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Effect of Micronutrients Spray on Fruits Yield and Quality of Tomato (*Lycopersicom esculentum* Mill.).

Trilok Chand* and V.M. Prasad
Department of Horticulture
Allahabad School of Agriculture. Sam Higgins Bottom University of Agriculture, Technology and Sciences, Allahabad UP-211007

ABSTRACT

A field experiment was carried out to study the Effect of micronutrients spray on fruits yield and quality of Tomato (Lycopersicon esculentum Mill.) during 2012-13 and 2013-14 on tomato variety Pusa Rohini (DT – 39) at the at the vegetable research farm of the Department of Horticulture, Allahabad School of Agriculture, Sam Higgin Bottom University of Agriculture, Technology and Sciences, Allahabad. The results based on two years mean revealed that out of twenty seven different treatments, the combined application of Boron (100ppm) x Zn (100ppmm) x copper 100ppm resulted in maximum fruit yield per plant (3.04 kg and 2.98 kg) and fruit yield (263.60 q/ha and 261.73 q/ha) Followed by 100ppm Zn and Boron @ 100 ppm recording fruit yield differed significantly from the control as well as other treatments. The maximum diameter and Dry matter of fruits (52.40 cm and 48.97 cm) and (25.41% and 24.96 %) recorded with application of Boron, x Zinc sulphate x copper sulphate @ 100ppm followed by significantly from the control as well as other treatments The total soluble solids in tomato fruits were maximum (5.82 Brix and 5.54 Brix) under combined spray of 250 ppm of Boron, Zn and Copper at both the stages. Maximum increase in ascorbic acid content of tomato fruits (25.29 mg/100 g and 24.41 mg/100g) was recorded with the application of zinc, Boron and copper @ 250 ppm which accounted for an increase of 62.39 per cent as compared to (14.45 mg/100 g and 13.78mg/100g) in control. Highest specific gravity was observed in Boron 100 ppm x Zn 100 ppm x Cu 250 ppm (1.17 g/ml and 1.12 g/ml).

Key words:*Tomato, micronutrients, spray, fruits yield, fruit quality,*

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INTRODUCTION

Tomato is one of the important vegetable crops grown all over the world. Average fruit and quality in crop plants greatly influence by both macro and micronutrients. Not only major nutrients, micronutrients also play a crucial role in seed production of tomato Sivaiah *et. al.* [14]. Some micronutrients like Zinc, Iron, Manganese, Copper, Boron and Magnesium have an important role in the physiology of tomato crop and are required for plant activities such as aspiration, meristamatic development, chlorophyll formation, photosynthesis, hormone synthesis, gossypol, tannin and phenolic compounds development [11]. Tomato yield can be pushed up by the judicious use of recommended dose of major nutrients along with micronutrients. Boron, Copper, and zinc also play an important role in enhancing the production of tomato crop by providing resistance against certain diseases becomes imperative in cultivation of tomato crops for increasing the production. Applications of micronutrients using boron, zinc and copper have been reported in increasing seed yield in tomato. Sivaiah *et al*. [14].Total soluble solids contents (TSS) are important for the industrialization process as product yield is directly related to ºBrix, especially when the objective is dehydration, concentration of the pulp, or both the Vitamin A & C play an important role in human health and it is found in fruits and vegetables in the form of ascorbic acid. Its main functions are in the prevention of scurvy and maintenance of skin and blood vessels Saravaiya *et al* [10], Lee and Kader [5]. The main objective of the paper is to study the effect of micronutrients viz., zinc, boron and copper application on tomato fruit yield and quality of tomato.

MATERIAL AND METHODS

The present investigations were carried out at the vegetable research farm of the Department of Horticulture, Allahabad School of Agriculture, Sam Higgins Bottom University of Agriculture, Technology and Sciences, Allahabad-211007 in winter seasons of the year 2012-13 and 2013-14 on tomato variety Pusa Rohini (DT – 39). Twenty seven micronutrient treatments consisting of i) Zinc ii) Boron iii) Copper each 0, 100 and 250 ppm and their in combination applied through foliar spray at two growth stages that is 10 and 20 days after transplanting. Boron as boric acid, Zinc as zinc sulphate, copper as copper sulphate was applied. The pH of the solution was adjusted to neutral before application. The trial was laid out in R.B.D. (factorial) with three replications. Nitrogen, phosphorus and potassium were applied at the rate of 100, 75 and 55 kg/ha to all treatments. Half dose of nitrogen and full dose of phosphorus and potassium were applied after first and second earthing up. Twenty five days old seedlings of tomato Pusa Rohini (D T – 39) were transplanted in both the years. Observations were taken on ten randomly selected plants. Fully mature fruits were harvested. The data on fruit yield and fruit quality characters like Dry matter content of tomato fruit (%), Specific gravity of fruit (g/ml), total soluble solids, ascorbic acid content were recorded and were subjected to statistical analysis following the principles and procedures outlined by Santosh Kumari [9], Sarawaiya *et al* [10].

