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Effects of varieties and boron on growth and yield of summer tomato

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ABSTRACT

A study was conducted to investigate the effects of varieties and boron (B) levels on growth and yield of summer tomato (Lycopersicon esculentum Mill.) at the Germplasm Centre in the Department of Horticulture, Patuakhali Science and Technology University, Patuakhali during the period from May, 2018 to September, 2018. Fifteen treatments were comprising (i) three summer tomato varieties (BARI hybrid tomato 4, 8 and 10) and (ii) five levels of boron as boric acid (0, 1, 2, 3 and 5 kg B ha^{-1}) in all combinations. Randomized complete block design with three replications was used in the earthen pot (0.79 ft^3) experimentation. The effects of varieties and boron levels showed significant variations ($p < 0.05$) on growth and yield of summer tomato at different days after transplanting. Among the varieties at final count plant^{-1}, delayed flowering (32.6 days), the highest plant height (93.8 cm), number of leaves (99.93), no. of branches (26.27), no. of flower clusters (18.53), no. of flowers (82.73), no. of fruits (51.87), longest fruit length (41.87 mm) and maximum fruit width (48.0 mm), weight of individual fruit (55.71 g) and total weight of fruits (2892.88 g) were observed in BARI hybrid tomato 8. In contrast, the lowest plant height (87.3 cm), no. of leaves (86.47), no. of branches (24.06), no. of flower clusters (15.87), no. of flowers (66.07), no. of fruits (37.33), weight of individual fruit (43.60 g) and total weight of fruits (1630.57 g) were found in BARI hybrid tomato 4; and early flowering (31.93 days), shortest fruit length (33.07 mm) and maximum fruit width (34.60 mm) were noticed in BARI hybrid tomato 10. Among the boron levels at final count plant^{-1}, early flowering (29.67 days), the maximum no. of flower clusters (18.44), no. of flowers (89.11), no. of fruits (46.22) and total weight of fruits (2364.29 g) were recorded in 2 kg B ha^{-1} treatment; the maximum plant height (96.50 cm), no. of leaves (102.89), no. of branches (28.11), longest fruit length (42.89 mm) and maximum fruit width (46.78 mm) and weight of individual fruit (51.74 g) were obtained in 3 kg B ha^{-1} treatment. Conversely, delayed flowering (34.67 days), minimum plant height (83.50 cm), no. of leaves (87.56), no. of branches (21.78), no. of flower clusters (15.89), no. of flowers (63.56), no. of fruits (40.33), shortest fruit length (31.78 mm) and minimum fruit width (34.67 mm), weight of individual fruit (47.47 g) and total weight of fruits (1936.00 g) were recorded in control (0 kg B ha^{-1}) treatment. Our results suggest that the inclusion of B (2–3 kg ha^{-1}) with the current fertilization practice will enhance the growth and yield of summer tomato grown at AEZ (agro-ecological zone) 13 while BARI hybrid tomato 8 could be recommended as one of the promising varieties.

Key Words: *Summer tomato, Variety, Boron, Growth and Yield parameters*

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I. Introduction

Tomato (*Lycopersicon esculentum* Mill.), an important widespread vegetable crop, is cultivated in both fields and under protected cultivation. Due to the varied soil and climatic adaptability tomato is grown all over the world including Bangladesh (Ahmed and Saha, 1976; Agyeman et al., 2014). Besides potato and sweet potato, tomato, a top listed canned vegetable, ranks third in world vegetable production (Choudhury, 1979; FAO, 2002). In Bangladesh, it occupies second and third positions in case of production and area of the winter vegetables, respectively (BBS, 2004). Nutritiously important tomatoes are widely used in fresh like salads, soups; and processed products like ketchup, sauce, marmalade, chutney, juice etc. Tomato contains a fair amount of vitamins A, C, minerals like Na, K, Fe, Ca, Mg and it provides antioxidant elements such as lycopen which prevents cancer (Bhutani and Kallo, 1983). In Bangladesh, due to high temperatures and heavy rainy conditions, tomato is mainly grown all over the country in winter season (Rahman et al., 1998) and it is not grown in summer season due to the lower yield. High temperature (34–38 °C) in summer season causes floral or fruit abscission resulting in poor fruit set occurs in tomato (Aung, 1976). In addition, high temperature adversely affects tomato quality attributes like fruit quality defects, uneven ripening and significantly increased commercial damage (Mulholland et al., 1999).

