Effect of foliar application of micronutrients on growth, yield and quality of tomato (*Solanum lycopersicum* L.) cv. Arka Samrat.

ABSTRACT

The was carried out on effect of foliar application of micronutrients on growth, yield and quality of tomato (*Solanum lycopersicum* L.) cv. Arka Samrat at the Department of Horticulture, Naini Agricultural Institute, Sam Higginbottom University of Agriculture Technology and Sciences, Prayagraj, Uttar Pradesh during the *Rabi*-2021-22 with a view to determine the effect of foliar application of micronutrients on tomato variety 'Arka Samrat' for its growth, quality and yield and to work out the economics of various treatments. Under this experiment, overall 8 treatment was taken T_1 Control (water spray), T_2 $FeSO_4$ @ 0.2% spray, T_3 $Ca(NO_3)_2$ @ 0.2% spray, T_4 H_3BO_3@0.1% spray, T_5 $ZnSO_4$ @ 0.2% spray, T_6 $FeSO_4$ @ 0.2% + $Ca(NO_3)_2$ @ 0.2% + H_3BO_3 @ 0.1% + $ZnSO_4$ @ 0.2% spray, T_7 $Ca(NO_3)_2$ @ 0.2% + $ZnSO_4$ @ 0.2% spray, T_8 $Ca(NO_3)_2$ @ 0.2% + H_3BO_3@0.1% spray. From the above experimental finding it may be concluded that, the treatment T_6 ($FeSO_4$ @ 0.2% + $(CaNO_3)_{-2}$ @ 0.2%+ H_3BO_3 @ 0.1% + $ZnSO_4$ @ 0.2%) was found to be the best in terms of growth Yield and quality of tomato. While, the maximum Plant height (167.85 cm), highest number of leaves per plant(204.33), Minimum Days to 50% flowering(37.33 DAS),Maximum number of flower per cluster(5.12), Maximum No. of fruit per plant(60.33) and maximum Fruit set per cluster(5.06), Maximum fruit weight(94.22g), Maximum average yield per plant(5.68kg), Maximum average yield per plot(34.10), Maximum average yield per hectare(189.43t/ha),Maximum Total soluble solid(5.23),Maximum Ascorbic Acid(26.11).

Keywords: Foliar application, micronutrients, H_3BO_3.

Introduction

Tomato, botanically known as *Solanum lycopersicum* L. or *Lycopersicon esculentum* Mill. is one of the most popular and widely grown vegetable crops throughout the world and treated as "protective food" universally. It is rich source of vitamins, vegetable protein and minerals and holds a glorious position among vegetable after the potato and sweet potato. Tomato known as poor man's apple (orange) in India & love of apple in England. Tomato is used as soup, salad, pickles, ketchup, puree, sauces, tomato paste, tomato juice and other products. The pulp and juice of tomato fruit are digestible and a mild aperients, a promoter of gastric secretion and a blood purifier.

Tomatoes are horticulture crop belongs to the family *Solanaceae* bearing chromosome number 2n=2X=24 (**Karpechenko, 1925**). It originated from South America (**Vavilov, 1935**). The tomato plants typically grow to 1–3 meters (3–10 ft) in height and have a weak stem that often sprawls over the ground and vines over other plants. Flowers are generally borne in clusters of 4 to 8 but small fruited types may have 30 to 50 flowers per cluster. Tomato plants are dicots, and grow as a series of branching stems, with a terminal bud at the tip that does the actual growing. Tomato plays a major role in human nutrition, fruit contain 93.1% water, 1.9% protein, 0.3 g fat, 0.7% fibre, 3.6%carbohydrates, 23 calorie, 320 I.U vitamin A., 0.07 mg vitamin B1, 0.01 mg vitamin B2, 31 mg vitamin C, 20 mg calcium, 36 mg phosphorus and 0.8 mg iron. Tomato has valuable vitamins and cholesterol. Approximately 20–50 mg of lycopene per 100g of fruit weight can be obtained from tomato. Tomato is a warm season crop. The best fruit colour and quality is obtained at a temperature range of 21-24°C. Tomato is one of the versatile crop in the world because of its fast and wide climate adaption and it is universally treated as protective food. Tomato contribute to a healthy, well balanced diet. They are rich in minerals, vitamins, essential amino acids, sugars, dietary fibres and it has many other uses tomato seed contain 24% of oil is used as salad oil and in the manufacture of margarine.

