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Effect of micro-nutrients on growth and yield of tomato (*Lycopersicon esculentum* Mill.)

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Abstract
An investigation was under taken at Research Field, Department of Horticulture, Udai Pratap Collage, Affiliated to Mahatma Gandhi Kashi Vidyapith, Varanasi) India. During Rabi season of 2016-17. The experiment was laid out in randomized block design with 08 treatments, each replicated thrice. The treatments consisted of different combinations of micronutrients i.e., Boric acid, Zinc sulphate, ammonium molybdate, copper sulphate, ferrous sulphate manganes sulphate, mixture of all treatments and control also. Among 08 treatments under study, it is concluded that treatment combination of Effects of micro-nutrients on height of the plant are not very evident. However, highest length of the plant is recorded in the treatment of (T_7) mixture of all the micro-nutrients followed by Manganese sulphate. Maximum number of branches in tomato plant was recorded by the application of (T_3) Ammonium molybdate. Results pertaining to the maximum number of fruits per plant were obtained by the application of (T_5) Ferrous sulphate followed by Zinc sulphate. Fruit diameter of tomato was not affected by the application of micro-nutrients and all have more or less equal effect. Fruit yield per plant was affected by the micro-nutrient application. Highest number is recorded with the treatment of mixture of all the nutrients application followed by (T_1) Boric acid. Application of (T_3) Ammonium molebdate has beneficial effect on the T.S.S value of tomato fruit. Yield of tomato fruit per hectare was recorded in the treatment of (T_7) mixture all the Micro-nutrients (632.66 q/ha) followed by Boric acid application (557.10 q/ha) and Zinc sulphate (548.21 q/ha). Details of economic return clearly indicates the highest response of the treatment of mixture of all the micro-nutrient with a net profit of Rs. 180937 per hectare and C:B ratio of 1:2.05 followed by the treatment of Boric acid with net profit of Rs. 148574 per hectare and C:B ratio of 1:1.68 and Zinc sulphate with net profit of Rs. 144946 per hectare and C:B ratio of 1:1.64.

Keywords: Tomato (*Solanum lycopersicon* L.), CuSo4, ZnSo4, boric acid, MnSo4

Introduction
Tomato (*Solanum lycopersicum* L.) belongs to family *Solanacae*. It is a self-pollinated crop and Peru-Equator region is considered to be the centre of origin. Tomato was introduced to India by the Portuguese. Tomato is cultivated in tropics and subtropics of the world. In India, tomato is grown in 809.9 (000 ha) with an annual production of 19697 (000 MT) and productivity 24.4 MT/Ha [1]. It is being cultivated in kitchen gardens, commercial fields under green house or poly house conditions and soilless culture or hydroponic systems. Tomato is one of the popular vegetables of great commercial value and is used in various forms of salad, soup, ketchup, sauce, chutney, pickles, powder, paste, juice, puree, whole canned fruits and also forms an important in gradient in the cocktails known as "Bloody Mary". It is believed that consumption of one tomato per day enhances the health status of individuals and considered to be important in diet as it is quite high in nutritive value. It contains higher quantity of total sugar (2.5- 4.5%), starch (0.6-1.2%) and minerals like potassium, calcium, sodium, magnesium, phosphorus, boron, manganese, zinc, copper, iron, etc. Apart from these, it also contains organic acids such as citric, malic and acetic acids which are known as health acids in fresh tomato fruit. The flavor of tomato fruits is controlled by various volatile compounds like ethanol and acetaldehyde. Tomato juice promotes gastric secretion, acts as a blood purifier and works as intestinal antiseptic.

High productive ability of Tomato puts tremendous pressure on soil for removal of nutrients. Tomatoes require nutrients such as N, P, K, Mg, Ca, Na and S for good production. These nutrients are specific in function and must be supplied to the plant at the right time and in the right quantity. Indiscriminate use of inorganic fertilizers has resulted in decreased nutrient uptake, poor quality of vegetables and deterioration of soil health [2]. Plants require mineral

elements, essential for the normal life processes of plants and are needed in very small amounts are called trace elements or minor elements such as boron and zinc etc. Boron plays an essential role in the development and growth of new cell in the plant meristem, it improves fruit quality and fruit set. Zinc involves in many enzymatic activities and IAA formation which enhance increase flower number and fruit set [3, 4, 5].

