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Effect of micronutrients and biofertilizers growth on yield and yield attributes character of tomato

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Abstract
The maximum number of flowers per cluster, number of fruits per cluster and percentage of fruit set was highest in T_7 (Mixture of all).T_{10} (Azotobacter + Azospirillum @ 1 kg/ha each as seedling treatment) recorded highest number of flowers per cluster and number of fruits per cluster. While percentage of fruit set did not vary significantly due to biofertilizers. Maximum fruit diameter, fruit length, fruit weight and number of fruits per plant were observed for T_7 (Mixture of all) amongst treatments of micronutrients. Maximum fruit diameter, fruit length, and fruit weight was highest in T_{10} (Azotobacter + Azospirillum @ 1 kg/ha each as seedling treatment) whereas number fruits per plant were higher in T_8 (Azotobacter @ 1 kg/ha as seedling treatment) amongst treatments of biofertilizers.T_7 (Mixture of all) recorded the highest yield per plant and yield q/ha followed by T_6 (Manganese sulphate (Mn) @ 100 ppm as foliar spray) and T_5 (Ferrus sulphate (Fe) @ 100 ppm as foliar spray). Yield per plant and yield q/ha did not vary significantly due to biofertilizers.

Keywords: Yield, yield attributes, biofrtilizers, micronutrients

Introduction
High yield is the ultimate goal in all crops with good qualities and tomato is no exception. Among the various yield increasing factor i.e. variety, time of planting, use of major and minor nutrient, the use of trace elements seems worthwhile to study in connection with tomato cultivation. The micronutrients play an important role as that of major nutrients for increasing production and quality of tomato. The production and productivity of tomato is being adversely affected in different areas due to deficiencies of micronutrients.

The deficiencies of trace elements i.e. zinc, manganese, iron, boron, molybdenum and copper may be prove to be limiting in production of tomato. The method of application of fertilizer is one of the basic factor for getting maximum yield potential. In recent advances in improved agriculture techniques, the foliar application of fertilizer plays a vital role in improving the quantity and quality of horticultural crops especially in tomato crop. Micronutrients are required in minute quantity for increasing growth, yield and quality of tomato, when micronutrients are applied in the field the required quantity of nutrients are utilized by the plants and remaining quantity is fixed in the soil. To over come this problem the foliar application of Micronutrients is one of the efficient method to provide the desired elements in standing crop. The method of foliar spray of Micronutrients is quick and efficient and required less time for assimilation. The foliar sprays are convenient and require less quantity of elements than that of soil application and cheapest method of fertilizer application Zenlorekuzi and Minami (1984) reported that foliar application of micronutrients (Cu, Mn and B) had advantageous effects than soil application.

Fertilizer application also plays a major role for harnessing optimum yields per unit area in tomato crop. At present, chemical fertilizers are in short supply and expensive too. Although these fertilizers contribute a lot in fulfilling the nutrient requirement of tomato but their regular, excessive and unbalanced use may lead to health and ecological hazards, deterioration of physico-chemical properties of the soil and ultimately poor crop yields. The problem of the nutrient drain from the soil is becoming so acute and is beyond the capacity of any single fertilizer to accept the challenge of appropriate nutrient supply. There is a need to enhance the yield without having adverse effects on soil properties. Hence, the present studies were undertaken to judge the effect of Azotobacter and Azospirillum on plant growth, yield and quality of tomato. Carrier based inoculants are used as seedling dipping in Azotobacter and Azospirillum.

Material and Method

The experiment was conducted to study the effect of Micronutrients and Biofertilizers on yield and yield attributes in Tomato (*Lycopersicon esculentum* Mill.) variety "JT-99" on farmers field of Panagar, Jabalpur (M.P.). During rabi season 2008-09 and 2009-10. Soil analysis was done to know the present status of micronutrients of the experimental area. The experiment was laid out in randomized block design with eleven treatments including control replicated three times.

The details of treatments are given below:

Table 1: Details of the treatments

S. No.	Symbol	Treatments
1.	T_0	Control
2.	T_1	Boric acid (B) @ 100 ppm as foliar spray
3.	T_2	Zinc sulphate (Zn) @ 100 ppm as foliar spray
4.	T_3	Ammonium molybdate (Mo) @ 50 ppm as foliar spray
5.	T_4	Copper sulphate (Cu) @ 100 ppm as foliar spray
6.	T_5	Ferrus sulphate (Fe) @ 100 ppm as foliar spray
7.	T_6	Manganese sulphate (Mn) @ 100 ppm as foliar spray
8.	T_7	Mixture of all
9.	T_8	Azotobacter @ 1 kg/ha as seedling treatment
10.	T_9	Azospirillum @ 1 kg/ha as seedling treatment
11.	T_{10}	Azotobacter + Azospirillum @ 1 kg/ha each as seedling treatment

