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Effect of foliar application of micronutrients and gibberellic acid on growth, yield attributes and yield of Tomato (Solanum lycopersicum L.) cv. PANT T-3

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ABSTRACT
A field experiment was conducted to study the effect of foliar application of micronutrients and gibberellic acid on growth, yield attributes and yield of tomato (Solanum lycopersicum L.) cv. PANT T-3 at the farm of College of Agriculture and Research Station, Kurud (C.G.) during rabi season of 2021-22. The experiment was carried out under randomized block design (RBD) with three replicates and nine treatments viz., T_1(Boron @ 100ppm), T_2(Copper Sulphate @ 100ppm), T_3 (Zinc Sulphate @ 100ppm), T_4 (GA_3 @ 75ppm), T_5 (Boron @ 100ppm + Copper Sulphate @ 100ppm + Zinc Sulphate @ 100ppm + GA_3 @ 75ppm), T_6 (Boron @ 100ppm + Copper Sulphate @ 100ppm), T_7 (Boron @ 100ppm + Zinc Sulphate @ 100ppm), T_8 (Boron @ 100ppm + GA_3 @ 75ppm) and T_9 (Control). Among all the treatments data clearly showed that the maximum growth, yield attributes and yield i.e., plant height (116.45 cm), number of branches per plant (5.33), stem girth (3.33 cm), number of fruits per plant (39.87), fruit diameter (4.83 cm), fruit length (4.44 cm), average fruit weight (53.53 g), yield per plant (2.11 kg), yield per plot (25.36 kg) and yield per hectare (782.71 q) was found in T_5 as compared to T_9 (Control). Therefore, combined effect of Boron @ 100ppm, Copper Sulphate @ 100ppm, Zinc Sulphate @ 100ppm and GA_3 @ 75ppm is suitable for higher growth and yield in tomato.

Keywords: Growth, yield attributes, gibberellic acid, tomato, Pant T-3 and micronutrients

I. INTRODUCTION

Tomato (Solanum lycopersicum L.) is also called Poor man's Orange, Love of Apple, Vilayati Baigan, Wolf Apple. The tomato is an annual herbaceous plant belonging to the family Solanaceae and originated in South America having chromosome number 2n=24. It is a tropical day neutral crop with significant self-pollination due to homomorphism and chasmogamy. Tomato fruits can be consumed raw or cooked. Single tomato can offer 40 % of the daily Vitamin C requirement which is a natural anti-oxidant. Tomatoes play a major role in blood clotting because they are rich in Vitamin-K. In India, all vegetables are grown on an area of 10,352.88 thousand hectare with an annual production of 1,91,769.11 thousand MT. Tomato is grown on an area of 812 thousand hectares with an annual production of 20,573 thousand MT and productivity 25.33 tons/ha (Anonymous, 2020). Boron is an essential micronutrient that plays a role in carbohydrate metabolism, cell division, cell wall formation, flowering, and fruit set. Zinc plays an important role in the growth and development as well as sexual fertilization, carbohydrates and protein metabolism of plants (Imtiaz et al., 2003; Vasconcelos et al., 2011). Copper is a component of several enzymes as well as vitamin A. Copper is a vital micronutrient for plant growth and development and is detrimental to photosynthetic membranes (Maksymiec, 1997). GA_3 promotes shoot growth by increasing the length of internodes by accelerating cell elongation and division in the subapical meristematic zone.

II. MATERIALS AND METHODS

The research study was conducted at College of Agriculture and Research Station, Kurud (C.G.) during rabi season of 2021-22. After 30 days of sowing seedlings of uniform size, age, free from insect pest and disease infestation were transplanted in sowing plots with row to row and plant to plant distance of 60 and 45 cm apart, respectively. Farm yard manure @ 20 t ha^{-1} was applied during the final ploughing and well mixed in the soil. The recommended fertilizer dose of 125 kg N, 75 kg P_2O_5 and 60 kg K_2O per ha was applied in the form of the urea, SSP and MoP,

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respectively. The experiment was carried out under randomized block design (RBD) with three replicates and nine treatments viz., T_1(Boron @ 100ppm) ,T_2(Copper Sulphate @ 100ppm), T_3 (Zinc Sulphate @ 100ppm), T_4 (GA_3 @ 75ppm), T_5 (Boron @ 100ppm + Copper Sulphate @ 100ppm + Zinc Sulphate @ 100ppm + GA_3 @ 75ppm), T_6 (Boron @ 100ppm + Copper Sulphate @ 100ppm), T_7 (Boron @ 100ppm + Zinc Sulphate @ 100ppm), T_8 (Boron @ 100ppm + GA_3 @ 75ppm) and T_9 (Control). The data collected from five randomly selected plants for above said parameters were subjected to analysis of variance technique (ANOVA) and least significance difference test was applied to separate different treatment means (Panse and Sukhatme, 1967).