India ranks second in Tomato production producing 30.26% of world's Tomato production first being China and is followed by Turkey ranking third in world. (FAOSTAT, 2020). The area under Tomato production in India accounts to 46.72 thousand ha with production of 34.29 million tonnes in year 2019-20. Andhra Pradesh ranks first in area and production of Tomato in year 2019-20 followed by Madhya Pradesh and Karnataka. In Uttar Pradesh area under production is 0.20 lakhs hectares while production is estimated to be 5.29 million tonnes for year 2019-20. (Source: NHB, Ministry of Agriculture & Farmers Welfare, Government of India, 2020-21).

Role of Fertilizer and Micronutrients on crop plants

High productive ability of tomato puts tremendous pressure on soil for removal of nutrients. As such liberal application of nutrients is need to meet the nutritional requirements of the corps, however, wake of energy crisis, harmful effect on soil health and ever increasing prices of chemical fertilizer becomes problem before the producers. Therefore, a dire need have been felt to apply fertilizers in more and more amount to fulfil the requirements of crop as well as to nourish the health and fertility status of soil, but

should be applied in appropriate doses to reduce imparity of soil.

Tomato is one of the most important crop and it has a rich economic importance. Micronutrients promote to produce higher yield and increase harvest quality, maximizing a plant genetic potential and the presence of micronutrients impact on root development, fruit setting, plant vigour and health. Micronutrients are fundamental for balanced nutrition and a tremendous tool to help farmers in increasing crop yield and quality. This experiment was conducted to help in understanding the **"Effect of foliar application of micronutrients on growth, yield and quality of tomato (*Solanum lycopersicum* L.) cv. Arka Samrat.**

Materials and Methods

The area of Prayagraj district comes under subtropical belt in the south east of Utter Pradesh, which experience extremely hot summer and fairly cold winter. The maximum temperature of the location reaches up to 46^{o} C-48^{o} C and seldom falls as low as 4^{o}C- 5^{o}C. The relative humidity ranges between 20 to 94 %. The average rainfall in this area is around 1013.4 mm annually. However, occasional precipitation is also not uncommon during winter months.

The experiment was conducted in Randomized Block Design with 8 treatment replicated thrice. The treatments were T_0 Control (water spray), T_1 $FeSO_4$ @ 0.2% spray, T_2 $Ca(NO_3)_2$ @ 0.2% spray, T_3 H_3BO_3@0.1% spray, T_4 $ZnSO_4$ @ 0.2% spray, T_5 $FeSO_4$ @ 0.2% + $Ca(NO_3)_2$ @ 0.2% + H_3BO_3 @ 0.1% + $ZnSO_4$ @ 0.2% spray, T_6 $Ca(NO_3)_2$ @ 0.2% + $ZnSO_4$ @ 0.2% spray, T_7 $Ca(NO_3)_2$ @ 0.2% + H_3BO_3@0.1% spray.

Result

Plant height at 30 DAT

The height of plant significantly varied among different treatment combinations. The maximum plant height (41.98 cm) at 30 DAT was observed with treatment T_6 (Feso4 @ 0.2% + $(CaNO_3)_{-2}$ @ 0.2%+ H_3BO_3 @ 0.1% + Znso4 @ 0.2%) followed by T_8 (Calcium nitrate @ 0.2% + H_3BO_3@0.1%) with 37.73 cm. Minimum plant height (28.15 cm) was observed in T_1 (control), while the remaining treatments are moderate in their growth habit.

Plant height at 60 DAT

The height of plant significantly varied among different treatment combinations. The maximum plant height (91.32 cm) at 60 DAT was observed with treatment T_6 (Feso4 @ 0.2% + $(CaNO_3)_{-2}$ @ 0.2%+ H_3BO_3 @ 0.1% + Znso4 @ 0.2%) followed by T_8 ($Ca(NO_3)_2$ @ 0.2% + H_3BO_3@0.1%) with 86.96 cm. Minimum plant height (77.68 cm) was observed in T_1 (control), while the remaining treatments are moderate in their growth habit.