High yield is the ultimate goal in all crops with good qualities and summer tomato is no exception. Although tomato has great demand throughout the year in Bangladesh. However, due to lower production, the supply of tomato is not sufficient in summer season which causes a higher market price. The lower production, however, does not indicate the low yield potentiality of this crop. There is a great possibility to increase yield potentiality of summer tomato by cultivating HYV with balanced fertilization. Bangladesh Agricultural Research Institute (BARI) released some HYV of summer tomato (for example BARI hybrid tomato 3, 4, 8, and 10) however; improvement of their cultivation technique needs to be evolved. Improving growth and yield potential of tomato crop demands an adequate amount of manure and fertilizers including micronutrients. Studies showed that micronutrient especially boron plays an important role in production and quality of tomato. Boron influences cell division and differentiation, transport of carbohydrates, calcium uptake, protein synthesis, regulation of plant hormone levels and root elongation (Marschner, 1995; Bose and Tripathi, 1996). Flowering and fruit formation are also influenced by boron (Nonnecke, 1989). However, boron deficiency is widespread (Gupta et al., 1985) and it can cause sterility, restriction of water absorption, transportation of carbohydrates, nitrogen, phosphorus, and synthesis of proteins which ultimately affects the fruit and seed formation and thus causes serious yield reductions and uneven ripening of tomato fruit (Islam and Anwar, 1994; Stanley et al., 1995; Adams, 2004). Leaves become curled, wilted or thickened, and fruits and roots become cracked or rotted due to deficiency of boron. Moreover, leaching of boron occurs under rainy conditions whose deficiency affects tomato growth in summer season.

Although boron requirement is low in crop cultivation, however, plants demand varied levels of it. Again, boron management is challenging since diverse soil requires various application rates (Gupta, 1993; Marschner, 1995). Previous reports revealed that toxic effects on crops might be occurred due to application of continuous and or elevated concentration of boron beyond the optimum level (Gupta et al., 1985; Metwally et al., 2012). Moreover, unconsciousness of farmers in relation to balanced fertilization to their crop fields creates an adverse effect on crop production (Rijpma and Jahiruddin, 2004). Importantly, less attention to boron application has been observed in different systemic research and extension projects especially summer tomato released by BARI. The judicious application of boron is necessary to improve their production system. The aim of this experiment was, therefore, undertaken to assess the response of varieties and boron on growth and yield of summer tomato.

II. Materials and Methods

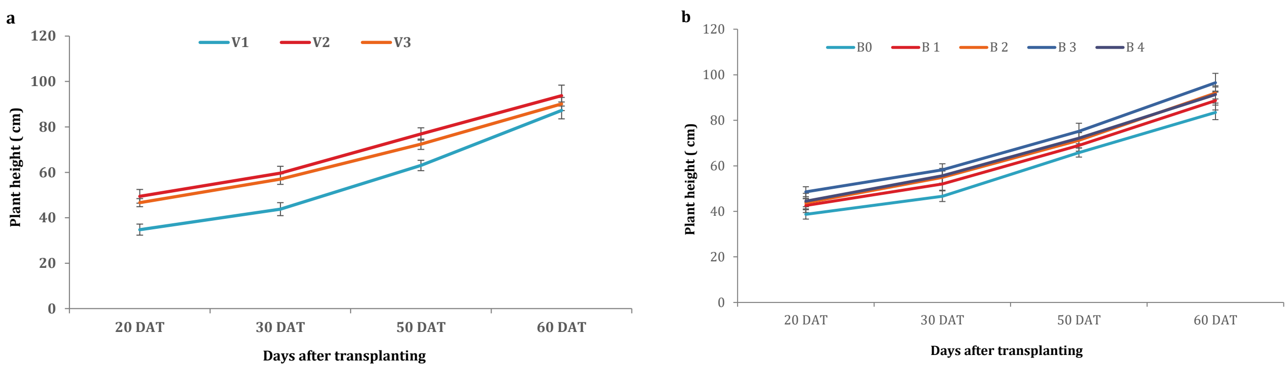
The experiment was performed at Germplasm Centre in the Department of Horticulture, Patuakhali Science and Technology University, Dumki, Patuakhali during the period from May 2018 to September 2018. The physical and chemical properties of air-dried initial soil samples (0–15 cm depth) obtained from the experimental field under AEZ (agro-ecological zone) 13 (Ganges Tidal Floodplain) were analyzed following standard procedure at Soil Resource Development Institute (SRDI) in Barisal (Quddus et al., 2014). Fifteen treatment combinations were comprising three summer tomato varieties *viz.*, BARI hybrid tomato 4, 8 and 10; and five different levels of boron (B) *viz.*, 0, 1, 2, 3 and 5 kg B ha^{-1}.

