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Effect of Foliar Spray of Different Micronutrients on Plant Growth, Seed Yield and Quality in Tomato

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ABSTRACT: A field experiment was conducted to study the effect of foliar spray of different micronutrients on plant growth, seed yield and quality in tomato at Main Vegetable Research Station, AAU, Anand and Department of Seed Science and Technology, B. A. College of Agriculture, Anand Agricultural University, Anand. The significantly higher plant height at 45, 60 and 75 DAT, mature fruits per plant, fruit yield (kg) per plant at red ripened stage, pulp to seed ratio (%), number of seeds per fruit, 1000 seed weight and seed yield per plant were recorded during kharif seasons 2020-21 and 2021-22 respectively. Seed quality attributing characters viz.,seed germination (%), seedling length (cm), seedling dry weight (mg), SVI-I and SVI-II were found significantly higher with Boron spray @ 0.2% during both years.

Keywords: Boric acid, Micronutrients, Tomato, Seed yield, Germination

INTRODUCTION

Tomato (*Solanum lycopersicum* L.) belongs to the family Solanaceae, and is one of the most important vegetables worldwide. It is a self-pollinated crop and a true diploid with 2n=2X=24. Plant is annual with herbaceous prostrate stem having determinate or indeterminate growth habit. In the determinate growth, terminal bud ends in a floral bud and further growth is arrested resulting in dwarf and bushy stature. India is the 2nd largest producer of tomatoes next to China occupying an area of 8.49 lakh hectares with production of about 20.40 MT and productivity of 24.02 t/ha [1]. In India, major tomato growing states are Andhra Pradesh, Madhya Pradesh, Karnataka, Gujarat, Odisha, West Bengal, Telangana, Chhattisgarh, Maharashtra and Bihar. In Gujarat, tomato cultivation occupies an area of 67.87 thousand hectares with a production of about 1.92 MT and productivity of 28.32 t/ha [2]. Tomato fruits are rich in organic acids, amino acids, vitamins and minerals. Seed yield and quality in plants are greatly influenced by both macro and micro nutrients. One way of overcoming micronutrient deficiency in a crop instantly is foliar application of micronutrients. Essential micronutrients viz., Zinc, Iron, Manganese, Copper, Boron and Magnesium play an important role in physiology of tomato crop being a part of the enzyme system or catalyst in enzymatic reactions. They are required for plant activities such as respiration, meristematic development, chlorophyll formation, photosynthesis, energy system, protein and oil synthesis and phenolic compounds development [3]. Nano-Particles (NPs) with small size and large surface area are expected to be the ideal material for use as a Zn fertilizer in plants.

MATERIAL AND METHOD

This study was conducted at Main Vegetable Research Station, AAU, Anand and Department of Seed Science and Technology, B.A. College of Agriculture, Anand Agricultural University, Anand during *Kharif* 2020-21 and 2021-22. Tomato crop was raised with foliar spray of different micronutrients in four replications with RBD design. Seeds of tomato var. 'Gujarat Anand Tomato 5' were obtained from Main Vegetable Research Station, Anand Agricultural University, Anand. Seedlings were transplanted at 90 × 45 cm2 in the plots on 9th July and 1st August for the *Kharif* seasons of 2020 and 2021, respectively. Treatment solutions were prepared using Analytical grade chemicals. The plants at 30, 40 and 50 DAT were subject to foliar applications with micronutrients viz. water, Boric Acid (0.2%), ZnSO4 (0.5%), FeSO4 (0.5%), ZnO NPs (30 ppm) and FeO NPs (30 ppm). FeO NPs and ZnO NPs solutions were obtained from the Department of Nanotechnology, AAU, Anand.

Table 1. Effect of foliar spray of different micronutrients on plant height (cm) at 30, 45,60 and 75 DAT

Treatments	Plant height (cm) at 30 DAT			Plant height (cm) at 45 DAT			Plant height (cm) at 60 DAT			Plant height (cm) at 75 DAT		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
T_1	46.93	55.20	51.06	77.00	75.50	76.25	83.75	87.95	85.85	120.95	122.80	121.88
T_2	50.35	68.55	59.45	79.10	84.85	81.98	91.80	93.40	92.60	126.65	130.10	128.38
T_3	48.10	63.85	55.98	78.90	77.05	77.98	86.20	90.43	88.31	122.61	123.41	123.01
T_4	46.55	53.23	49.89	70.45	73.80	72.13	82.05	86.80	84.43	115.75	118.43	117.10
T_5	50.30	65.40	57.85	79.00	82.45	80.73	89.75	91.76	90.76	125.95	127.75	126.85
T_6	50.70	70.10	60.40	81.50	89.85	85.68	92.95	98.65	95.80	128.10	132.65	130.38
S.Em.±	2.19	4.84	3.76	2.21	2.63	2.43	2.59	2.50	2.54	2.65	2.92	2.79
C.D.@5%	NS	NS	NS	6.65	7.93	NS	7.79	7.52	NS	7.99	8.80	NS
CV%	8.99	15.42	13.46	5.68	6.53	6.14	5.89	5.45	5.67	4.30	4.64	4.48