The important parameters encompassed in the study were plant height (cm), number of branches per plant, stem girth (cm), number of fruits per plant, fruit diameter (cm), fruit length (cm), average fruit weight (g), yield per plant (kg), yield per plot (kg) and yield per hectare (q).

III. RESULTS AND DISCUSSION

Data pertaining to growth, yield attributes and yield influenced by various treatments has been given in Table 1, 2, 3.

Significantly maximum plant height 116.45 cm was recorded in T_5 (Boron @ 100ppm + Copper Sulphate @ 100ppm + Zinc Sulphate @ 100ppm + GA_3 @ 75ppm), followed by 109.32 cm in T_8 (Boron @ 100ppm + GA_3 @ 75ppm) and 104.56 cm in T_7 (Boron @ 100ppm + Zinc Sulphate @ 100ppm). Whereas, minimum plant height 80.18 cm was recorded in T_9 (Control). In earlier studies, Sivaiah et al. (2012) found that combined application of micronutrients produced the maximum plant height and Jakhar et al. (2018) reported that plant sprayed with GA_3 found superior in all growth parameters such as plant height.

Significantly maximum number of branches 5.33 was found in T_5 (Boron @ 100ppm + Copper Sulphate @ 100ppm + Zinc Sulphate @ 100ppm + GA_3 @ 75ppm) followed by 5.27 in T_8 (Boron @ 100ppm + GA_3 @ 75ppm) and 5.07 in T_7 (Boron @ 100ppm + Zinc Sulphate @ 100ppm). While, lowest number of branches 3.60 per plant was observed in T_9 (Control). In earlier studies, Jakhar et al. (2018) reported the maximum number of branches per plant was found in GA_3 sprayed plants and Saravaiya et al. (2014) found the similar results by foliar application of the mixture of all micronutrients.

The spraying of different micronutrients and gibberellic acid showed singnificantly positive response in plant girth. Maximum plant girth 3.33 cm was observed in T_5 (Boron @ 100ppm + Copper Sulphate @ 100ppm + Zinc Sulphate @ 100ppm + GA_3 @ 75ppm) which found to be superior than all other treatments followed by 3.23 cm in T_8 (Boron @ 100ppm + GA_3 @ 75ppm) and 3.19 cm in T_7 (Boron @ 100ppm + Zinc Sulphate @ 100ppm). Minimum plant girth 2.25 cm was recorded in T_9 (Control). In earlier studies Dixit et al. (2018) reported that spray of mixture of micronutrients resulted in maximum plant girth.

The result revealed that the minimum days to first flowering 29.67 was recorded in T_5 (Boron @ 100ppm + Copper Sulphate @ 100ppm + Zinc Sulphate @ 100ppm + GA_3 @ 75ppm), which was significantly superior over other treatments, followed by 30.33 days in T_8 (Boron @ 100ppm + GA_3 @ 75ppm) and 31.00 days in T_4 (GA_3 @ 75ppm). While, maximum number of days to first flowering 35.67 days was observed in T_9 (Control).

Significantly earliest 50% flowering 33.67 days has been observed from treatment T_5 (Boron @ 100ppm + Copper Sulphate @ 100ppm + Zinc Sulphate @ 100ppm + GA_3 @ 75ppm), followed by 34.00 days in T_8 (Boron @ 100ppm + GA_3 @ 75ppm) and 34.67 days in T_4 (GA_3 @ 75ppm).While, maximum number of days to 50% flowering 39.67 days was shown by T_9 (Control). Due to the rapid increase in the physiological process, there may be a greater accumulation of carbohydrates, owing to greater photosynthesis which caused early flowering reported by Wittwer et al. (1957).

Significantly minimum days to first fruiting 36.67 days was recorded in T_5 (Boron @ 100ppm + Copper Sulphate @ 100ppm + Zinc Sulphate @ 100ppm + GA_3 @ 75ppm), which was significantly superior over other treatments followed by 37.33 days in T_8 (Boron @ 100ppm + GA_3 @ 75ppm) and 38.33 days in T_4 (GA_3 @ 75ppm). While maximum days to first fruiting 44.67 days were observed in T_9 (Control). Singh et al. (2021) also reported that application of GA3 @ 100ppm resulted in early days to first fruit set.