Randomized complete block design (RCBD) with three replications was used to arrange the two-factorial experiment. A blanket dose of 150 kg ha^{-1} urea, 100 kg ha^{-1} MoP, 60 kg ha^{-1} TSP, 120 kg ha^{-1} gypsum, and 25 ton ha^{-1} cowdung were incorporated with soil in the potting mixture. During pot mixture preparation the whole amount of cowdung, TSP, gypsum along half of the MoP were incorporate into the soil. Application of the remaining half of MoP and entire urea was done at two equal splits, first at 15 days after planting and second at the flowering stage followed by light irrigation. Boron as boric acid (H_3BO_3) was applied as spray methods to the soil during pot mixture preparation. Summer tomato seeds which are high yielding, thermotolerant and indeterminate type varieties were collected from the Vegetable Research Division of Bangladesh Agricultural Research Institute (BARI), Joydebpur, Gazipur. Transplanting of about one month old seedling was done in earthen pot (0.79 feet^3) under poly-shed house conditions. Intercultural operations and plant protection measures were done to keep the plant healthy. Red colouring of fruits was the indicator of crop maturity. Fruits were harvested from 55 to 70 days after transplanting (DAT). Average crop performance data on plant height (cm), number of leaves plant^{-1}, number of branches plant^{-1}, days to first flowering, number of flower clusters plant^{-1}, number of flower plant^{-1}, number of fruit plant^{-1}, fruit length (mm), fruit diameter (mm), individual fruit weight (gm) and total fruit weight plant^{-1} (gm) were recorded. Collected data of different parameters were statistically analyzed using Minitab 17 statistical software program (Minitab Inc, State College, PS, USA) to determine the significance of variation resulting from the experimental treatments. General linear model (GLS) was used for analyses of variances (ANOVA) of different parameters and the means were separated with Tukey at 5% level of probability (p <0.05).

III. Results and Discussion

Plant height

Varieties and different levels of boron exhibited significant variations (p <0.05) in respect of plant height of summer tomato at different days after transplanting (DAT) (Figure 01a and 01b). Plant height increased gradually with time. The highest plant height (93.8 cm) was observed in V_2 (BARI hybrid tomato 8) and the lowest (87.3 cm) was found in V_1 (BARI hybrid tomato 4) variety at 60 DAT (Figure 01a). The differences in plant height might be due to the genetic potentiality of summer tomato varieties (Fayaz et al., 2007). Plant height of tomato increased with increasing application of boron (Hatwar et al., 2003; Ali et al., 2015). The maximum plant height (96.50 cm) was recorded in a plant grown with B_3 treatment (3 kg B ha^{-1}) while the minimum value (83.50 cm) was noted from the control (0 kg B ha^{-1}) treatment at 60 DAT (Figure 01b). The maximum plant height at 3 kg B ha^{-1} indicates its optimum level where maximum cell division might occur (Bose and Tripathi, 1996) and above that concentration cell division might be reduced due to a toxic level and plant height might be declined (Gupta et al., 1985). Sakamoto (2012) showed that plant growth is impaired by both excess and deficient levels of boron in the soil, resulting in the reduction of quantity and quality of crops. Boron helps with auxin synthesis and together with zinc assists in development of cell wall and cell differentiation of plants (Basavarajeswari et al., 2008).