At the time of field preparation farm yard manure was applied @ 200 quintal/ha before second harrowing. N: P: K was applied @ 120 kg N_2, 60 kg P_2O_5 and 60 kg K_2O per hectare. Phosphorus and potash were given as basal dose at the time of planting, whereas, half of the nitrogen was applied as basal dose and remaining half quantity in two split doses at 25 days and 50 days after transplanting.100gm of biofertilizers dissolved in one liter of water and root was dipped for 15 minutes. The seedlings root were dipped before transplanting in both biofertilizer Azotobacter and Azospirillum separately as @ 1 kg/ha and in mixture of both biofertilizers (Azotobacter + Azospirillum) ½ parts of both biofertilizer were collected in separate open pan. Plant protection measures were adopted as per recommendation. Three sprays of micronutrient were given at an interval of 10 days starting from 30 days after transplanting. In control no micronutrient and biofetilizers was applied. The observation recorded were flowers per cluster, fruits per cluster, percentage of fruit set, fruit diameter, fruit length, fruit weight, fruits per plant, fruit yield per plant, and fruit yield per hectare.

Result and Discussion

It was observed that the application of micronutrients resulted not only in better vegetative growth but also exhibited higher number of flowers per cluster, number of fruits per cluster and percentage of fruit set. It is obvious from the data presented in Table 5.3 that all the micronutrients possessed higher number of flowers per cluster, number of fruits per cluster and percentage of fruit set as compared to control.

Data presented in Table elucidates that T_7 had highest number of flowers per cluster (5.33) followed by T_6 (5.19) whereas it was lowest in T_0 (4.27). Amongst the micronutrients the minimum effect of copper was noticed on this trait (4.85) followed by boron (4.90) which were at par. Zinc and iron also had almost similar effect on this trait (5.04 and 5.05 respectively) while molybdenum proved better (5.11) than zinc and iron.

As regards the number of fruits per cluster T_7 (4.06) was found to be significantly superior to all other treatments. T_3 (3.60), T_5 (3.61) and T_6 were found at par with each other but better than T_1 (3.25), T_2 (3.44) and T_4 (3.27). On the other hand in control only 2.77 fruits per cluster were noted.

In respect to percentage of fruit set it was recorded that T_7 gave the highest percentage of fruit set (76.26%) followed by T_5 (71.46%) and T_3 (70.33%). However amongst the micronutrients minimum percentage of fruit set was observed in T_1 (66.31%) followed by T 4(67.37%), T_2 (68.31%) and T_6 (68.87%). Although all the treatments exhibited greater percentage of fruit set as compared to control.

Increase in flowers per cluster, number of fruits per cluster and percentage of fruit set may be probably because of role of boron and zinc which they play in flowering. Boron increases RNA and DNA contents in reproductive tissues. The pollen germinates properly which leads to fruit setting.

Table 2: Effect of micronutrients and biofertilizers on yield and yield attributes of tomato

	Treatments	Flowers/ cluster	Fruits/ cluster	% of fruit set	Fruit diameter (cm)	Fruit length (cm)	Fruit weight (g)	No. of fruits/ plant	Yield /plant (Kg)	Yield (q/ha)
T_0	Control	4.27	2.77	65.03	4.40	4.31	41.78	16.01	0.98	209.82
T_1	Boric acid (B) @ 100 ppm as foliar spray	4.90	3.25	66.31	5.01	5.05	51.55	20.10	1.23	257.39
T_2	Zinc sulphate (Zn) @ 100 ppm as foliar spray	5.04	3.44	68.31	4.67	4.96	52.47	19.90	1.13	220.84
T_3	Ammonium molybdate (Mo) @ 50 ppm as foliar spray	5.11	3.60	70.33	4.98	5.08	54.47	20.95	1.20	242.29
T_4	Copper sulphate (Cu) @ 100 ppm as foliar spray	4.85	3.27	67.37	5.04	5.00	58.25	20.90	1.22	250.55
T_5	Ferrus sulphate (Fe) @ 100 ppm as foliar spray	5.05	3.61	71.46	5.06	5.23	51.29	21.48	1.29	270.58
T_6	Manganese sulphate (Mn) @ 100 ppm as foliar spray	5.19	3.58	68.87	5.26	5.22	45.08	20.25	1.32	272.73
T_7	Mixture of all	5.33	4.06	76.26	6.21	6.28	67.62	24.66	1.43	288.77
T_8	Azotobacter @ 1 kg/ha as seedling treatment	4.79	3.39	70.95	5.48	5.13	52.03	22.18	1.28	274.11
T_9	Azospirillum @ 1 kg/ha as seedling treatment	4.77	3.38	70.82	5.46	5.26	53.18	21.48	1.27	275.96
T_{10}	Azotobacter + Azospirillum @ 1 kg/ha each as seedling treatment	5.02	3.54	70.69	5.72	5.71	54.70	21.93	1.24	275.50
	SEm±	0.02	0.03	0.66	0.07	0.06	0.17	0.74	0.01	1.19
	C.D. 5%	0.06	0.10	1.97	0.21	0.19	0.53	0.25	0.05	3.54

Dhanasekaran and bhuvaneswari (2005) [3] found highest number of flowers per cluster and highest fruit set with combined application of humic acid, NAA and micronutrient mixture.The respective maximum and minimum number of flowers per cluster was noted in T_{10} (5.02) and control (4.27). T_8 (4.79) and T_9 (4.77) were found at par regarding this trait. Similarly number of fruits per cluster were also recorded highest in T_{10} (3.4) followed by T_8 (3.39) and T_9 (3.38), whereas under control 2.77 fruits per cluster wee observed. All treatments of biofertilizers did not exhibit any differences amongst them for percentage of fruit set, although effect of biofertilizers was found significant over control. Application of Azotobacter + Azospirillum increases the microbial activity in root zone which ultimately enhances the nutrient uptake better nitrogen fixation and results in better root system development and possible synthesis of plant growth harmones. Thus better development of plant and phenological parameters takes place. Similar findings of biofertilizers on phenological characters have also been reported by Sudhakar and Purushottam (2008) [8].

