products: a review. *Crit. Rev. In food Sci. Nutr.* 54, 1032-1049. [10.1080/10408398.2011.623799](https://doi.org/10.1080/10408398.2011.623799)
6. Agarwal S., Rao A.V. (2000). Tomato lycopene and its role in human health and chronic diseases. *CMAJ* 163, 739-744.
7. Bose, T.K. and Som, M.G. (1990). *Vegetable crops in India*. Published by B. Mitra and Naya Prakash, 206-Bidhan Sarani, Calcutta, India. p. 249.
8. Rashid, M.M. (1983). *Sabjeer Chash*, 1st Edn., Begum Shahla Rashid publishers, Joydebpur, Gazipur, 86-87.
9. Diouf I.A., Derivot L., Bitton F., Pascual L., Causse M. (2018). Water deficit and salinity stress reveal many specific qtl for plant growth and fruit quality traits in tomato. *Front. plant Sci.* 9, 279. [10.3389/fpls.2018.00279](https://doi.org/10.3389/fpls.2018.00279).
10. Fahad S., Bajwa A.A., Nazir U., Anjum S.A., Farooq A., Zohaib A., et al. (2017). Crop production under drought and heat stress: plant responses and management options. *Front. in plant Sci.* 8, 1147. [10.3389/fpls.2017.01147](https://doi.org/10.3389/fpls.2017.01147).
11. Gharbi E., Martinez J.P., Benahmed H., Lepoint G., Vanpee B., Quinet M., et al. (2017). Inhibition of ethylene synthesis reduces salt tolerance in tomato wild relative species *Solanum chilense*. *J. Plant Physiol.* 210, 24-37. [10.1016/j.jplph.2016.12.001](https://doi.org/10.1016/j.jplph.2016.12.001).
12. Zhou R., Kong L., Wu Z., Rosenqvist E., Wang Y., Zhao L., et al. (2019). Physiological response of tomatoes at drought, heat and their combination followed by recovery. *Physiol. plant* 165, 144-154. [10.1111/ppl.12764](https://doi.org/10.1111/ppl.12764).
13. Magalhaes, J.R.Dc., Solwa, C.E.W.L.Dc. and Monnerat, P.H. (1980). Levels and methods of boron application in tomatoes. *Pesquisa Agropecuria Brasilesia*. 10(2): 153-157.
14. Demoranville, C.J. and Deubert, K.H. (1987). Effect of commercial calcium-boron and manganese-zinc formulations on fruit set of cranberries. *J. Hort. Sci.* 62: 163-166.
15. Bose U.S. and Tripathi, S.K. 1996. Effect of micronutrients on growth, yield and quality of tomato cv. Pusa Ruby. *Crop. Res.* 12(1): 61-64.
16. Naresh, B. (2002). Response of foliar application of boron on vegetative growth, fruit yield and quality of tomato var. Pusa-Ruby. *Indian J. of Hilly farming*. 15(1): 109-112.
17. Gurmani, A.R., J. Uddin., S.U. Khan., R. Andaleep., K. Waseem., A. Khan and Hadyullah. (2012). Soil application of Zinc improves growth and yield of tomato. *Int. J. of Agri. Culture and Bio.*, 14(1): 91-96.
18. Shkolnik, M.J. (1974). *Micronutrients in plant life of Nauka, Leningard*. 323.
19. Pandav A.K., Nalla M.K., Aslam T., Rana M.K. and Bommesh, J.C. (2016). Effect of foliar application of micronutrients on growth and yield parameters in eggplant cv. HLB 12. *Environment and ecology*, 35(3): 1745-1748.

20. Acharya U., Sharma N., Rimal K., Venkatesan T., Saraswathi K. and Subramanian S. (2015). Response on growth, yield and quality parameters of multiplier onion (*Allium cepa* L. var. *aggregatum* Don.) var. CO (On) 5 with different doses and method of zinc application. *Int. J. Agron and Agril Res*, 6(4):59-67.
21. Sliman. Z.T., Abdelhakim M.A. and Omran A.A. (1999) Response of onion to foliar application of some micronutrients. *Egyptian J. of Agr. Res.*, 77(3):983-993.
22. Gogoi, S., M.R. Das., P. Bora and N. Mazumder. (2014). Effect of foliar application of nutrients on fruit and seed production of brinjal (*Solanum melongena* L.). *Ind. J. Assam. Agric. Sci.*, 2(1-2):23-27.
23. Raj. G.B., M.C. Patnaik., I.P. Reddy and A.P. Rao (2001). Response of brinjal (*Solanum melongena* L.) to zinc and iron. *Vegetable Science*, 28(1):80-81.
24. Ume Kalsoom Afridi (2015). Response of brinjal (*Solanum melongena* L.) cultivars to zinc levels. *ARPN J. Agril. Bio. Sci.*, 10(5):172-178
25. Bhuvaneshwari. R., Nayana N.L., Srinivasan. S., Karthikeyan. P. and Suganthi. (2020). Response of humic acid and zinc fertilization on the yield characters of brinjal (*Solanum melongena* L.). 20:1332-1334.
26. Solanki, M.M., Solanki, S.M., Thakare, G., Jogi, D.P. and Sapkal, R.D. (2017). Effect of zinc and boron on growth of brinjal (*Solanum melongena* L.). *Inter. J. Plant Sci.* 12(2):160-163.
27. Verma, A.N., Ram, K. and Sharma, R.K. (1973). Growth, yield and quality of tomato (*Lycopersicon esculentum* Mill.) as affected by foliar applications of boron in sand culture. *Mysore J. Agric. Sci.*, 7:130-132
28. Padma, M., Reddy, S.A. and Babu, R. (1989). Effect of foliar sprays of molybdenum (Mo) and boron (B) on vegetative growth and dry matter production of french bean (*Phaseolus vulgaris* L.). *J. Res. Andhra Pradesh Agric. Univ.*, 17:87-89.
29. Ingle, V.G., Thakre, A.U., Badhe, S.B. and Khan, M.A.H. (1993). Effect of foliar spray of auxins, micronutrients with urea on fruit drop and yield of chilli cv. CA-960. *Panjabrao Krishi Vidyapeeth Res. J.*, 17:142-145.
- .
- .
- .