Plant height at 90 DAT

The height of plant significantly varied among different treatment combinations. The maximum plant height (167.85 cm) at 90 DAT was observed with treatment T_6 (Feso4 @ 0.2% + $(CaNO_3)_{-2}$ @ 0.2%+ H_3BO_3 @ 0.1% + Znso4 @ 0.2%) followed by T_8 ($Ca(NO_3)_2$ @ 0.2% + H_3BO_3@0.1%) with 155.41 cm. Minimum plant height (141.11 cm) was observed in T_1 (control), while the remaining treatments are moderate in their growth habit.

Number of leaves per plant at 30 DAT

It is evident that the Number of leaves per plant was influenced by different treatments at all successive stage of growth. There was significant difference between the

treatments at 30 days after planting among the treatments applied, T_6 (Feso4 @ 0.2% + $(CaNO_3)_{-2}$ @ 0.2%+ H_3BO_3 @ 0.1% + Znso4 @ 0.2%) with 96.33 increase significantly better Number of leaves per plant followed by T_8 ($Ca(NO_3)_2$ @ 0.2% + H_3BO_3@0.1%) with 91.67 whereas the minimum score was observed in treatment T_1 (Control) with 76.67.

Number of leaves per plant at 60 DAT

It is evident that the Number of leaves per plant was influenced by different treatments at all successive stage of growth. There was significant difference between the treatments at 60 days after planting among the treatments applied, T_6 (Feso4 @ 0.2% + $(CaNO_3)_{-2}$ @ 0.2%+ H_3BO_3 @ 0.1% + ZnSO4 @ 0.2%) with 144.67 increase significantly better Number of leaves per plant followed by T_8 (Calcium nitrate @ 0.2% + H_3BO_3@0.1%) with 136.67 whereas the minimum score was observed in treatment T_1 (Control) with 129.33.

Number of leaves per plant at 90 DAT

It is evident that the Number of leaves per plant was influenced by different treatments at all successive stage of growth. There was significant difference between the treatments at 90 days after planting among the treatments applied, T_6 (Feso4 @ 0.2% + $(CaNO_3)_{-2}$ @ 0.2%+ H_3BO_3 @ 0.1% + Znso4 @ 0.2%) with 204.33 increase significantly better Number of leaves per plant followed by T_8 ($Ca(NO_3)_2$ @ 0.2% + H_3BO_3@0.1%) with 200.67 whereas the minimum score was observed in treatment T_1 (Control) with (192.67).

The minimum Days to 50% flowering T_6 ($FeSO_4$ @ 0.2% + $(CaNO_3)_{-2}$ @ 0.2%+ H_3BO_3 @ 0.1% + $ZnSO_4$ @ 0.2%) with 37.33 days, followed by T_8 ($Ca(NO_3)_2$ @ 0.2% + H_3BO_3 @0.1%) with 38.33 days whereas maximum Days to 50% flowering 44.67 days was recorded in control.

At harvest time maximum number of flower per cluster 5.12 was recorded in T_6 (Fe SO_4 @ 0.2% + $(CaNO_3)_{-2}$ @ 0.2%+ H_3BO_3 @ 0.1% + Zn SO_4 @ 0.2%) followed by 4.84 T_8 ($Ca(NO_3)_2$ @ 0.2% + H_3BO_3@0.1%) whereas minimum fruits per cluster 3.92 were found in T_1 (control).

The maximum number of fruits per plants (60.33) were recorded in treatment T_6 (Fe SO_4 @ 0.2% + $(CaNO_3)_{-2}$ @ 0.2%+ H_3BO_3 @ 0.1% + Zn SO_4 @ 0.2%) followed by T_8 ($Ca(NO_3)_2$ @ 0.2% + H_3BO_3@0.1%) i.e., 57.67 and the lowest number of fruit per plant (50.33) were observed in T_1 (Control).

The maximum number of fruits per plants (5.06) were recorded in treatment T_6 (Fe SO_4 @ 0.2% + $(CaNO_3)_{-2}$ @ 0.2%+ H_3BO_3 @ 0.1% + Zn SO_4 @ 0.2%) followed by T_8 ($Ca(NO_3)_2$ @ 0.2% + H_3BO_3@0.1%) i.e., 4.61 and the lowest fruit set per cluster (3.90) were observed in T_1 (Control).