V_1= BARI hybrid tomato 4, V_2= BARI hybrid tomato 8, V_3= BARI hybrid tomato 10; B_0= 0 Kg B ha^{-1}, B_1= 1 Kg B ha^{-1}, B_2= 2 Kg B ha^{-1}, B_3= 3 Kg B ha^{-1} and B_4= 5 Kg B ha^{-1}. The error bars represent standard error of the means of three independent replicates.

Figure 01. Effects of varieties (a) and boron levels (b) on plant height of summer tomato

Number of leaves plant^{-1}

Number of leaves per plant showed significant differences (p <0.05) in relation to varieties of summer tomato and different levels of boron (Table 01). The highest no. of leaves (99.93) was obtained in V_2 (BARI hybrid tomato 8) while the lowest value (86.47) was found in V_1 (BARI hybrid tomato 4) variety at 60 DAT (Table 01). The significant variations were possibly due to the varietal characters of summer tomato (Arun et al., 2004; Deepa and Thakur 2008). Number of leaves increased with increasing certain levels of boron application and then it was declined. The maximum no. of leaves (102.89) was noted in B_3 (3 kg B ha^{-1}) while minimum (87.56) was recorded in control (0 kg B ha^{-1}) treatment at 60 DAT (Table 01). Reports revealed that number of leaves significantly increased due to the application of B and Zn (Oyinlola 2004; Singh and Tiwari, 2013; Ali et al., 2015).

Number of branches plant^{-1}

There were significant influences (p <0.05) of variety and boron levels on number of branches per plant (Table 01). The highest no. of branches (26.27) was obtained in V_2 (BARI hybrid tomato 8) and the lowest data (24.06) was observed in V_1 (BARI hybrid tomato 4) variety at 60 DAT (Table 01). The differences of no. of branches might be due to the different genetic makeup of the summer tomato varieties. These findings are in agreement with Alam et al. (2010) and Khondakar et al. (2017). Number of branches increased with increasing levels of boron up to a certain level and then it was declined. The maximum no. of branches (28.11) was found in B_3 (3 kg B ha^{-1}) and minimum (21.78) was noted in control (0 kg B ha^{-1}) treatment at 60 DAT (Table 01). Number of branches/plant increased by application of boron (Basavarajeswari et al., 2008) and zinc (Kiran et al., 2010). Reports showed that higher photosynthetic activity largely depends on increased number and size of leaf resulting from more number of branches which might indirectly contribute to improving growth and yield of summer tomato (Khondakar et al., 2017).

Table 01. Effects of varieties and different levels of boron on number of leaf plant^{-1} and number of branch plant^{-1} of summer tomato

Treatments	Number of leaf plant^{-1}				Number of branch plant^{-1}			
	20 DAT	30 DAT	50 DAT	60 DAT	20 DAT	30 DAT	50 DAT	60 DAT
Varieties								
V_1	15.87 b	41.00 b	70.07 c	86.47 b	3.53 b	8.00 b	17.13 b	24.06 b
V_2	15.93 b	43.20 ab	76.67 a	99.93 a	4.20 a	9.2 a	18.47 a	26.27 a
V_3	17.87 a	45.07 a	73.33 b	96.27 a	3.80 b	8.07 b	16.87 b	25.13 ab
Level of significance	*	*	*	*	**	*	**	*
Boron levels								
B_0	14.67 c	38.89 c	69.22 c	87.56 c	3.11 c	6.78 c	15.78 c	21.78 c
B_1	15.44 bc	41.22 bc	73.11 abc	90.56 bc	3.56 bc	7.78 bc	16.78 bc	23.33 bc
B_2	16.89 ab	44.00 ab	72.56 bc	93.78 b	3.89 abc	8.84 b	18.00 ab	25.78 ab
B_3	18.67 a	46.44 a	77.67 a	102.89 a	4.67 a	10.22 a	19.33 a	28.11 a
B_4	17.11 ab	44.89 ab	74.22 ab	96.33 a	4.00 ab	8.89 ab	17.56 abc	26.78 a
Level of significance	*	*	**	*	**	*	*	*
CV (%)	13.48	10.34	6.70	9.34	12.45	18.69	10.53	11.95

