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Effects of foliar application of zinc and boron on growth and yield of summer tomato

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ABSTRACT

To increase the yield of BARI hybrid tomato 4, cultivated in summer season of Bangladesh, foliar application of zinc and boron [T_0: control; T_1: 25-ppm $ZnSO_4$ (Zinc Sulphate); T_2: 25-ppm H_3BO_3 (Boric Acid) and T_3: 12.5-ppm $ZnSO_4$ + 12.5-ppm H_3BO_3] was done. Maximum plant height (106.9 cm), number of leaves (68.9/plant), leaf area (48.2 cm^2), number of branches (11.9/plant), number of clusters (21.6/plant), number of fruits (1.8/clusters and 33.6/plant), fruit length (5.3 cm), fruit diameter (5.1 cm), single fruit weight (60.4 g) and yield (1.9 kg/plant, 25.7 kg/plot and 58.3 t/ha) were found from foliar application of 12.5-ppm $ZnSO_4$ + 12.5-ppm H_3BO_3 while minimum from control. Early flowering (49.3 days) and minimum diseased infested plant (9.4%) were also found from foliar application of 12.5-ppm $ZnSO_4$ + 12.5-ppm H_3BO_3.Combined foliar application of zinc and boron was more effective than the individual application of zinc or boron on growth and yield for summer season tomato (BARI hybrid tomato 4).

Key words: *Lycopersicon esculentum, BARI hybrid tomato 4, $ZnSO_4$, H_3BO_3, growth and yield*

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I. Introduction

Tomato (*Lycopersicon esculentum* Mill) is an important vegetable crop generally grown winter season in Bangladesh. It is very difficult to produce tomato during summer due to high temperature and heavy rainfall. The availability of tomato is not adequate in summer season due to very lower production. For that reason consumer has to pay more for tomato during this season. High temperature during day and night was considered as major barrier to fruit set during summer season so that it is essential to find out the suitable genotypes for summer season in Bangladesh. Many researchers are trying to develop new variety through traditional

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breading or varietal trail (Mehraj *et al.*, 2014; Alam *et al.*, 2010). Bangladesh Agricultural Research Institute (BARI) has already developed three hybrid tomato varieties for summer cultivation and BARI hybrid tomato 4 is one these (BARI, 2011). On the other hand, supplementation of micronutrients is essential for higher yield of an established variety. In foliar application, nutrients enter through aqueous pores of leaf cuticles, cell wall of the epidermal cells and plasma membrane by active transport (Cheristensen, 2005). Micronutrients have an important role in the plant activities and foliar application can improve the vegetative growth, fruit set and yield of tomato (Adams, 2004) by increasing photosynthesis of green plants (Mallick and Muthukrishnan, 1980). Among micronutrients, Zn and B are important for plant nutrition. Tomato requires both major and micronutrients for its proper plant growth (Sainju et al., 2003).Zn plays important role on growth and development as well as carbohydrates, protein metabolism and sexual fertilization of plant (Imtiaz *et al.*, 2003; Vasconcelos *et al.*, 2011) while B deficiency reduced yield and quality in tomatoes (Davis *et al.*, 2003). Balanced fertilization of macro and micro nutrients can increases production (Swan *et al.*, 2001; Ali *et al.*, 2008) but foliar application of micronutrients is the not only efficient but also secured way (Aghtape *et al.*, 2011).The objective of the study was to evaluate the effect of foliar application of zinc and boron on tomato growth and yield of tomato cultivated at summer season in Bangladesh.

II. Materials and Methods

Experiment was conducted at Olericulture Research field, Horticulture Research Centre, Bangladesh Agricultural Research Institute, Joydebpur, Bangladesh from May to September 2014 following completely randomized complete block design using three replications. Seeds were sown on the seedbed in 15thMay and seedlings were transplanted into the main field on 16thJune, 2014.BARI hybrid tomato 4 was used in the experiment. Three foliar sprays with control viz. T_0: control; T_1: 25-ppm $ZnSO_4$ (Zinc Sulphate); T_2: 25-ppm H_3BO_3 (Boric Acid) and T_3: 12.5-ppm $ZnSO_4$ + 12.5-ppm H_3BO_3 were used in the experiment. Each treatment was applied two times firstly at 15 days after transplanting (DAT) and secondly at 45 DAT. The unit plot size was 2.4 m x 1.6 m. The plant spacing was 40cm in rows of 60cm plant. Each plot contains 16 plants. Cowdung (10 t/ha), urea (300 kg/ha), TSP (200 kg/ha) and MP (210 kg/ha) were applied (BARI, 2011).The entire amount of organic manure, TSP and half of the MP were applied during final land preparation. The remaining half of MP and entire urea applied in two equal installments, 1st at 15 days after planting and 2nd at flowering. Data were collected on plant height, number of leaves, leaf area, number of branches, number of clusters, days to first flowering, number of fruits, fruit length, fruit diameter, single fruit weight, yield and percentage of disease infected plants. Collected data were statistically analyzed using MSTAT-C program, mean was calculated and analysis of variance for each of treatment was represented by F-test. Differences between treatments were evaluated by Least Significance Difference (LSD) test at 5% level of significance (Gomez and Gomez, 1984).