The maximum fruits weight (94.22g) were recorded in treatment T_6 (Fe SO_4 @ 0.2% + $(CaNO_3)_{-2}$ @ 0.2%+ H_3BO_3 @ 0.1% + Zn SO_4 @ 0.2%) followed by T_8 ($Ca(NO_3)_2$ @ 0.2% + H_3BO_3@0.1%) i.e., 87.94g and the lowest fruits weight (64.74g) were observed in T_1 (Control).

The maximum average yield per plant (5.68 kg) were recorded in treatment T_6 (Fe SO_4 @ 0.2% + $(CaNO_3)_{-2}$ @ 0.2%+ H_3BO_3 @ 0.1% + Zn SO_4 @ 0.2%) followed by T_8 ($Ca(NO_3)_2$ @ 0.2% + H_3BO_3@0.1%) i.e., 5.07 kg and the lowest average yield per plant (3.26 kg) were observed in T_1 (Control).

The maximum average yield per plot (34.10 kg/plot) were recorded in treatment T_6 (Fe SO_4 @ 0.2% + $(CaNO_3)_{-2}$ @ 0.2%+ H_3BO_3 @ 0.1% + Zn SO_4 @ 0.2%) followed by T_8 ($Ca(NO_3)_2$ @ 0.2% + H_3BO_3@0.1%) i.e., 30.42 kg/plot and the lowest average yield per plot (19.55 kg/plot) were observed in T_1 (Control).

The maximum average yield per hectare (189.43 t/ha) were recorded in treatment T_6 (Fe SO_4 @ 0.2% + $(CaNO_3)_{-2}$ @ 0.2%+ H_3BO_3 @ 0.1% + Zn SO_4 @ 0.2%) followed by T_8 (Calcium nitrate @ 0.2% + H_3BO_3@0.1%) i.e., 169.01 t/ha and the lowest average yield per hectare (108.63 t/ha) were observed in T_1 (Control)

The maximum TSS (5.23 ^{0}Brix) was observed in treatment T_6 (Fe SO_4 @ 0.2% + $(CaNO_3)_{-2}$ @ 0.2%+ H_3BO_3 @ 0.1% + Zn SO_4 @ 0.2%) followed by T_8 ($Ca(NO_3)_2$ @ 0.2% + H_3BO_3@0.1%) with 4.80 ^{0}Brix respectively. The minimum TSS (3.83 ^{0}Brix) was noticed in treatment T_1 (Control).

The maximum Ascorbic acid (mg/100g) (26.11mg) was observed in treatment T_6 (Fe SO_4 @ 0.2% + $(CaNO_3)_{-2}$ @ 0.2%+ H_3BO_3 @ 0.1% + Zn SO_4 @ 0.2%) followed by T_8 (Calcium nitrate @ 0.2% + H_3BO_3@0.1%) with 24.30mg respectively. The minimum Ascorbic acid (17.38mg) was noticed in treatment T_1 (Control).

Conclusion

Best on the experimental finding of the study it is therefore, concluded that, the treatment T_6 (Fe SO_4 @ 0.2% + $(CaNO_3)_{-2}$ @ 0.2%+ H_3BO_3 @ 0.1% + $ZnSO_4$ @ 0.2%) was found to be best in the terms of growth Yield and quality of tomato. While, maximum Plant height , highest number of leaves per plant, Minimum Days to 50% flowering ,Maximum number of flower per cluster, Maximum No. of fruit per plant and maximum Fruit set per cluster, Maximum fruit weight, Maximum average yield per plant, Maximum average yield per plot, Maximum average yield per hectare, Maximum Total soluble solid, Maximum Ascorbic Acid.

Discussion

The foliar application of micronutrients might have improved the soil physical and chemical properties and leading to the adequate supply of nutrients to the plants which might have promoted the maximum vegetative growth while the minimum plant growth was due to non-availability of nutrients. Similar findings were reported by Sivaiah *et al.* (2013); Meena *et al.* (2015); Kumar*et al.* (2016); Singh *et al.* (2018) and Swetha *et al.* (2018) in tomato.

Integration of organic fertilizers and biofertilizers favoured vigorous growth and synthesized more cytokinins in plants, which might have helped to the translocation of cytokinins as well as more quantity of available phosphorus through the xylem vessels and their accumulation in the axillary buds that would have favoured the plant to enter into reproductive phase (Dange *et al*., 2002). Similar results have also been reported by**Singh and Tiwari (2013)**, **Dixit *et al.* (2018)** and**Singh *et al*., (2018).**

Table 1:- Effect of foliar application of micronutrients based on plant height , Number of leaves per plant, Days to 50 % flowering , Number of flowers per cluster, Number of fruit per plant.