V_1= BARI hybrid tomato 4, V_2= BARI hybrid tomato 8, V_3= BARI hybrid tomato 10; B_0= 0 kg B ha^{-1}, B_1= 1 kg B ha^{-1}, B_2= 2 kg B ha^{-1}, B_3= 3 kg B ha^{-1}, B_4= 5 kg B ha^{-1}; * and ** indicate significant at 5% and 1% level of probability respectively; DAT= Days after transplanting; CV= Co-efficient of variation; In a column, figures having same letter do not differ significantly at 5% level of probability analyzed by Tukey.

Days to first flowering

Varieties of summer tomato exhibited non-significant variations whereas different levels of boron showed significant variations (p <0.05) in relation to days to first flowering (Table 02). The longest period (32.6 days) was required for first flowering in V_2 (BARI hybrid tomato 8) whereas requirement for shortest period (31.93 days) was in V_3 (BARI hybrid tomato 10) variety (Table 02). Prolonged vegetative growth due to the genetic effects was perhaps liable to require the longest time to the first flowering of BARI hybrid tomato 8 variety. Hence, choosing early flowering is of importance to increase cropping intensity. Days to first flowering were decreased with the increasing boron up to a certain level and then it was increased (Table 02). The plant fertilized with B_2 (2 kg B ha^{-1}) treatment produced early flowering (29.67 days) and delayed flowering (34.67 days) was found from the control (0 kg B ha^{-1}) treated plant (Table 02). These findings were supported by Ali et al. (2015).

Number of flower clusters plant^{-1}

There were significant differences (p <0.05) among varieties of summer tomato and boron levels in respect of number of flower clusters plant^{-1} (Table 02). The highest number of flower clusters plant^{-1} (18.53) was noticed at V_2 (BARI hybrid tomato 8) while the lowest value (15.87) was observed from the V_1 (BARI hybrid tomato 4) variety at 50 DAT (Table 02). Genetic influences of varieties might be associated with differences in number of flower cluster plant^{-1} in summer tomato. Naz et al. (2012) found that number of flower clusters plant^{-1} had significant variation among the tomato varieties. The highest number of flower clusters per plant (18.44) was found at B_2 (2 kg B ha^{-1}) and the lowest value (15.89) was recorded from the control (0 kg B ha^{-1}) treated plant at 50 DAT (Table 02). The highest number of flower cluster plant^{-1} might be due to optimum supply of B at 2 kg ha^{-1} (Naz et al., 2012). Reports showed that phosphorus directly promotes flowering, therefore, stimulation of phosphorus absorption by plant roots might occur in optimum boron level which might play role in increasing number of flower cluster plant^{-1} of summer tomato (Day, 2000).

Number of flowers plant^{-1}

The significant effects (p <0.05) of varieties of summer tomato and boron levels were observed in the number of flowers plant^{-1} (Table 02). The highest number of flowers plant^{-1} (82.73) was observed from V_2 (BARI hybrid tomato 8) while the lowest data (66.07) was found in V_1 (BARI hybrid tomato 4) variety at 50 DAT (Table 02). The marked differences in number of flower plant^{-1} might be related to varietal character of summer tomato (Aung, 1976; Stevens, 1979; Mehraj et al., 2014). The number of flowers plant^{-1} was increased with the increasing levels of boron up to a certain level and then it was declined. The maximum number of flowers plant^{-1} (89.11) was obtained from B_2 (2 kg B ha^{-1}) while the minimum (63.56) was obtained from the control (0 kg B ha^{-1}) treatment at 50 DAT (Table 02). The maximum number of flowers plant^{-1} at 2 kg B ha^{-1} application could be due to accumulation of more carbohydrates resulted from improved photosynthetic activity, which might correlate with increased number of flowers in summer tomato plant (Shukha, 2011; Sivaiah et al., 2013).