III. Results and Discussion

Plant Growth Characters

Plant height: Plant height of BARI hybrid tomato 4 varied significantly among the treatments at 60 days after transplanting (DAT). T_3 produced the tallest plant (106.9 cm) followed by T_1 (97.6 cm) whereas the shortest plant from T_0 (85.5 cm) at 60 DAT (Table 01). Plant height of tomato increased due to the application of zinc and boron (Hatwar *et al.*, 2003). Tomato plant height responses by foliar application of different micronutrients were also determined by Singh and Tiwari (2013). Tomato plant height ranged from 122.0 to 137.0 cm among the different concentrations and types of nutrients (Davis, 2003). Zinc helps on auxin synthesis and in

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association with boron helps on cell wall development and cell differentiation of plants (Basavarajeswari *et al.*, 2008).

Number of leaves: Number of leaves of BARI hybrid tomato 4 showed significant variation among the treatments at 60 DAT. Maximum number of leaves was found from T_3 (68.9/plant) followed by T_1 (65.6/plant) while minimum from T_0 (50.5/plant) (Table 01). Number of leaves increased due to the foliar application of Zn and B (Singh and Tiwari, 2013).

Leaf area: Significant variation was found in leaf area of BARI hybrid tomato 4 at 60 DAT. Maximum leaf area was found from T_3 (68.9 cm^2) followed by T_1 (65.6 cm^2) while minimum from T_0 (42.7 cm^2) at 60 DAT (Table 01).

Number of branches and cluster: Branches and cluster were also varied significantly among the treatments at 60 DAT. Maximum number of branches and cluster was found from T3 (11.9/plant and 21.6/plant respectively) which was followed by T_1 (9.4/plant and 20.4/plant respectively) whereas minimum from T_0 (7.4/plant and 19.4/plant respectively) at 60 DAT (Table 01).

Number of branches/plant increased by application of boron (Basavarajeswari et al., 2008), Zinc (Kiran et al., 2010) and micronutrient mixture with Zn, Fe and B (Hatwar et al., 2003).

Table 01. Growth response of BARI hybrid tomato 4 to foliar application of zinc and boron[X]

Treatments[Y]	At 60 days after transplanting				
	Plant height (cm)	Number of leaves/plant	Leaf area (cm^2)	Number of branches/plant	Number of clusters/plant
T_0	85.5 d	50.5 d	42.7 b	7.4 c	19.4 d
T_1	97.6 b	65.6 b	41.1 c	9.4 b	20.4 b
T_2	92.9 c	62.9 c	40.1 c	9.4 b	19.9 c
T_3	106.9 a	68.9 a	48.2 a	11.9 a	21.6 a
LSD 0.05	*2.9*	*2.7*	*1.1*	*1.3*	*0.2*
CV %	*0.5*	*0.8*	*1.2*	*0.9*	*0.4*

[X] In a column mean values having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of significance

[Y] T_0: control; T_1: 25-ppm $ZnSO_4$ (Zinc Sulphate); T_2: 25-ppm H_3BO_3 (Boric Acid) and T_3: 12.5-ppm $ZnSO_4$ + 12.5-ppm H_3BO_3

Days to first flowering: Days to first flowering showed a significant variation among the treatments. Early flowering was found from T_3 (49.3 days) while T_0 showed late flowering (55.5 days) (Table 02).

Number of fruits: Number of per cluster showed statistically similar but number of fruits/plant varied significantly among the treatments. Maximum number of fruits was found from T_3 (1.8/cluster and 33.6/plant) while minimum from T_0 (1.6/cluster and 29.4/plant) (Table 02). Combined application of zinc and boron increased the number of fruits/plant in tomato (Yadav *et al*, 2001).