Notation	Treatment	Plant height			No. of leaves per plant			Days to 50 % flowering	Number of flowers per cluster	Number of fruit per plant
		30 DAT	60 DAT	90 DAT	30 DAT	60 DAT	90 DAT			
T1	Control	28.15	77.68	141.11	76.67	129.33	192.67	44.67	3.92	50.33
T2	FeSO4 @ 0.2%	29.80	78.99	145.17	80.67	130.33	194.33	43.67	4.39	51.67
T3	Ca(NO3) 2 @ 0.2%	31.54	81.75	145.51	83.00	130.67	195.00	42.33	4.33	53.33
T4	H3BO3@ 0.1%	33.25	83.43	150.03	85.33	132.33	197.00	40.00	4.56	54.67
T5	ZnSO4 @ 0.2%	34.54	85.66	151.72	87.00	132.33	197.33	39.33	4.39	55.67
T6	Feso4 @ 0.2% + (CaNO3)2 @ 0.2%+ H3BO3 @ 0.1% + Znso4 @ 0.2%)	41.98	91.32	167.85	96.33	144.67	204.33	37.33	5.12	60.33
T7	CaNO3@ 0.2% + ZnSO4@0.2%	35.70	86.89	153.97	89.67	133.33	199.00	39.00	4.84	54.00
T8	CaNO3@ 0.2% + H3BO3@0.1%	37.73	86.96	155.41	91.67	136.67	200.67	38.33	4.55	57.67
	'F' test	S	S	S	S	S	S	S	S	S
	C.V.	1.50	0.45	0.95	1.82	2.09	0.70	3.15	5.40	2.09
	C.D. at 5%	0.90	0.67	2.54	2.77	4.95	2.44	2.26	0.43	2.02
	SE.d(□)	0.42	0.31	1.18	1.28	2.29	1.13	1.05	0.20	0.93

Table 2:- Effect of foliar application of micronutrients based on fruit set per cluster, Average fruit weight, Average yield per plant, Average yield per hectare, Total soluble solid, Ascorbic Acid.

Notation	Treatment	Fruit set per cluster	Average fruit (g)weight	Average Yield kg/per plant	Average Yield kg/per plot	Average Yield per t/hectare	Total soluble solid	Ascorbic Acid
T1	Control	3.90	64.74	3.26	19.55	108.63	3.83	17.38
T2	FeSO4 @ 0.2%	4.17	71.26	3.68	22.09	122.71	4.20	18.29
T3	Ca(NO3) 2 @ 0.2%	4.30	75.57	4.03	24.18	134.34	4.25	19.27
T4	H3BO3@ 0.1%	4.44	78.17	4.27	25.64	142.43	4.28	21.28
T5	ZnSO4 @ 0.2%	4.33	83.25	4.64	27.80	154.47	4.44	22.23
T6	Feso4 @ 0.2% + (CaNO3)2 @ 0.2%+ H3BO3 @ 0.1% + Znso4 @ 0.2%)	5.06	94.22	5.68	34.10	189.43	5.23	26.11
T7	CaNO3@ 0.2% + ZnSO4@0.2%	4.44	85.80	4.63	27.80	154.44	4.78	24.21
T8	CaNO3@ 0.2% + H3BO3@0.1%	4.61	87.94	5.07	30.42	169.01	4.80	24.30
	'F' test	S	S	S	S	S	S	S
	C.V.	4.09	0.81	1.76	1.80	1.79	3.30	1.95
	C.D. at 5%	0.32	1.14	0.14	0.84	4.66	0.26	0.74
	SE.d(□)	0.15	0.53	0.06	0.39	2.15	0.12	0.34

Nutrients play an important role in improving productivity and quality of Tomato. Added dose of nitrogen, phosphorus and other essential nutrients increased the vigor of plants, assimilating area, size of fruit, thereby resulting into higher weight of fruit. These results are in close conformity with the findings of Ali *et al.* (2015); Haleema *et al.* (2017); Satyamurthy *et al.* (2017); Pandiyan *et al.* (2018); Singh *et al.* (2018) andShnain *et al.* (2021)as reported in tomato.

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