Yield performance of tomato hybrids during the summer season in Sylhet

Original Research article

ABSTRACT

The experiment was conducted to evaluate the yield performance of five new hybrid combinations of tomato (DCH1, DCH2, DCH3, TCH1 and TCH2) along with BARI Hybrid Tomato-4 at the experimental field of Horticulture Department, Sylhet Agricultural University in Randomized Complete Block Design (RCBD) under with and without hormone application systems (4-para chlorophenoxy acitic acid) during the summer season from May to September 2015. Both hybrids and hormone application systems had a significant influence on growth and yield of tomato during summer. The hybrid, BARI Hybrid Tomato-4 produced the highest number of fruits plant^{-1} (22.67) and fruit yield plant^{-1} (0.89 kg) closely followed by TCH1 (0.84 kg plant^{-1}). The hybrid DCH3 produced the heaviest individual fruit weight (46.65 g), but its plant yield was only 0.63 kg. The number of fruits plant^{-1}, individual fruit weight and fruit yield were largely affected due to hormone application. Fruit yield plant^{-1} was quite high in the hormone-treated plant (0.82 kg) compared to untreated plant (0.68 kg). In general, all the hybrids performed better when treated with the hormone in respect of yield compared to their corresponding untreated plants. Among the hybrids, BARI Hybrid Tomato-4 had the highest fruit yield (1.03 kg plant^{-1}) followed by TCH1 (0.92 kg plant^{-1}) when the plants were treated with the hormone. These two hybrids again produced appreciable amount of tomato under untreated condition (0.75 kg plant^{-1} and 0.77 kg plant^{-1}, respectively). This indicates that, there is a possible scope of tomato production during the summer season in Sylhet region with and without hormone application, though hormone application had benefit on fruit yield.

Keywords: Tomato hybrids, growth, yield, summer season.

1. INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is a favourite garden vegetable mostly grown in the winter season in Bangladesh. It likes cold and dry weather for better growth and development (Rashid, 1999). In general, tomato cultivation only confines during the winter season i. e. November to February is congenial time for tomato production. But its demand remains high throughout the year. During rainy summer (June to September) in our country, there found a crisis period of vegetable production due to adverse climatic condition i.e. high temperature, high rainfall causing poor fruit setting. In such climatic conditions during summer, severe flower dropping in tomato is occurred (Picken, 1984). The varietal effects suggest that specific variety having resistant to heat stress should be planted during the summer season. In order to prevent fruit dropping, BARI Hybrid Tomato-4 can be cultivated with an application of PGRs during summer season (Hossain, 2013). Heat tolerant tomato hybrids could be grown in Bangladesh under poly tunnel production system with excellent yield (Ahmad *et. al.,* 2008). In hot and humid condition, plant hormones application is reported to have better performances. Hormone application during hot summer tomato production was found very effective (Kuo, 1993). Application of plant growth regulators has been shown to improve fruit setting (AVRDC, 1990). Sprays of hormone especially Tomatotone (4-chlorophenoxy acetic acid; 4-CPA) on flower cluster effectively increase the fruit set as well as fruit

production. Tomato-tone has been found to be effective in improving tomato fruit set under higher temperature conditions (Kuo *et al*., 1978). Tomato-tone now used commercially in Korea, Japan and China to increase fruit set in tomatoes. The growth regulator has an important effect on the fruit retention of tomato as well as other horticultural crops and thus increasing the yield substantially (Younis and Tigani, 1977). Tomato-tone is also used in reducing pre-harvest fruit drop and resulting in increased number of fruits and yield in tomato crop. Recently, Bangladesh Agricultural Research Institution (BARI) has developed many new hybrids with satisfactory yields such as BARI Hybrid Tomato-3, BARI Hybrid Tomato-4 and BARI Hybrid Tomato-8 to boost up the production and quality of tomato for the summer season in Bangladesh (Anonymus, 2016). Considering farmers' and consumers' demand, several research works have been done at different areas by scientists (Ahmad *et al*., 2008; Patwary, 2009; Islam *et al*., 2011; Yesmin *et al*., 2014) to improve the adaptability of heat tolerant tomato hybrids. To develop cultivars for hot summer, selection of genotypes which are capable of setting fruits under heat stress is needed. This study was undertaken to select tomato hybrids on yield attributes with or without hormone treatment during summer condition in Sylhet.