RESULTS AND DISCUSSION

The application Boron, Zinc and Copper significantly increased fruit yield per plant as well as yield per hectare in both the year. Results presented in Table 1 indicated that maximum fruit yield (3.04 and 2.98 kg) per plant was obtained with the combined application of Boron, Zn and Copper @ 100 ppm followed by Boron (100ppm) with Copper (100 ppm) (2.69 and 2.70 kg) while unsprayed plants recorded minimum fruit yield per plant (1.52 and 1.50 kg) during 2012-13 and 2013-14, respectively. It is also observed that the application of 100 ppm Boron gave highest fruit yield per plant followed by Boron 250 ppm while it was minimum under unsprayed plants in both the years. Similarly 100 ppm Copper and 100 ppm Zinc also gave best performance regarding fruit yield in present investigation.

A significant increase in fruit yield per hectored was observed with the foliar application of micronutrients (Table 2). Results showed that maximum fruit yield was produced with individual application of 100 ppm Boron (22.86 q/ha and 221.17 q/ha)), 100 ppm Zn (233.94 and 230.25 q/ha) and 100 ppm Copper produced highest (243.21 and 240.21 q/ha) during 2012-13 and 2013-14, respectively. The highest (263.6 and 261.73 q/ha) fruit yield per hectare was obtained with combined foliar application of Boron (100ppm), Zn (100ppm) and Copper (100ppm) which was significantly higher than the application of individual (Boron, Zn or Copper), combination of two micronutrient or higher dose (more than 100 ppm) during 2012-13 and 2013-14, respectively. Average increased yield due to micronutrients application may be attributed to enhanced photosynthesis activity and increased production and accumulation of carbohydrates and favorable effect on vegetative growth and retention of flowers and fruits, which increased number of fruits per plant besides increasing the size. Similarly, the Mishra *et al*. [6], Patil *et al.* [8], Sivaiah *et al*. [14] and Sathya *et al*. [12] obtained higher yield and yield attributes with the application of micronutrient. Presented Table 3 indicated the significant variation in dry matter content of fruits was observed with application of micronutrient. Among the concentration of Bo, Zn and Cu highest dry matter content (25.41 % and 24.96 %) were noted with spray @100 ppm in both the years. The combined effect of micronutrient maximum dry matter content was recorded with Boron, Zn and copper @ 100 ppm each while unsprayed plants recorded minimum dry matter content in fruits in present investigation.

The diameter of fruit showed in Table 4 significant variation on diameter was recorded with application of Boron, Zinc sulphate and Copper sulphate @ 100 ppm (52.40 cm and 48.97 cm) in 2012-13 and 2013-14, respectively, however, unsprayed plants estimated small in size of fruits, besides increasing the size of fruit. This is supported by the finding of Saravaiya *et al* [11], who has observed the similar results in tomato.

Results presented in Table 5 showed that micronutrients had significant effect on specific gravity of tomato fruits in both the years. Highest value of specific gravity was observed in Boron 100 ppm x Zn 100 ppm x Cu 250 ppm (1.17g/ml and 1.12 g/ml) respectively in both the year and results are in accordance with the findings of Saravaiya [10], Gupta *et al* [4] and Suhathiya and Singaravel [15]. While minimum specific gravity was observed with untreated plants.

The total soluble solids in tomato fruit were maximum with the spray of 250 ppm of Boron x Zn x Copper (5.82 Brix and 5.54 Brix) in 2012-13 and 2013-14, respectively. However, unsprayed plants estimated less amount of TSS in fruits. The possible reason for this may be increase in dry matter content which turned into total solids in presented Table 6. This is supported by the findings of Santosh Kumari [9], Bhatt and Srivastava [1], who have observed the similar results in tomato.