Table 02. Effects of varieties and boron levels on days to first flowering, number of flower clusters plant^{-1} and number of flowers plant^{-1} of summer tomato

Treatments	Days to first flowering	Number of flower clusters plant^{-1}				Number of flowers plant^{-1}			
		35 DAT	40 DAT	45 DAT	50 DAT	35 DAT	40 DAT	45 DAT	50 DAT
Varieties									
V_1	32.20 a	3.93 b	6.87 c	11.93 c	15.87 c	13.60 b	28.53 c	50.47 c	66.07 c
V_2	32.60 a	6.40 a	9.53 a	14.60 a	18.53 a	21.33 a	39.60 a	60.87 a	82.73 a
V_3	31.93 a	4.87 b	8.07 b	13.27 b	17.13 b	16.00 b	33.80 b	55.40 b	76.67 b
Level of significance	NS	**	*	*	**	*	**	*	**
Boron levels									
B_0	34.67 a	3.89 b	7.00 b	12.00 b	15.89 c	10.67 c	27.56 c	48.00 c	63.56 c
B_1	32.00 b	5.89 a	8.89 a	14.00 a	17.89 ab	20.56 b	35.56 b	56.00 b	79.78 b
B_2	29.67 c	6.33 a	9.33 a	13.33 ab	18.44 a	25.33 a	45.00 a	70.78 a	89.11 a
B_3	30.78 bc	5.22 ab	8.22 ab	14.56 a	17.33 abc	17.33 b	32.89 bc	53.33 bc	78.00 b
B_4	34.11 a	4.00 b	7.33 b	12.44 b	16.33 bc	11.00 c	28.89 c	49.78 bc	65.33 c
Level of significance	*	**	*	**	*	*	**	*	*
CV (%)	6.55	12.03	8.07	13.39	10.26	16.96	9.34	18.31	17.06

V_1= BARI hybrid tomato 4, V_2= BARI hybrid tomato 8, V_3= BARI hybrid tomato 10; B_0= 0 kg B ha^{-1}, B_1= 1 kg B ha^{-1}, B_2= 2 kg B ha^{-1}, B_3= 3 kg B ha^{-1}, B_4= 5 kg B ha^{-1}; * and ** indicate significant at 5% and 1% level of probability respectively; NS= Not-significant; DAT= Days after transplanting; CV = Co-efficient of variation. In a column, figures having same letter do not differ significantly at 5% level of probability analyzed by Tukey.

Number of fruit plant^{-1}

Varieties of summer tomato and levels of boron exhibited significant influence (p <0.05) on the number of fruits plant^{-1} (Table 03). The highest number of fruits plant^{-1} (51.87) was observed from V_2 (BARI hybrid tomato 8) while the lowest value (37.33) was noticed from V_1 (BARI hybrid tomato 4) at 70 DAT (Table 03). The significant variation in relation to number of fruits plant^{-1} was probably due to the genetic potentiality of the summer tomato varieties (Nandpuri et al., 1977; Prasad and Prasad, 1979; Islam and Khan, 1991). The maximum number of fruits per plant (46.22) was recorded from B_2 (2 kg B ha^{-1}) while the minimum (40.33) was found in control (0 kg B ha^{-1}) treatment at 70 DAT (Table

03). The highest number of fruits plant^{-1} might be due to higher fruit set percent of summer tomato plants at 2 kg B ha^{-1} which maintains cell integrity, improves respiration, enhances metabolic and photosynthetic activities, retains flowers and fruits, and uptake of nutrients (Nonnecke, 1989; Naz et al., 2012; Sivaiah et al., 2013).

Fruit length and width

Fruit length and width were also varied significantly (p <0.05) among the varieties of summer tomato and boron levels (Table 03). The longest fruit length (41.87 mm) and maximum fruit width (48.0 mm) were recorded from V_2 (BARI hybrid tomato 8) while the shortest fruit length (33.07 mm) and minimum fruit width (34.60 mm) were observed from V_3 (BARI hybrid tomato 10) variety (Table 03). The marked differences in fruit length and fruit width might be due to the different genetic makeup of the summer tomato varieties. The longest fruit length (42.89 mm) and maximum fruit width (46.78 mm) were obtained from B_3 (3 kg B ha^{-1}) while the shortest fruit length (31.78 mm) and minimum fruit width (34.67 mm) were noticed in control (0 kg B ha^{-1}) treatment (Table 03). Increased length and width of summer tomato fruit by boron application might be due to synthesizing tryptophan and auxin that improve cell size or cell number (Bose and Tripathi, 1996; Wojcik and Wojcik, 2003; Khayyat et al., 2007).