2. MATERIALS AND METHODS

The experiment was conducted at the experimental field of Department of Horticulture, Sylhet Agricultural University, Sylhet, during May, 2015 to September, 2015 in randomized complete block design (RCBD) with three replications. Hybrid seeds of DCH1, DCH2, DCH3, TCH1, and TCH2 developed by the Department of Horticulture, Sylhet Agricultural University, Sylhet and BARI Hybrid Tomato-4 from Bangladesh Agricultural Research Institute (BARI). The soil of the area is deep brown in color, hill soil in texture and highly acidic in nature (Rahman *et al*., 2003). The area belongs to the series of Estern Shurma-Kushiara Floodplain under the Agro-Ecological Zone (AEZ-20).The pH of the soil is around 4.98, soil organic matter was 1.79%, soil EC is 0.47ds/m (Bhuiyan *et al.,* 2009). The analytical data of soil sample from the experimental site was determined in Soil Resource Development Institute (SRDI), Regional Laboratory, Sylhet. The individual plot size was 2.3 m × 2.4 m having 4 rows bed^{-1} and 6 plants row^{-1} and total 24 plants $plot^{-1}$. Plant spacing was maintained about 60 cm between row and 40 cm between plant, respectively. For seedling, seeds were sown in the raised seedbed on May 7, 2015. The bed was made 15 cm in height in order to avoid soil moist during heavy rain. Plot was fertilized with cow dung (N-P-K = 0.5-1.5 0.4-0.8 0.5-1.9 % respectively) 15 ton ha^{-1}, Urea 300 kg ha^{-1}, Triple Super Phosphate (TSP) 200 kg ha^{-1} and Murate of Potash (MoP) 150 kg ha^{-1}. Half of cow dung, entire TSP and half of MoP (Rashid and Singh, 2000) were applied during final land preparation. Pits were prepared one week before transplanting seedlings. The remaining cow dung was applied during pit preparation. Topdressing was done in three equal instalments at 15, 30 and 50 days after transplanting by applying the entire urea and rest of MoP. Poly-tunnel was used to protect the crop from heavy rainfall and scorching sunlight during the entire cropping period. The height at the middle part of poly-tunnel was 6.00 feet as well as 4.5 feet on both sides of the poly-tunnel. This structure was covered by transparent polythene sheet to ensure sunlight for the crops and both sides were opened to facilitate air movement. After few days of transplanting, some plants were failed to survive due to the unwanted injury during the pulverization of soil at the base of the plant. Weeding and soil mulching were accomplished at 15 days interval to keep the crop field free from weeds for better soil aeration and to break the crust. It also helped in soil moisture conservation. Properly staking was given at the time of well establishment of seedlings using bamboo sticks to keep the plants erect. Irrigation was followed by top dressing. Along with this several surfaces, irrigations were given throughout the growing season as the temperature was high. But it was controlled due to heavy seasonal rain at the mid-period of the growing season. Maladan was applied at the rate of 2ml/litre as a preventive measure against insect pests like cutworm, leaf hoppers and fruit borers. The insecticides were applied at fortnight as routine work from a week after transplanting to a week before first harvesting. Furadan 5G was applied into the soil to control bacterial diseases during the final land preparation. Tomato-tone (4-parachlorophenoxy acetic acid), the growth regulator, at the rate of 2% was sprayed on plants having 4-5 flower clusters at a full blooming stage. Plants received three sprays at seven days interval, and at early morning only blooming flower clusters were sprayed. Two rows in each plot were remained untouched by hormone and which were considered as without hormone-treated plants. Precautionary measures against diseases especially late blight of tomato was taken by spraying Dithane M-45 at the rate of 2g/l fortnight during the early vegetative stage. Data on number of fruits $plant^{-1}$, individual fruit weight (g), fruit yield (kg $plant^{-1}$), fruit length (cm), fruit breadth

(cm), pericarp thickness (mm), locule number and TSS (Total Soluble Solids) of Tomato hybrids for growth and yield contributing characters were recorded separately. Data were statistically analyzed using MSTAT C software. Means were adjudged by DMRT to find out the variation among the different genotypes.