Significant variation was observed in different treatments of micronutrients and found maximum (25.29 mg/100g and 24.41mg/100 g) ascorbic acid content in tomato fruit was recorded with the application of zinc, Boron and copper @ 250 ppm which accounted for an increase of 62.39 per cent as compared to 14.11 mg/100 g in control in presented Table 7. These results are in conformity with those of Dube *et al* [3], Santosh Kumari [9], Singh and Tiwari [13] and Desai *et al*. [2]. Next best treatment was of Boron 250pp, Zn 250 ppm and copper 100 ppm (23.08 mg/100 g) followed by boron 250 ppm x Cu 250 ppm (22.90 mg/100 g) and Boron 250ppm x Zn 100 ppm x Cu 250 ppm (22.87 mg/100 g).

Table: 1. Effect of Boron, Copper and Zinc on Weight of fruit per plant (Kg)

Treatments	2012-13				2013-14				Pooled			
Bo & Zn ppm ↓ / → Cu ppm	Cu 0	Cu 100	Cu 250	Mean	Cu 0	Cu 100	Cu 250	Mean	Cu 0	Cu 100	Cu 250	Mean
B0 x Zn 0	1.52	2.52	1.70	1.91	1.50	2.43	1.77	1.90	1.51	2.48	1.74	1.91
B0 x Zn 100	2.11	2.75	2.35	2.40	2.10	2.60	2.22	2.31	2.11	2.67	2.29	2.36
B0 x Zn 250	1.77	2.31	2.11	2.06	1.74	2.31	2.05	2.04	1.76	2.32	2.09	2.05
Mean	1.80	2.53	2.06	2.13	1.78	2.44	2.01	2.08	1.79	2.49	2.04	2.11
B 100 x Zn 0	1.98	2.69	2.08	2.25	1.89	2.70	2.07	2.22	1.94	2.69	2.08	2.24
B 100 x Zn 100	2.66	3.04	2.56	2.75	2.65	2.98	2.44	2.69	2.66	3.01	2.50	2.72
B 100 x Zn 250	2.26	2.54	2.28	2.36	2.17	2.51	2.18	2.29	2.21	2.53	2.23	2.33
Mean	2.30	2.76	2.31	2.45	2.24	2.73	2.23	2.40	2.27	2.74	2.27	2.43
B 250 x Zn 0	1.63	2.63	1.98	2.08	1.57	2.45	1.92	1.98	1.60	2.54	1.95	2.03
B 250 x Zn 100	2.16	2.63	2.19	2.33	2.05	2.44	2.02	2.17	2.11	2.54	2.11	2.25
B 250 x Zn 250	1.95	2.45	2.18	2.19	1.91	2.34	2.12	2.12	1.93	2.40	2.15	2.16
Mean	1.91	2.57	2.12	2.20	1.84	2.41	2.02	2.09	1.88	2.49	2.07	2.15
Over all mean	0 ppm	100 ppm	250 ppm		0 ppm	100 ppm	250 ppm		0 ppm	100 ppm	250 ppm	
Bo	2.13	2.45	2.20		2.08	2.40	2.09		2.11	2.43	2.15	
Zn	2.08	2.49	2.21		2.03	2.39	2.15		2.06	2.44	2.18	
Cu	2.00	2.62	2.16		1.95	2.53	2.09		1.98	2.58	2.13	
	SE(m)	SE(d)	C.D. at 5%	F test	SE(m)	SE(d)	C.D. at 5%	F test	SE(m)	SE(d)	C.D. at 5%	F test
Boron	0.026	0.036	0.073	44.721	0.021	0.030	0.060	72.274	0.018	0.025	0.050	97.19
Zinc	0.026	0.036	0.073	67.725	0.021	0.030	0.060	73.425	0.018	0.025	0.050	122.62
B x Zn	0.044	0.063	0.126	3.399	0.037	0.052	0.104	6.637	0.031	0.044	0.087	8.06
Copper	0.026	0.036	0.073	154.204	0.021	0.030	0.060	199.995	0.018	0.025	0.050	303.39
B x Cu	0.044	0.063	0.126	3.210	0.037	0.052	0.104	3.144	0.031	0.044	0.087	5.20
Zn x Cu	0.044	0.063	0.126	10.326	0.037	0.052	0.104	14.974	0.031	0.044	0.087	20.88
B x Zn x Cu	0.077	0.109	NS	0.620	0.064	0.090	NS	0.350	0.053	0.075	NS	0.79

Table: 2. Effect of Boron, Copper and Zinc on Yield (q/ha)