A perusal of data clearly indicates that T_7 exhibited maximum fruit diameter (6.21 cm) followed by T_6 (5.26 cm). T_5 and T_6 were at par. On the other hand the lowest fruit diameter was exhibited by control (4.40 cm) followed by T_2 (4.67 cm) and T_3 (4.98 cm). Similarly fruit length was also highest in T_7 (6.28 cm) followed by T_5 (5.23 cm) and T_6 (5.22 cm) which was significantly maximum than recorded in control (4.31 cm). All the micronutrients had significant effect on fruit weight. The maximum fruit weight was noticed under T_7 (67.62 g) followed by T_4 (58.25 g) and T_3 (54.47 g). T_6 exhibited the minimum effect (45.08 g) followed by T_5 (51.29 g) and T_2 (51.55 g). Similar to the fruit weight maximum number of fruits per plant were also noted for T_7 (24.66) followed by T_5 (21.48). T_3 (20.95) and T_4 (20.90) had almost similar effect on fruits per plant. The minimum effect T_2 (19.90) was noticed on this attribute. T_1 (20.10) and T_6 (20.25) were also found to be at par but had more number of fruits per plant than control and T_2.

In present investigation maximum fruit diameter, fruit length and fruit weight was found in T_7 i.e. mixture of all micronutrients which is probably because boron alongwith other micronutrients not only affect the formation and accumulation of different fraction of carbohydrate but also affect the normal physiological and metabolic process of the plant. Combination of micronutrients particularly boron increase the level of sugar on stigma of flower which helped in fruit set due to the better pollen germination and pollen tube growth. These results are in agreement with the findings of Tanaka *et al.* (2003), Dhanasekaran and Bhuvaneswari (2005) [3].

Effect of micronutrients on yield per plant is obvious from the data presented in Table 5.4. As noticed for yield attributes T_7 had maximum effect on yield per plant also (1.43 Kg) and proved to be significantly superior to other treatments of micronutrients. T_6 (1.32 Kg) ranked second for yield per plant followed by T_5 (1.29). T_1 (1.23 Kg), T_3 (1.20 Kg) and T_4 (1.22 Kg) were found at par. T_2 exhibited the minimum effect on yield per plant (1.13 Kg).Similarly maximum yield of 288.77 q/ha was noted for T_7 which was significantly higher than all treatments followed by T_6 (272.73 q/ha) and T_5 (270.58 q/ha). T_2 exhibited the minimum effect on yield (220.84 q/ha) followed by T_3 (242.29 q/ha), T_4 (250.55 q/ha) and T_1 (257.39 q/ha).These findings are in conformity with those of Devis *et al.* (2003) [2], Alexander *et al.* (2004) [1], Kumaresan and Kalamani (2004) [5].

All the treatments of biofertilizers had significant effect on yield and yield components as compared to control. Fruit diameter increased considerably due to use of biofertilizers. The respective maximum and minimum fruit diameter was recorded for T_{10} (5.72 cm) and T_0 (4.40 cm). T_8 (5.48 cm) and T_9 (5.46 cm) were found to be at par but significantly superior to control and significantly inferior to T_{10}. Similarly fruit length was also higher in T_{10} (5.71 cm) followed by T_9 (5.26 cm).T_8 (5.13 cm) exhibited minimum effect on fruit length.Fruit weight increased significantly due to biofertilizers. The maximum fruit weight was observed under T_{10} (54.70g) followed by T_9 (53.18g), whereas T_8 (52.03g) had minimum effect on it. Number of fruits per plant also increased appreciably due to biofertilizers. The maximum fruits per plant were noted for T_8 (22.18) followed by T_{10} (21.93) and T_9 (21.48).A considerable increase was observed in yield per plant and yield q/ha due to use of biofertilizers over control. But the effect of all the treatments of biofertilizers did not differ significantly for these parameters of study.

In present investigation highest yield was obtained with use of biofertilizers which is probably due to better plant stand and direct contribution of biofertilizers in improving the fertility condition of the soil because of bacterial activity. The increase in yield might be attributed to increased availability of nitrogen and phosphorus as well as accumulation of plant hormones synthesized by biofertilizers which in turn might have increased carbohydrate supply and nutrient mobility by improving better root activity, leaf area, chlorophyll content and photosynthetic rate in addition to increasing hormonal levels in the active sinks viz; flowers fruits etc.

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