Fruit length and diameter: Fruit length and diameter were also varied significantly among the treatments. Longest fruit (5.3 cm) and maximum fruit diameter (5.1 cm) was found from T_3 while shortest fruit (3.7 cm) and minimum diameter (3.6 cm) was found from T_0 (Table 02). Length of fruit significantly increased by zinc and boron (Wojcik and Wojcik, 2003) application by improving cell size or cell number (Khayyat *et al.*, 2007).

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Table 02. Effect of foliar application of zinc and boron on flower and fruit characters BARI hybrid tomato 4[X]

Treatments [Y]	Days to first flowering	Number of fruits/clusters	Number of fruit/plant	Fruit length (cm)	Fruit diameter (cm)
T_0	55.5 a	1.6 a	29.4 c	3.7 c	3.6 d
T_1	51.6 c	1.7 a	30.4 b	4.2 b	4.4 b
T_2	52.9 b	1.6 a	30.4 b	4.1 b	4.1 c
T_3	49.3 d	1.8 a	33.6 a	5.3 a	5.1 a
LSD 0.05	*1.2*	*0.2*	*0.9*	*0.3*	*0.2*
CV %	*1.0*	*5.9*	*0.3*	*2.4*	*2.2*

[X] In a column mean values having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of significance
[Y]T_0: control; T_1: 25-ppm $ZnSO_4$ (Zinc Sulphate); T_2: 25-ppm H_3BO_3 (Boric Acid) and T_3: 12.5-ppm $ZnSO_4$ + 12.5-ppm H_3BO_3

Single fruit weight: Fruit weight varied significantly among the treatments. Maximum single fruit weight was found from T_4 (60.4 g) which was followed by T_1 (55.4 g) while minimum from T_0 (49.8 g) (Table 03). Foliar application of B and Zn increase weight (Sindhu *et al.*, 1999). Boron play key role on accumulation of photosynthates that has correlation with fruit weight (Shukha, 2011). Zinc and boron in improves fruit growth by synthesizing tryptophan and auxin (Wojcik and Wojcik, 2003).

Yield: Yield of BARI hybrid tomato 4 showed a significant variation among treatments. Maximum yield was found from T_3 (1.9 kg/plant, 25.7 kg/plot and 58.3 t/ha respectively) while minimum from T_0 (15.0 kg/plant, 20.6 kg/plot and 45.1 t/ha respectively) (Table 03). Foliar application of zinc and boron significantly increases the yield of different crops (Singram and Prabhu, 2001; Mustafa *et al.*, 2006; Sindhu *et al.*, 1999; Ashoori *et al.*, 2013).

Table 03. Response of yield characters on BARI hybrid tomato 4 to foliar application of zinc and boron on [X]

Treatments[Y]	Single fruit weight (g)	Yield			Diseased infected plants (%)
		(kg)/plant	(kg)/plot	t/ha	
T_0	49.8 d	1.5 b	20.6 d	45.1 d	31.7 a
T_1	55.4 b	1.7 b	22.4 b	49.9 b	17.6 c
T_2	53.8 c	1.5 b	21.0 c	46.5 c	19.2 b
T_3	60.4 a	1.9 a	25.7 a	58.3 a	9.4 d
LSD 0.05	*1.0*	*0.2*	*0.2*	*1.0*	*0.2*
CV %	*0.9*	*6.0*	*0.4*	*1.0*	*0.5*

[X] In a column mean values having similar letter(s) are statistically similar and those having dissimilar letter(s) differ significantly as per 0.05 level of significance
[Y]T_0: control; T_1: 25-ppm $ZnSO_4$ (Zinc Sulphate); T_2: 25-ppm H_3BO_3 (Boric Acid) and T_3: 12.5-ppm $ZnSO_4$ + 12.5-ppm H_3BO_3

Diseased infected plants: Diseased plant was also varied significantly among the treatments. However minimum diseased plant was found from T_3 (9.4%) which was followed by T_2 (19.2%) while minimum from T_0 (31.7%) (Table 03). There is a relation between zinc nutrient stress and plant disease (Graham, 1983); it has been found that symptoms of viral infections were disappeared by zinc application which may be by suppressing virus-induced zinc deficiency.

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IV. Conclusion

It was apparent that combined foliar application of boron and zinc micronutrients enhanced plant growth characteristics (plant height, number of leaves, leaf area, number of branches, number of clusters), reduce crop duration & percentage of disease infected plants and also gave highest result for yield characteristics (number of fruits, fruit length, fruit diameter, single fruit weight, yield) in BARI hybrid tomato 4. So external foliar application of zinc with boron may increase yield of BARI hybrid tomato 4 cultivated in summer.

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