Significantly minimum days to maturity 60.67 days was recorded in T_5 (Boron @ 100ppm + Copper Sulphate @ 100ppm + Zinc Sulphate @ 100ppm + GA_3 @ 75ppm), followed by 61.67 days in T_8 (Boron @ 100ppm + GA_3 @ 75ppm) and 62.33 days in T_7 (Boron @ 100ppm + Zinc Sulphate @ 100ppm).Whereas, maximum number of days to maturity 73.33 days recorded in T_9 (Control). Similar results for micronutrients

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application were found by Naz et al. (2012) and Ali et al. (2013) in tomato.

The data showed significantly maximum number of fruits 39.87 per plant was found in T_5 (Boron @ 100ppm + Copper Sulphate @ 100ppm + Zinc Sulphate @ 100ppm + GA_3 @ 75ppm) was significantly superior over other treatments followed by 38.80 in T_8 (Boron @ 100ppm + GA_3 @ 75ppm) and 37.53 in T_4 (GA_3 @ 75ppm). The lowest number of fruits 28.27 per plant was observed in T_9 (Control). Uddain et al. (2009) in tomato found that application of gibberellic acid resulted in maximum number of fruits plant^{-1}

Among all the treatments, maximum fruit length 4.44 cm was observed in the treatment T_5 (Boron @ 100ppm + Copper Sulphate @ 100ppm + Zinc Sulphate @ 100ppm + GA_3 @ 75ppm), which was significantly superior over other treatments followed by 4.27 cm T_8 (Boron @ 100ppm + GA_3 @ 75ppm) and 4.30 cm T_7 (Boron @ 100ppm + Zinc Sulphate @ 100ppm). While, the minimum fruit length 3.34 cm was recorded in the T_9 (Control). Saravaiya et al. (2014) found that application of application of the mxture of all micronutrients resulted in maximum fruit length similar result was found by Desai et al. (2012) by applying gibberellic acid.

Among all the treatments, maximum fruit diameter 4.83 cm was found in T_5 (Boron @ 100ppm + Copper Sulphate @ 100ppm + Zinc Sulphate @ 100ppm + GA_3 @ 75ppm), which was significantly superior over other treatments followed by 4.76 cm in T_8 (Boron @ 100ppm + GA_3 @ 75ppm) and 4.72 cm in T_4 (GA_3 @ 75ppm). Whereas, minimum fruit diameter 3.64 cm was recorded in the treatment T_9 (Control). Desai et al. (2012) in tomato found that gibberellic acid application resulted in maximum fruit diameter and similarly Dixit et al. (2018) also found the similar result by application of mixture of micronutrients.

The maximum average fruit weight 53.53 g was recorded in treatment T_5 (Boron @ 100ppm + Copper Sulphate @ 100ppm + Zinc Sulphate @ 100ppm + GA_3 @ 75ppm), which was significantly superior over other treatments followed by 52.27 g in T_8-Boron @ 100ppm + GA_3 @ 75ppm) and 51.37 g in T_4 (GA_3 @ 75ppm). Whereas, minimum fruit weight 39.87 g was observed in the treatment T_9 (Control). Saravaiya et al. (2014) and Dixit et al. (2018) reported that the application of mixture of micronutrients increased the average fruit weight similarly Singh et al. (2021) also reported that application of gibberellic acid increased the fruit weight.

Maximum fruit yield 2.11 kg per plant was recorded in the treatment T_5 (Boron @ 100ppm + Copper Sulphate @ 100ppm + Zinc Sulphate @ 100ppm + GA_3 @ 75ppm), which was significantly superior over the other treatments followed by 2.01 kg T_8 (Boron @ 100ppm + GA_3 @ 75ppm) and 1.92 kg T_4 (GA_3 @ 75ppm). Whereas, the minimum fruit yield 1.17 kg per plant was found in treatment T_9 (Control). Sivaiah et al. (2013) and Saravaiya et al. (2014) reported that mixture of micronutrients increased the fruit yield similarly application of gibberellic acid increased the fruit yield reported by Singh et al. (2021).