T_1-Control; T_2-Boric Acid @ 0.2%; T_3-$ZnSO_4$ @ 0.5%; T_4-$FeSO_4$ @ 0.5%; T_5-ZnO NPs @ 30 ppm; T_6-FeO NPs @ 30 ppm
DAT: Days After Transplanting

Table 2. Effect of foliar spray of different micronutrients on Mature fruits per plant, Fruit yield (kg) per plant at red ripenstage, Pulp to seed ratio (%) and Number of seeds per fruit

Treatments	Mature fruits per plant			Fruit yield (kg) per plant at red ripen stage			Pulp to seed ratio (%)			Number of seeds per fruit		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
T_1	32.64	35.64	34.14	1.50	1.65	1.57	0.640	0.725	0.683	80.53	85.72	83.12
T_2	41.24	44.24	42.74	2.01	2.21	2.11	0.810	0.905	0.858	92.31	99.87	96.09
T_3	35.98	38.98	37.48	1.74	1.89	1.82	0.710	0.818	0.764	85.24	91.93	88.58
T_4	31.95	34.95	33.45	1.48	1.63	1.55	0.605	0.647	0.626	78.49	79.95	79.22
T_5	39.68	42.68	41.18	1.83	1.98	1.90	0.792	0.892	0.842	88.40	94.14	91.27
T_6	41.57	44.57	43.07	2.12	2.26	2.19	0.888	1.047	0.968	100.38	104.07	102.23
S.Em.±	1.65	1.55	1.60	0.10	0.15	0.13	0.03	0.07	0.05	2.37	2.22	2.30
C.D.@5%	4.96	4.67	NS	0.31	0.45	NS	0.09	0.21	NS	7.14	6.69	NS
CV%	8.85	7.72	8.27	11.56	15.47	13.83	8.13	16.78	13.71	5.41	4.80	5.10

T_1-Control; T_2-Boric Acid @ 0.2%; T_3-$ZnSO_4$ @ 0.5%; T_4-$FeSO_4$ @ 0.5%; T_5-ZnO NPs @ 30 ppm; T_6-FeO NPs @ 30 ppm

RESULTS AND DISCUSSION

In general, foliar spray of micronutrients at 45, 60 and 75 days increased the plant heights in tomato. Application of FeO NPs was most effective since iron is involved in chlorophyll synthesis. Effect of FeO nano particles on plant height in carrot was also found significant [4]. Significantly higher number of mature fruits per plant was recorded by foliar spray with T6: FeO NPs @ 30 ppm for the year 2020-21 (41.57) and 2021-22 (44.57) respectively. The effect of Fe may be attributed to higher rate of chlorophyll synthesis, cytochrome oxidase activity and enhanced rate of photolysis of water [5], all of which contribute to more photosynthetic activity and higher production of sugars and ultimately more number of fruits per plant. Significantly higher fruit yield (kg) per plant at red ripened stage was recorded in T6, with foliar spray with FeO NPs @ 30ppm for the year 2020-21 (2.12 kg) and 2021-22 (2.26 kg) respectively, which could be the result of the continued supply of food material and water to plants [6]. Increased yield due to the micronutrient applications may be attributed to enhanced photosynthesis activity, accumulation of carbohydrates and its favourable effect on vegetative growth, retention of flowers and fruits leading to increased production. Significantly higher pulp to seed ratio was recorded in T6: with foliar spray of FeO NPs @ 30 ppm for the year 2020-21 (0.89%) and 2021-22 (1.05%) respectively. The increase may be due to enhanced synthesis of metabolites, increased absorption of water and mobilization of sugars and minerals in the expended cells. Ferrous either singly or in combination also helped in maximum increase in seed ratio by accelerating the transportation of photosynthates from leaf to the developing fruits and produced maximum average fruit

Table 3. Effect of foliar spray of different micronutrients on 1000 seeds weight (g), Seed yield (g) per plant, Seed germination (%) and Seedling length (cm)