Individual fruit weight plant^{-1}

Statistical analysis displayed significant differences (p <0.05) among varieties of summer tomato and levels of boron on individual fruit weight (Table 03). The highest weight of individual fruit (55.71 g) was observed from V_2 (BARI hybrid tomato 8) while the lowest weight (43.60 g) was noticed from V_1 (BARI hybrid tomato 4) variety (Table 03). Varietal character was possibly responsible for differences in individual fruit weight plant^{-1} of summer tomato. Individual fruit weight was increased gradually with the increasing levels of boron up to a certain limit and then it was declined. The highest individual fruit weight (51.74 g) was obtained from B_3 (3 kg B ha^{-1}) while the lowest value (47.47 g) was found in control (0 kg B ha^{-1}) treatment (Table 03). The highest individual fruit weight of summer tomato at 3 kg B ha^{-1} was probably happened due to increased accumulation of carbohydrates, which might correlate with increased individual fruit weight (Shukha, 2011; Sivaiah et al., 2013).

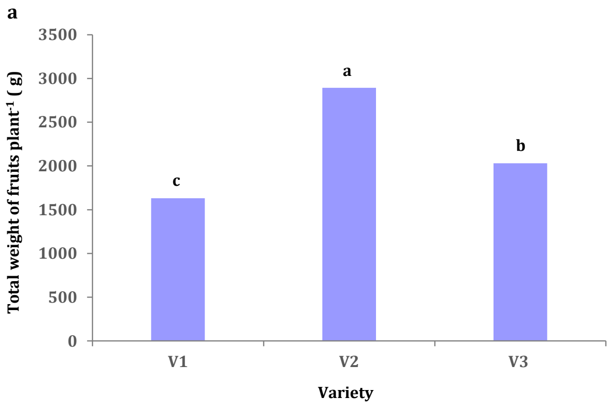
Table 03. Effects of varieties and boron levels on yield contributing attributes of summer tomato

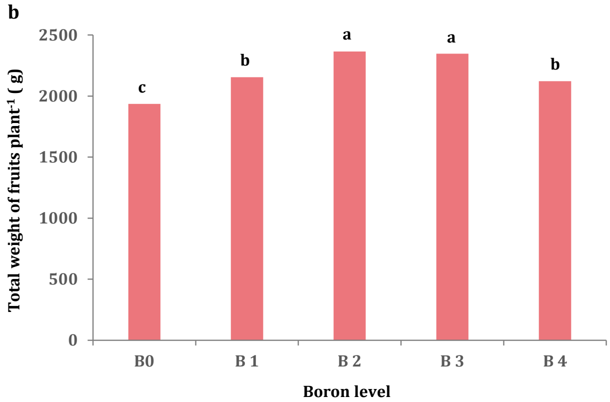
Treatments	Yield contributing attributes						
	Number of fruit plant^{-1}				Fruit length (mm)	Fruit width (mm)	Individual fruit weight (g)
	55 DAT	60 DAT	65 DAT	70 DAT			
Varieties							
V_1	8.20 c	17.20 c	28.07 c	37.33 c	38.47 b	40.53 b	43.60 c
V_2	16.93 a	25.40 a	37.60 a	51.87 a	41.87 a	48.00 a	55.71 a
V_3	11.53 b	21.20 b	31.27 b	41.33 b	33.07 c	34.60 c	49.17 b
Level of significance	**	**	*	**	*	*	*
Boron levels							
B_0	9.56 b	17.67 b	30.00 b	40.33 d	31.78 d	34.67 c	47.47 c
B_1	13.44 a	23.00 a	33.00 a	44.33 b	37.89 bc	40.44 b	47.88 c
B_2	14.56 a	24.22 a	34.22 a	46.22 a	39.89 ab	42.56 b	50.44 ab
B_3	13.22 a	22.33 a	33.22 a	44.78 ab	42.89 a	46.78 a	51.74 a
B_4	10.33 b	19.11 b	31.11 b	41.89 c	36.56 c	40.78 b	49.92 b
Level of significance	**	*	*	*	**	*	*
CV (%)	9.32	16.79	13.63	5.27	15.45	7.43	11.23