Treatments	2012-13				2013-14				Pooled			
Bo & Zn ppm ↓ / Cu ppm →	Cu 0	Cu 100	Cu 250	Mean	Cu 0	Cu 100	Cu 250	Mean	Cu 0	Cu 100	Cu 250	Mean
B0 x Zn 0	143.63	236.07	172.10	183.93	141.20	232.00	169.37	180.86	142.42	234.03	170.73	182.39
B0 x Zn 100	198.60	250.67	201.60	216.96	193.83	247.77	198.73	213.44	196.22	249.22	200.17	215.20
B0 x Zn 250	171.67	221.30	197.40	196.79	169.57	218.93	196.00	194.83	170.62	220.12	196.70	195.81
Mean	171.30	236.01	190.37	199.23	168.20	232.90	188.03	196.38	169.75	234.46	189.20	197.80
B 100 x Zn 0	182.73	247.33	185.03	205.03	179.67	243.27	181.63	201.52	181.20	245.30	183.33	203.28
B 100 x Zn 100	235.43	263.60	244.30	247.78	233.67	261.73	241.70	245.70	234.55	262.67	243.00	246.74
B 100 x Zn 250	211.10	232.13	213.07	218.77	207.63	230.50	210.70	216.28	209.37	231.32	211.88	217.52
Mean	209.76	247.69	214.13	223.86	206.99	245.17	211.34	221.17	208.37	246.43	212.74	222.51
B 250 x Zn 0	153.87	243.40	181.97	193.08	151.30	241.13	177.10	189.84	152.58	242.27	179.53	191.46
B 250 x Zn 100	212.07	263.17	236.00	237.08	208.83	258.30	233.67	233.60	210.45	260.73	234.83	235.34
B 250 x Zn 250	178.97	231.30	206.97	205.74	176.50	228.23	203.87	202.87	177.73	229.77	205.42	204.31
Mean	181.63	245.96	208.31	211.97	178.88	242.56	204.88	208.77	180.26	244.26	206.59	210.37
Over all mean	0 ppm	100 ppm	250 ppm		0 ppm	100 ppm	250 ppm		0 ppm	100 ppm	250 ppm	
Bo	199.23	223.86	211.97		196.38	221.17	208.77		197.80	222.51	210.37	
Zn	194.01	233.94	207.10		190.74	230.91	204.66		192.38	232.43	205.88	
Cu	187.56	243.22	204.27		184.69	240.21	201.42		186.13	241.71	202.84	
	SE(m)	SE(d)	C.D. at 5%	F test	SE(m)	SE(d)	C.D. at 5%	F test	SE(m)	SE(d)	C.D. at 5%	F test
Boron	0.627	0.887	1.779	386.165	0.733	1.037	2.080	285.940	0.633	0.896	1.796	381.55
Zinc	0.627	0.887	1.779	1053.977	0.733	1.037	2.080	774.672	0.633	0.896	1.796	1037.38
B x Zn	1.086	1.536	3.082	10.057	1.269	1.795	3.603	9.136	1.096	1.551	3.110	10.95
Copper	0.627	0.887	1.779	2075.363	0.733	1.037	2.080	1509.891	0.633	0.896	1.796	2032.42
B x Cu	1.086	1.536	3.082	56.819	1.269	1.795	3.603	39.474	1.096	1.551	3.110	54.31
Zn x Cu	1.086	1.536	3.082	139.648	1.269	1.795	3.603	100.138	1.096	1.551	3.110	135.69
B x Zn x Cu	1.881	2.660	5.338	7.303	2.199	3.110	6.241	5.263	1.898	2.686	5.387	7.05

Table: 3. Effect of Boron, Copper and Zinc on Dry matter contents of tomato fruit (%)

Treatments	2012-13				2013-14				Pooled			
Bo & Zn ppm ↓ / Cu ppm →	Cu 0	Cu 100	Cu 250	Mean	Cu 0	Cu 100	Cu 250	Mean	Cu 0	Cu 100	Cu 250	Mean
B0 x Zn 0	8.95	12.93	9.91	10.60	8.46	11.76	10.74	10.32	8.71	12.35	10.32	10.46
B0 x Zn 100	11.30	13.17	11.68	12.05	11.50	12.91	11.51	11.97	11.40	13.04	11.59	12.01
B0 x Zn 250	10.14	12.26	10.23	10.87	9.60	11.76	10.02	10.46	9.87	12.01	10.12	10.67
Mean	10.13	12.79	10.60	11.17	9.85	12.14	10.75	10.92	9.99	12.47	10.68	11.05
B 100 x Zn 0	15.13	20.54	16.95	17.54	14.84	19.66	16.17	16.89	14.99	20.10	16.56	17.22