Maximum fruit yield 25.36 kg per plot was recorded in the treatment T_5 (Boron @ 100ppm + Copper Sulphate @ 100ppm + Zinc Sulphate @ 100ppm + GA_3 @ 75ppm), which was significantly superior over the other treatments followed by 24.12 kg in T_8 (Boron @ 100ppm + GA_3 @ 75ppm) and 23.05 kg T_4 (GA_3 @ 75ppm). Whereas, the lowest fruit yield 14.04 kg per plot was found in treatment T_9 (Control).

Maximum fruit yield 782 q per hectare was recorded in the treatment T_5 (Boron @ 100ppm + Copper Sulphate @ 100ppm + Zinc Sulphate @ 100ppm + GA_3 @ 75ppm), which was significantly superior over the other treatments followed by 744.44 q in T_8 (Boron @ 100ppm + GA_3 @ 75ppm) and 711.31 q T_4 (GA_3 @ 75ppm). Whereas, the lowest fruit yield 433.33 q per plot was found in treatment T_9 (Control).

Table 1: Effect of micronutrients and gibberellic acid on mean performance of growth traits of tomato

Treatment	Plant height (cm)	Number of branches	Plant girth (cm)	Days to first flowering	Days to 50% flowering	Days to first fruiting	Days to maturity
T_1	94.49	4.53	2.72	33.33	37.00	41.33	66.00

International Journal of Pharmaceutical Research and Applications
Volume 7, Issue 4 July-Aug 2022, pp: 708-713 www.ijprajournal.com ISSN: 2456-4494

T_2	90.66	4.13	2.46	34.33	38.33	42.33	67.33
T_3	92.36	4.27	2.77	33.67	37.67	41.67	66.67
T_4	101.12	4.67	2.84	31.00	35	38.33	63.67
T_5	116.45	5.33	3.33	29.67	33.67	36.67	60.33
T_6	98.01	4.33	3.13	32.67	36.67	40.67	64.33
T_7	104.56	5.07	3.19	32.00	35.67	39.67	62.33
T_8	109.32	5.27	3.23	30.33	34.00	37.33	61.67
T_9	80.18	3.6	2.25	35.67	39.67	44.67	73.33
Mean	98.57	4.57	2.88	32.51	36.41	40.29	65.07
CV (%)	8.13	10.16	7.11	6.44	5.86	6.83	6.38
CD (0.05)	13.88	0.8	0.35	3.62	3.69	4.76	7.19
SE(m±)	4.62	0.26	0.11	1.21	1.23	1.58	2.39

Table 2: Effect of micronutrients and gibberellic acid on mean performance of yield attributing traits and yield of tomato

Treatment	Number of fruits per plant	Fruit Length (cm)	Fruit Diameter (cm)	Average fruit weight (g)	Yield per plant (kg)	Yield per plot (kg)	Yield per hectare (q)
T_1	33.07	3.75	4.28	47.97	1.53	18.36	566.66
T_2	32.13	3.62	4.14	45.23	1.43	17.12	528.39
T_3	32.73	3.66	4.22	46.2	1.48	17.72	546.91
T_4	37.53	4.16	4.72	51.37	1.92	23.05	711.31
T_5	39.87	4.44	4.83	53.53	2.11	25.36	782.71
T_6	35.4	4.07	4.48	46.37	1.64	19.72	608.64
T_7	35.93	4.3	4.53	47.97	1.71	20.52	633.33
T_8	38.8	4.27	4.76	52.27	2.01	24.12	744.44

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T_9	28.27	3.34	3.64	39.83	1.17	14.04	433.33
Mean	34.85	3.95	4.4	47.85	1.66	20.01	617.31
CV (%)	8.26	7.21	7.1	8.36	11.09	11.15	11.15
CD (P=0.05)	4.98	0.49	0.54	6.92	0.32	3.86	119.13
SE(m±)	1.66	0.16	0.18	2.31	0.11	1.28	39.73

IV. CONCLUSION:

The growth, yield attributes and yield parameters i.e., plant height (cm), number of branches per plant, stem girth (cm), number of fruits per plant, fruit diameter (cm), fruit length (cm), average fruit weight (g), yield per plant (kg), yield per plot (kg) and yield per hectare (q) were significantly superior in T_5 (Boron @ 100ppm + Copper Sulphate @ 100ppm + Zinc Sulphate @ 100ppm + GA_3 @ 75ppm). On the basis of above findings, T_5 found to be the best treatment among all the treatments in first position and T_8 stand in second order of preference. Therefore, it may be concluded that treatments T_5 may be preferred for higher growth and yield in tomato.

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