V_1= BARI hybrid tomato 4, V_2= BARI hybrid tomato 8, V_3= BARI hybrid tomato 10; B_0= 0 kg B ha^{-1}, B_1= 1 kg B ha^{-1}, B_2= 2 kg B ha^{-1}, B_3= 3 kg B ha^{-1} and B_4= 5 kg B ha^{-1}; * and ** indicate significant at 5% and 1% level of probability respectively; DAT= Days after transplanting; CV= Co-efficient of variation. In a column, figures having same letter do not differ significantly at 5% level of probability analyzed by Tukey.

Total weight of fruits plant^{-1}

The significant effects (p <0.05) of summer tomato varieties and boron levels were observed in respect of total weight of fruits plant^{-1} (Figures 02a and 02b). The highest total weight of fruits plant^{-1} (2892.88 g) was obtained from V_2 (BARI hybrid tomato 8) while the lowest data (1630.57 g) was recorded from V_1 (BARI hybrid tomato 4) variety (Figure 02a). The significant difference in total weight of fruits was perhaps due to the genetic potentiality of summer tomato varieties. Total fruit weight plant^{-1} was increased gradually with the increasing levels of boron up to a certain limit and then it was declined. The plant fertilized with B_2 (2 kg B ha^{-1}) treatment produced maximum total weight of fruits (2364.29 g) followed by statistically similar 2347.09 g at B_3 (3 kg B ha^{-1}) while minimum value (1936.0 g) was found in control (0 kg B ha^{-1}) treatment (Figure 02b). The highest total weight of fruits plant^{-1} at 2 kg B ha^{-1} might be due to enhanced accumulation of carbohydrates and favourable influence of retaining more flowers and fruits resulting in an increased total weight of fruits plant^{-1} in summer tomato (Sivaiah et al., 2013). Moreover, Davis et al. (2003) and Basavarajeswari et al. (2008) reported that increased yield may be occurred due to a higher application rate of micronutrients (B, Zn, or both together) in different vegetable crops.





V_1= BARI hybrid tomato 4, V_2= BARI hybrid tomato 8, V_3= BARI hybrid tomato 10; B_0= 0 Kg B ha^{-1}, B_1= 1 Kg B ha^{-1}, B_2= 2 Kg B ha^{-1}, B_3= 3 Kg B ha^{-1}, B_4= 5 Kg B ha^{-1}. The figures having common letter (s) do not differ significantly at 5% level of probability analysed by Tukey.

Figure 02. Effects of varieties (a) and boron levels (b) on total weight of fruits plant^{-1} of summer tomato

IV. Conclusion

In conclusion, significant variations (*p* <0.05) were observed among varieties and boron levels on growth and yield of summer tomato. In varieties, except delayed flowering, BARI hybrid tomato 8 showed the best performances on plant height, number of leaves, no. of branches, no. of flower clusters, no. of flowers, no. of fruits, fruit length, fruit width, weight of individual fruit and total weight of fruits, while the least performances of those parameters were observed in BARI hybrid tomato 4 variety except the shortest fruit length and minimum fruit width, and early flowering that were noticed in BARI hybrid tomato 10. In boron levels, application of 2 kg B ha^{-1} gave the best effects in terms of early flowering, no. of flower clusters, no. of flowers, no. of fruits and total weight of fruits, whereas, application of 3 kg B ha^{-1} gave the best effects on plant height, no. of leaves, no. of branches, fruit length, fruit width and weight of individual fruit. However, the lowest effects of those parameters were recorded in control (0 kg B ha^{-1}) treatment. By combing all these results together, it can be concluded that the application of B at a low rate (2–3 kg ha^{-1}) might increase the growth and yield of summer tomato while grown in the Ganges Tidal Floodplain soil. Moreover, BARI hybrid tomato 8 can be considered as one of the promising varieties for this region.

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