Treatments	1000 seeds weight (g)			Seed yield (g) per plant			Seed germination (%)			Seedling length (cm)		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
T_1	2.55	2.75	2.65	6.72	8.40	7.56	93.00	96.00	94.50	9.42	10.16	9.79
T_2	2.97	3.17	3.07	11.29	13.99	12.64	97.25	98.50	97.88	10.65	11.45	11.05
T_3	2.82	3.02	2.92	8.67	10.85	9.76	95.50	97.50	96.50	9.58	10.71	10.14
T_4	2.45	2.65	2.55	6.13	7.38	6.75	92.00	95.50	93.75	8.68	9.85	9.26
T_5	2.90	3.10	3.00	10.13	12.42	11.27	96.50	98.00	97.25	10.45	10.98	10.72
T_6	3.16	3.36	3.26	13.18	15.57	14.37	93.50	97.00	95.25	9.54	10.66	10.10
S.Em.±	0.04	0.09	0.07	0.47	0.57	0.53	1.08	0.68	0.90	0.36	0.19	0.29
C.D.@5%	0.12	0.27	NS	1.43	1.73	NS	3.27	2.04	NS	1.07	0.56	NS
CV%	2.92	5.99	4.81	10.14	10.03	10.12	2.29	1.39	1.89	7.34	3.52	5.60

T_1-Control; T_2-Boric Acid @ 0.2%; T_3-$ZnSO_4$ @ 0.5%; T_4-$FeSO_4$ @ 0.5%; T_5-ZnO NPs @ 30 ppm; T_6-FeO NPs @ 30 ppm

Table 4. Effect of foliar spray of different micronutrients on Seedling dry weight (mg), Seedling Vigour Index-I and Seedling Vigour Index-II

Treatments	Seedling dry weight (mg)			Seedling Vigour Index-I			Seedling Vigour Index-II		
	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled	2020-21	2021-22	Pooled
T_1	8.00	11.65	9.83	877	975	926	744	1119	931
T_2	10.85	16.98	13.91	1037	1126	1082	1056	1698	1377
T_3	10.03	13.10	11.56	914	1043	979	957	1277	1117
T_4	6.30	10.50	8.40	799	940	869	580	967	773
T_5	10.18	14.30	12.24	1010	1076	1043	983	1401	1192
T_6	8.45	11.88	10.16	893	1033	963	791	1152	972
S.Em.±	0.29	0.24	0.27	36.00	21.00	29.00	33.00	26.00	30.00
C.D.@5%	0.88	0.73	0.78	107.00	65.00	NS	101.00	79.00	87.00
CV%	6.52	3.72	4.88	7.71	4.16	6.01	7.83	4.12	5.65

T_1-Control; T_2-Boric Acid @ 0.2%; T_3-$ZnSO_4$ @ 0.5%; T_4-$FeSO_4$ @ 0.5%; T_5-ZnO NPs @ 30 ppm; T_6-FeO NPs @ 30 ppm

weight, fruit length, fruit breadth, pulp weight and seed weight [7]. Significantly higher number of seeds per fruit was recorded in T6: FeO NPs @ 30ppm in both the years . Active role of these micronutrients in metabolic processes of plants and photosynthesis and thus, tended to increase flowering, and grain formation which plant biomass (14%) and consequently increasing in seed yield (34%) when compared to the normal treatment. Significantly higher 1000 seed weight (g) was recorded in T6: FeO NPs @ 30 ppm for the year 2020-21 (3.16 g) and 2021-22 (3.36 g), respectively. The micronutrients might have enhancing role in seed setting that resulted in the improvement of seed recovery. Significant variations were observed for 100-seed weight (g) of control and treated plants. Greater mobilization of photosynthates to the developing seeds by application of micronutrients could result in increase in seed weight. Significantly higher seed yield (g) per plant was recorded by foliar spray with FeO NPs @ 30 ppm for the year 2020-21 (13.18 g) and 2021-22 (15.57 g), respectively. Increase in seed yield may be due to higher fruit set, number of fruits per plant, and number of seeds per fruit. The results of present investigation are in agreement with earlier findings in tomato [8] and in brinjal [9]. Foliar spray with T2: Boric acid @ 0.2% recorded significantly higher seed germinaion (%), which was much above the Indian Minimum Seed Certification Standard during the year 2020-21 (97.25%), 2021-22 (98.50%) respectively. These results are in agreement with the previous findings [10]. Foliar spray with Boric acid @ 0.2% also recorded significantly higher seedling length (cm) during the year 2020-21 (10.65 cm), 2021-22 (11.45 cm) respectively. Effective mobilization of the available food reserves in the seeds resulted in the early emergence and growth of the seedlings. Similar trend was seen in seedling dry weight as well. These in turn were reflected on enhanced seed germination, elongation of root and shoot of tomato seedlings and Vigour Index. Field emergence and dry weight of seedlings were increased due to better seed quality of heavier and bigger sized seeds. As a result of

higher germination and seedling growth, significantly higher SVI-I and SVI-II were recorded with foliar spray of Boric acid @ 0.2% in both the years. On the basis of the field and laboratory experiments, it was summarized that among the different treatments foliar application of FeO NPs @ 30 ppm was best for getting higher seed yield. Whereas, foliar application with Boric acid @ 0.2% showed the best performance in seed germination and other quality parameters.

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