As such liberal application of nutrients is needed to meet the nutritional requirements of the crops, however, wake of energy crisis, harmful effect on soil health and ever increasing prices of chemical, fertilizers becomes problem before the producers. Micronutrients is one of the important parts of continuous improvement of soil productivity. It has been observed that sole application of organic manures or inorganic fertilizers are not able to sustain the soil fertility and crop productivity [6]. However their integration has proved superior to individual components with respect to yield, quality and nutrient uptake [7]. In view of above a dire need have been felt to reduce the cost of fertilizer which is costly input and this can be managed through organic manure which involves conjunctive use of fertilizer and organic manure is recent eco-friendly concept to sustain crop production and maintenance of soil health [8].

Materials and Methods

An experiment was conducted at Horticultural Experimental field, Department of Horticulture, Udai Pratap Collage(Autonomous), affiliated to Mahatma Gandhi Kashi Vidyapith, Varanasi India. During Rabi season of 2016-17. The experiment was laid out in randomized block design with 08 treatments and each replicated thrice. The following treatments were the part of experiment (where RDF: micro nutrients)

Table 1: The following treatments were the part of experiment (where RDF: micro nutrients)

Treatments	Chemical	Quantity (ppm)	Symbol
Boric acid	B	100(0.571 gm/lit)	T1
Zinc sulphate	Zn	100(0.246 gm/lit)	T2
Ammonium molybadate	Mo	50 (0.644 gm/lit)	T3
Copper sulphate	Cu	100(0.52 gm/lit)	T4
Ferrous sulphate	Fe	100(0.515 gm/lit)	T5
Manganese sulphate	Mn	100(0.32 gm/lit)	T6
Mixture of all	B + Zn + Mo + Cu + Fe + Mn	100(0.469 gm/lit)	T7
Control	-	-	T0

The plot size was 1.0 x 2.40 m and spacing followed was 60 x 45cm. The land was brought to a fine tilth through ploughing and tillage. Irrigation channels and bunds were maintained properly. Thirty days old healthy and uniform seedlings were transplanted on 02nd sept. 2016. Light irrigation was given after transplanting. The organic manures were applied one week before transplanting, for proper decomposition, full dose of phosphorus and potassium and half dose of nitrogen as per treatment were applied just before the transplanting. All cultural practices were followed regularly during crop growth and observations were recorded on growth characters i.e., plant height, No. of branches, and yield parameters like total number of fruits per plant, diameter of fruit, yield per plant, yield per plot and yield per hectare and quality parameters like TSS, acidity, and ascorbic acid were recorded from time to time. The data on these parameters were subjected to statistical analysis to draw logical conclusions.

Results and Discussion

Growth parameters

Among morphological characters, height of the plant was recorded on 60, 90, and at 120 days after transplanting. However, maximum numerical value is obtained with the treatment of mixture of all the micro-nutrients followed by Manganese sulphate. Number of branches per tomato plant has been recorded at 60, 90, and 120 days after transplanting. Maximum numbers of branches were recorded in Ammonium molybdate treatment followed by Zinc sulphate.

Yield parameters

Numbers of fruits per plant were recorded at 60, 90 and at 120 days of transplanting. Data recorded reveals that maximum numbers of fruits were obtained in Ferrous sulphate treatment followed by Zinc sulphate. The fruit diameter (cm) was not affected significantly due to the micro-nutrient application. However, the highest value is with Ammonium molydbate followed by Copper sulphate. Highest numbers of tomato fruit per plot have been recorded with the treatment of mixture of all the micro-nutrient followed by Zinc sulphate and Ferrous sulphate. Highest fruit number per plant is obtained with the treatment of mixture of all the micro-nutrient followed by Boric acid and Zinc sulphate.

Quality parameters

Experimental results on T.S.S value of fruit indicates that Ammonium molybdate treatment has maximum T.S.S value (5.0 Brix) followed by manganese sulphate. Tomato fruit yield per plot indicates that micro-nutrient have very Significant response is noticed with the treatment of mixture of all followed by Boric acid and Zinc sulphate. Mixture of all the micro-nutrient have yielded maximum yield of tomato fruits per hectare (632.66 q/ha) followed by Boric acid (557.10 q/ha) and Zinc sulphate (548.08 q/ha).