B 100 x Zn 100	19.72	25.41	22.39	22.51	19.02	24.96	22.03	22.00	19.37	25.19	22.21	22.26
B 100 x Zn 250	12.98	16.43	13.89	14.44	12.12	16.04	13.36	13.84	12.55	16.24	13.63	14.14
Mean	15.95	20.80	17.74	18.16	15.32	20.22	17.19	17.58	15.64	20.51	17.47	17.87
B 250 x Zn 0	10.08	13.57	11.02	11.56	7.96	12.59	9.77	10.11	9.02	13.09	10.39	10.83
B 250 x Zn 100	12.28	14.91	13.60	13.59	11.88	13.09	12.47	12.48	12.08	14.00	13.04	13.04
B 250 x Zn 250	9.71	13.19	11.15	11.35	9.18	12.60	11.51	11.10	9.45	12.90	11.33	11.23
Mean	10.69	13.89	11.92	12.17	9.67	12.76	11.25	11.23	10.18	13.33	11.59	11.70
Over all mean	0 ppm	100 ppm	250 ppm		0 ppm	100 ppm	250 ppm		0 ppm	100 ppm	250 ppm	
Bo	11.17	18.16	12.17		10.92	17.58	11.23		11.05	17.87	11.70	
Zn	13.23	16.05	12.22		12.44	15.49	11.80		12.84	15.77	12.01	
Cu	12.26	15.82	13.42		11.62	15.04	13.06		11.94	15.44	13.24	
	SE(m)	SE(d)	C.D. at 5%	F test	SE(m)	SE(d)	C.D. at 5%	F test	SE(m)	SE(d)	C.D. at 5%	F test
Boron	0.156	0.220	0.442	590.399	0.140	0.199	0.398	717.036	0.104	0.147	0.297	1298.82
Zinc	0.156	0.220	0.442	162.782	0.140	0.199	0.398	196.956	0.104	0.147	0.297	357.40
B x Zn	0.269	0.381	0.765	47.462	0.243	0.344	0.690	64.546	0.181	0.256	0.514	109.70
Copper	0.156	0.220	0.442	136.782	0.140	0.199	0.398	150.030	0.104	0.147	0.297	286.08
B x Cu	0.269	0.381	0.765	4.758	0.243	0.344	0.690	8.082	0.181	0.256	0.514	12.30
Zn x Cu	0.269	0.381	NS	2.014	0.243	0.344	NS	2.286	0.181	0.256	0.514	3.83
B x Zn x Cu	0.467	0.660	NS	1.052	0.421	0.596	1.195	3.492	0.313	0.443	0.890	3.39

Table: 4. Effect of Boron, Copper and Zinc on Diameter of fruit (cm) at 1st picking

Treatments	**2012-13**				**2013-14**				**Pooled**			
Bo & Zn ppm ↓ / Cu ppm →	Cu 0	Cu 100	Cu 250	Mean	Cu 0	Cu 100	Cu 250	Mean	Cu 0	Cu 100	Cu 250	Mean
B0 x Zn 0	40.41	45.69	41.90	42.67	39.55	45.50	41.82	42.29	39.98	45.60	41.86	42.48
B0 x Zn 100	42.45	47.54	43.92	44.64	41.66	47.07	43.32	44.02	42.06	47.31	43.63	44.33
B0 x Zn 250	41.42	45.91	42.11	43.15	41.88	44.54	41.93	42.78	41.65	45.22	42.03	42.97
Mean	41.43	46.38	42.65	43.48	41.03	45.70	42.36	43.03	41.23	46.04	42.50	43.26
B 100 x Zn 0	44.44	47.10	43.59	45.04	43.39	47.78	41.88	44.35	43.92	47.44	42.74	44.70
B 100 x Zn 100	46.34	52.40	43.98	47.57	46.38	48.97	40.11	45.15	46.36	50.69	42.05	46.37
B 100 x Zn 250	40.38	44.84	41.00	42.07	40.40	42.73	39.97	41.03	40.39	43.79	40.49	41.56
Mean	43.72	48.11	42.86	44.90	43.39	46.49	40.65	43.51	43.56	47.31	41.76	44.21
B 250 x Zn 0	39.87	41.75	40.42	40.68	37.70	41.10	39.29	39.36	38.78	41.43	39.86	40.02
B 250 x Zn 100	40.56	43.27	41.45	41.76	40.62	42.67	40.10	41.13	40.59	42.97	40.78	41.45
B 250 x Zn 250	37.40	38.24	35.84	37.16	37.60	39.70	35.36	37.55	37.50	38.97	35.61	37.36
Mean	39.28	41.09	39.24	39.87	38.64	41.16	38.25	39.35	38.96	41.12	38.75	39.61
Over all mean	0 ppm	100 ppm	250 ppm		0 ppm	100 ppm	250 ppm		0 ppm	100 ppm	250 ppm	
Bo	43.48	44.90	39.87		43.03	43.51	39.35		43.26	44.21	39.61	
Zn	42.80	44.66	40.79		42.00	43.43	40.46		42.40	44.05	40.63	
Cu	41.48	45.19	41.58		41.02	44.45	40.42		41.25	44.83	41.00	

	SE(m)	SE(d)	C.D. at 5%	F test	SE(m)	SE(d)	C.D. at 5%	F test	SE(m)	SE(d)	C.D. at 5%	F test
Boron	0.264	0.373	0.749	96.609	0.278	0.393	0.788	67.284	0.210	0.297	0.596	133.52
Zinc	0.264	0.373	0.749	53.591	0.278	0.393	0.788	28.738	0.210	0.297	0.596	66.31
B x Zn	0.457	0.647	1.298	7.709	0.481	0.680	1.365	4.564	0.364	0.515	1.033	9.13
Copper	0.264	0.373	0.749	64.352	0.278	0.393	0.788	61.345	0.210	0.297	0.596	103.70
B x Cu	0.457	0.647	1.298	5.445	0.481	0.680	1.365	5.713	0.364	0.515	1.033	8.47
Zn x Cu	0.457	0.647	NS	1.183	0.481	0.680	1.365	2.686	0.364	0.515	NS	2.25
B x Zn x Cu	0.792	1.120	NS	1.531	0.833	1.178	2.364	2.381	0.630	0.891	1.788	2.77

Table: 5. Effect of Boron, Copper and Zinc on Specific gravity of fruit (g/ml)

Treatments	2012-13				2013-14				Pooled			
Bo & Zn ppm ↓ / Cu ppm →	Cu 0	Cu 100	Cu 250	Mean	Cu 0	Cu 100	Cu 250	Mean	Cu 0	Cu 100	Cu 250	Mean
B0 x Zn 0	0.84	0.93	0.95	0.90	0.90	0.91	0.94	0.91	0.87	0.92	0.94	0.91
B0 x Zn 100	0.91	0.97	0.99	0.96	0.92	0.96	0.98	0.95	0.92	0.96	0.98	0.95
B0 x Zn 250	0.87	1.06	0.91	0.95	0.91	1.00	0.91	0.94	0.89	1.03	0.91	0.94
Mean	0.87	0.98	0.95	0.94	0.91	0.96	0.94	0.93	0.89	0.97	0.94	0.93
B 100 x Zn 0	0.91	0.93	1.00	0.95	0.90	0.93	1.00	0.94	0.91	0.93	1.00	0.94
B 100 x Zn 100	0.97	1.09	1.17	1.08	0.96	1.04	1.12	1.04	0.96	1.07	1.15	1.06
B 100 x Zn 250	1.03	1.13	0.95	1.04	1.09	1.08	0.95	1.04	1.06	1.11	0.95	1.04
Mean	0.97	1.05	1.04	1.02	0.98	1.02	1.02	1.01	0.97	1.03	1.03	1.01
B 250 x Zn 0	0.93	1.14	0.89	0.99	0.92	1.11	0.87	0.96	0.92	1.13	0.88	0.98
B 250 x Zn 100	0.98	1.12	0.97	1.02	0.96	1.07	0.95	0.99	0.97	1.09	0.96	1.01
B 250 x Zn 250	1.02	1.14	1.05	1.07	1.00	1.11	1.03	1.05	1.01	1.13	1.04	1.06
Mean	0.97	1.13	0.97	1.03	0.96	1.10	0.95	1.00	0.97	1.12	0.96	1.01
Over all mean	0 ppm	100 ppm	250 ppm		0 ppm	100 ppm	250 ppm		0 ppm	100 ppm	250 ppm	
Bo	0.94	1.02	1.03		0.93	1.01	1.00		0.93	1.01	1.01	
Zn	0.95	1.02	1.02		0.94	0.99	1.01		0.94	1.01	1.01	
Cu	0.94	1.06	0.99		0.95	1.02	0.97		0.94	1.04	0.98	
	SE(m)	SE(d)	C.D. at 5%	F test	SE(m)	SE(d)	C.D. at 5%	F test	SE(m)	SE(d)	C.D. at 5%	F test
Boron	0.009	0.013	0.025	32.405	0.008	0.011	0.022	27.672	0.006	0.008	0.018	52.36
Zinc	0.009	0.013	0.025	22.126	0.008	0.011	0.022	22.119	0.006	0.008	0.018	38.26
B x Zn	0.015	0.022	0.044	3.834	0.013	0.019	0.038	3.993	0.011	0.016	0.031	6.51
Copper	0.009	0.013	0.025	43.914	0.008	0.011	0.022	24.147	0.006	0.008	0.018	58.91
B x Cu	0.015	0.022	0.044	7.618	0.013	0.019	0.038	9.957	0.011	0.016	0.031	14.87
Zn x Cu	0.015	0.022	0.044	4.648	0.013	0.019	0.038	4.666	0.011	0.016	0.031	7.75
B x Zn x Cu	0.027	0.038	0.076	5.802	0.023	0.033	0.065	7.041	0.019	0.027	0.054	10.64