Economic parameters

Details of the economics of different treatments indicates the superiority of the treatment mixture of all nutrients with a net return of Rs. 180937 per hectare with C: B ratio of 1:2.05 followed by Boric acid with net profit of Rs. 148574 per hectare and C:B ratio of 1:1.68.

Conclusion

Considering the result of the present investigation it is concluded that treatment combination of Effects of micro-nutrients on height of the plant are not very evident. However, highest length of the plant is recorded in the treatment of mixture of all the micro-nutrients followed by Manganese sulphate. Maximum number of branches in tomato plant was recorded by the application of Ammonium molybdate. Results pertaining to the maximum number of fruits per plant were obtained by the application of Ferrous sulphate followed by Zinc sulphate. Fruit diameter of tomato was not affected by the application of micro-nutrients and all have more or less equal effect. Fruit yield per plant was affected by the micro-nutrient application. Highest number is recorded with the treatment of mixture of all the nutrients application followed by Boric acid. Application of Ammonium molebdate has beneficial effect on the T.S.S value of tomato fruit. Yield of tomato fruit per hectare was recorded in the treatment of mixture all the Micro-nutrients (632.66 q/ha) followed by Boric acid application (557.10 q/ha) and Zinc sulphate (548.21 q/ha). Details of economic return clearly indicates the

highest response of the treatment of mixture of all the micro-nutrient with a net profit of Rs. 180937 per hectare and C:B ratio of 1:2.05 followed by the treatment of Boric acid with net profit of Rs. 148574 per hectare and C:B ratio of 1:1.68 and Zinc sulphate with net profit of Rs. 144946 per hectare and C:B ratio of 1:1.64. The information obtained from the experiment is helpful to design nutrition program according to plant growth.

Table 1: Effect of organic manures and micronutrient on plant growth in tomato (*Solanum lycopersicum* L.)

Treatments No.	Treatments combination	Plant height (cm)			No. of branches		
		60 DAP	90 DAP	120 DAP	60 DAP	90 DAP	120 DAP
T_1	Boric acid	31.11	48.46	55.01	5.24	9.01	10.68
T_2	Zinc sulphate	32.55	48.57	54.12	5.35	9.12	10.90
T_3	Ammonium molybadate	34.18	51.45	56.12	7.68	10.02	11.25
T_4	Copper sulphate	35.58	53.35	56.12	6.12	9.68	10.46
T_5	Ferrous sulphate	34.09	50.68	55.12	5.79	8.23	9.25
T_6	Manganese sulphate	35.84	49.57	56.25	5.46	8.46	9.46
T_7	Mixture of all	33.27	50.57	57.46	5.8	9.35	9.90
T_8	Control	32.35	46.46	52.79	5.12	8.35	9.01
	F-test	0.3855	S	S	S	S	S
	C.D. at 0.5%	0.3855	0.8281	0.3711	0.3659	0.4635	0.3481
	S.Ed	0.1797	0.3861	0.1730	0.1706	0.2161	0.1623

Table 2: Effect of organic manures and micronutrient on yield and yield related traits in Tomato (*Solanum lycopersicum* L.).

Treatments No.	Treatments combination	60 number of fruit/plant	120 number of fruit/plant	Diameter of fruit (cm)	Fruit yield/ plant (kg)	Fruit yield/plot (kg)	T.S.S	Yield/ha (QTL.)
T_1	Boric acid	4.90	140.12	3.98	2.74	62.79	4.96	557.10
T_2	Zinc sulphate	5.90	147.86	4.05	2.63	61.79	4.79	548.21
T_3	Ammonium molybadate	6.90	134.54	4.27	2.33	52.13	5.13	462.35
T_4	Copper sulphate	7.34	142.34	4.26	2.41	56.29	4.79	499.33
T_5	Ferrous sulphate	9.23	166.77	3.95	2.43	56.96	4.79	505.28
T_6	Manganese sulphate	6.68	135.63	3.97	2.34	54.63	4.96	484.57
T_7	Mixture of all	5.46	143.43	4.00	3.09	71.29	4.96	632.66
T_8	Control	5.34	127.83	3.87	2.10	48.79	4.63	432.66
	F-test	S	S	S	S	S	S	S
	C.D. at 0.5%	0.3386	1.0516	0.0470	0.0424	1.1185	0.2909	0.7068
	S.Ed	0.1579	0.4903	0.0219	0.0908	0.5215	0.1357	0.3296

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