Table: 6. Effect of Boron, Copper and Zinc on Total soluble solid of tomato fruit (Brix)

Treatments	2012-13				2013-14				Pooled			
Bo & Zn ppm ↓ / Cu ppm →	Cu 0	Cu 100	Cu 250	Mean	Cu 0	Cu 100	Cu 250	Mean	Cu 0	Cu 100	Cu 250	Mean
B0 x Zn 0	2.34	2.36	2.53	2.41	2.30	2.35	2.45	2.37	2.32	2.36	2.49	2.39
B0 x Zn 100	2.41	2.49	2.87	2.59	2.33	2.49	2.79	2.53	2.37	2.49	2.83	2.56
B0 x Zn 250	3.02	3.22	2.68	2.97	2.92	3.15	2.51	2.86	2.97	3.19	2.60	2.92
Mean	2.59	2.69	2.69	2.66	2.52	2.66	2.58	2.59	2.55	2.68	2.64	2.62
B 100 x Zn 0	3.13	3.55	3.70	3.46	3.20	3.37	3.66	3.41	3.16	3.46	3.68	3.43
B 100 x Zn 100	3.53	4.46	4.14	4.04	3.81	4.35	4.09	4.08	3.67	4.40	4.12	4.06
B 100 x Zn 250	4.16	4.67	4.55	4.46	3.91	4.41	4.42	4.25	4.04	4.54	4.49	4.36
Mean	3.61	4.23	4.13	3.99	3.64	4.04	4.06	3.91	3.62	4.13	4.09	3.95

B 250 x Zn 0	3.85	4.24	4.17	4.09	3.60	4.12	4.21	3.98	3.72	4.18	4.19	4.03
B 250 x Zn 100	3.32	4.26	3.55	3.71	3.20	4.18	3.38	3.59	3.26	4.22	3.47	3.65
B 250 x Zn 250	3.77	5.73	5.82	5.10	3.44	4.99	5.54	4.66	3.60	5.40	5.63	4.88
Mean	3.64	4.77	4.48	4.30	3.41	4.43	4.38	4.07	3.53	4.60	4.43	4.19
Over all mean	0 ppm	100 ppm	250 ppm		0 ppm	100 ppm	250 ppm		0 ppm	100 ppm	250 ppm	
Bo	2.66	3.99	4.30		2.59	3.91	4.07		2.62	3.95	4.19	
Zn	3.32	3.45	4.18		3.25	3.40	3.92		3.29	3.42	4.05	
Cu	3.28	3.90	3.77		3.19	3.71	3.67		3.23	3.80	3.72	
	SE(m)	SE(d)	C.D. at 5%	F test	SE(m)	SE(d)	C.D. at 5%	F test	SE(m)	SE(d)	C.D. at 5%	F test
Boron	0.041	0.058	0.116	456.144	0.040	0.057	0.114	412.475	0.035	0.050	0.100	577.64
Zinc	0.041	0.058	0.116	129.118	0.040	0.057	0.114	77.052	0.035	0.050	0.100	135.23
B x Zn	0.071	0.100	0.201	20.920	0.070	0.098	0.197	18.589	0.061	0.086	0.173	25.89
Copper	0.041	0.058	0.116	63.388	0.040	0.057	0.114	52.561	0.035	0.050	0.100	76.79
B x Cu	0.071	0.100	0.201	14.156	0.070	0.098	0.197	14.040	0.061	0.086	0.173	18.15
Zn x Cu	0.071	0.100	0.201	5.461	0.070	0.098	0.197	5.477	0.061	0.086	0.173	6.92
B x Zn x Cu	0.123	0.173	0.348	10.298	0.121	0.170	0.342	10.620	0.105	0.149	0.299	13.42

Table: 7. Effect of Boron, Copper and Zinc on Ascorbic acid (mg/100g)

Treatments	2012-13				2013-14				Pooled			
Bo & Zn ppm ↓ / Cu ppm →	Cu 0	Cu 100	Cu 250	Mean	Cu 0	Cu 100	Cu 250	Mean	Cu 0	Cu 100	Cu 250	Mean
B0 x Zn 0	14.45	17.14	17.53	16.37	13.78	16.35	16.93	15.69	14.12	16.74	17.23	16.03
B0 x Zn 100	16.03	19.70	20.42	18.72	15.30	18.92	20.18	18.13	15.67	19.31	20.30	18.43
B0 x Zn 250	15.37	19.55	21.84	18.92	14.51	19.04	20.93	18.16	14.95	19.30	21.39	18.54
Mean	15.28	18.79	19.93	18.00	14.53	18.10	19.35	17.33	14.91	18.45	19.64	17.67
B 100 x Zn 0	19.39	21.04	22.49	20.97	18.71	21.43	22.29	20.81	19.05	21.24	22.39	20.89
B 100 x Zn 100	20.89	23.39	21.22	21.83	19.66	22.47	21.25	21.13	20.28	22.93	21.24	21.48
B 100 x Zn 250	19.92	20.89	21.45	20.75	19.20	19.92	20.90	20.01	19.57	20.41	21.18	20.38
Mean	20.07	21.77	21.72	21.19	19.19	21.28	21.48	20.65	19.63	21.53	21.60	20.92
B 250 x Zn 0	19.88	22.81	23.49	22.06	18.73	21.13	22.32	20.73	19.31	21.98	22.91	21.40
B 250 x Zn 100	19.86	21.93	23.11	21.63	19.33	21.28	22.64	21.08	19.60	21.61	22.88	21.36
B 250 x Zn 250	22.09	23.50	25.29	23.63	21.92	22.66	24.41	23.00	22.01	23.08	24.85	23.31
Mean	20.61	22.75	23.96	22.44	19.99	21.69	23.13	21.60	20.30	22.22	23.54	22.02
Over all mean	0 ppm	100 ppm	250 ppm		0 ppm	100 ppm	250 ppm		0 ppm	100 ppm	250 ppm	
Bo	18.00	21.19	22.44		17.33	20.65	21.60		17.67	20.92	22.02	
Zn	19.80	20.73	21.10		19.07	20.11	20.39		19.44	20.42	20.75	
Cu	18.65	21.11	21.87		17.90	20.36	21.32		18.28	20.73	21.60	
	SE(m)	SE(d)	C.D. at 5%	F test	SE(m)	SE(d)	C.D. at 5%	F test	SE(m)	SE(d)	C.D. at 5%	F test
Boron	0.187	0.265	0.531	149.472	0.100	0.142	0.284	501.900	0.112	0.158	0.317	411.59
Zinc	0.187	0.265	0.531	12.734	0.100	0.142	0.284	47.820	0.112	0.158	0.317	37.09
B x Zn	0.324	0.458	0.920	9.964	0.174	0.245	0.493	39.858	0.193	0.273	0.549	29.05
Copper	0.187	0.265	0.531	80.698	0.100	0.142	0.284	308.333	0.112	0.158	0.317	237.12
B x Cu	0.324	0.458	0.920	5.787	0.174	0.245	0.493	17.002	0.193	0.273	0.549	14.53
Zn x Cu	0.324	0.458	NS	1.661	0.174	0.245	0.493	2.662	0.193	0.273	0.549	3.09
B x Zn x Cu	0.561	0.794	1.593	2.215	0.301	0.425	0.853	7.365	0.335	0.474	0.951	5.86

CONCLUSION

From the above discussion, it may be concluded that combination of Boron, Copper sulphate and Zinc sulphate @ 100 ppm with recommended dose of NPK Yield per plant (kg), Yield (q/ ha), Diameter of fruit (cm), Dry matter(%), and TSS (Brix), Ascorbic acid (mg/100g) @ 250 ppm Boron, Copper sulphate, Zinc sulphate and Specific gravity (g/ml) Boron, @ 100 ppm, Zinc sulphate @ 100 ppm, Copper sulphate @ 250 ppm may be suggested for better yield and quality of Tomato.

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