3. RESULTS AND DISCUSSION

3.1 Performance of hybrids

Hybrid combinations showed a significant result on yield performance of tomato during summer (Table 1). Among hybrids, regarding days to the first flower, BARI Hybrid Tomato-4 showed the earliest flower (51.17 days) as it is a heat tolerant variety which was followed by DCH2 (51.67 days) and DCH3 was (55.33 days). Considering the first harvest of fruit, TCH2 was earlier (89.33 days) than DCH3 (91.83 days). The highest number of fruit per plant (22.67) was recorded from BARI Hybrid Tomato-4 because heat tolerant plant blooming more in the open area whereas the lowest number (13.62) from DCH3 but heaviest individual fruit weight (46.65 g) was recorded from DCH3 followed by TCH1 (42.33 g). The maximum fruit yield (0.89 kg plant^{-1}) was harvested from BARI Hybrid Tomato-4 due to the highest number of fruits and minimum fruit yield (0.63 kg plant^{-1}) found in DCH3 due to lowest number of fruits. Fruit yield was (30.26 t ha^{-1}) in BARI Hybrid Tomato-4 where the lowest (21.42 t ha^{-1}) was recorded from DCH3. Remarkable variation was observed among the tomato hybrids. The varietal difference in fruit setting in summer tomato could be due to variation of endogenous auxins before or after anthesis or response of varieties to the application of hormone (Kuo *et al*., 1989) in conjunction with the physiological state of the tissues. Any of the hybrids were not susceptible to hot weather rather among five new hybrids TCH1 showed better yield (0.84 kg plant^{-1}) and excellent individual fruit weight from DCH3 (46.65 g). A similar experiment with regard to fruit number plant^{-1}, individual fruit weight and fruit yield among summer tomato lines through with or without hormone application was conducted by Ahmad *et al*., 2011 and observed that WP7 x C-51 gave the highest individual fruit weight (56.0 g). Among the hybrids, HT019 x WP10 gave highest fruit yield per plant (1.81 kg). In fruit characteristics like fruit length, breadth and locule number, significant variation was recorded among the hybrids. Total soluble solids among the hybrids varied from 5.01% to 5.40%. Statistically significant pericarp thickness is an indication for the hybrids of higher shelf life as tomato fruit of higher pericarp thickness is associated with the higher shelf life (Thakur and Kohli, 2005).

3.2 Effect of growth hormone

Days to the first harvest were positively responsive due to hormone application (Table 2). Minimum 88.94 days required for the first harvest from hormone-treated plants and 91.44 days from untreated condition focusing on at least 2 days early harvesting possibilities. Application of hormone had a significant influence on cell enlargement and cell elongation. It was observed that the higher number of fruits (19.25) was observed with hormone-treated plants compared to untreated plants (16.94) proving better fruit setting as exogenous hormone application prevents flower bud senescence. At higher temperatures, the level of endogenous auxin (IAA like substance) becomes low which arrests the growth of the floral organs and causes abscission (Leopold and Kriedemann, 1975). The maximum individual fruit yield (43.08 g) was collected while plants were with hormone comparing to without hormone (40.06 g). The highest (0.82 kg plant^{-1}) fruit yield was recorded from hormone-treated plants which were higher than that of untreated plants (0.68 kg plant^{-1}). On the other hand, 27.88 t ha^{-1} fruit yield was harvested from hormone-treated plants while it was 23.12 t ha^{-1} from non-hormone plants. Fruit length, breadth also found significant due to cell enlargement comparing fruits of untreated plants.

3.3 Hybrids and hormone interactions

The interaction between hybrids and hormone application were found non-significant in respect of days to first flower and days to first harvest. The maximum (93.33 days) were needed from untreated hybrid 4 (V_4H_0) whereas the minimum (88.00 days) was required to harvest from hybrid 2 (V_2H_1) and hybrid 6 (V_6H_1) when treated with the hormone. Yield and yield attributes of summer tomato were largely influenced by hybrids and hormone interactions. The higher number of fruits plant^{-1} (25.67) was recorded

from hormone-treated hybrid 1 (V_1H_1) while the lowest number (13.03) was obtained from untreated hybrid 4 (V_4H_0) as producing lowest fruit numbers. Hormone-treated hybrid 4 (V_4H_1) showed the highest individual fruit weight (50.41 g) while untreated hybrid 6 (V_6H_0) showed the lowest value (37.49 g). Even all hybrids with the hormone produced the heaviest fruit than without hormone. It was observed that the interaction between hybrid 1 with hormone (V_1H_1) treatment produced highest amount (1.03 kg plant^{-1}) of fruits which was followed by hormone-treated hybrid 5 (0.92 kg plant^{-1}) (V_5H_1). The lowest amount (0.58 kg plant^{-1}) was observed in the interaction of untreated hybrid 6 (V_6H_0). Among all hybrids, only hybrid 3 produced same yield (0.72 kg plant^{-1}) both in hormone and control treatment clearly indicated that this hybrid could be grown during summer without exogenous hormone application. The highest fruit yield (35.02 t ha^{-1}) was recorded from BARI Hybrid Tomato-4 with hormone; while the lowest (19.04 t ha^{-1}) was obtained from untreated hybrid 4 (V_4H_0). Application of growth hormone not only improves fruit setting but also fruit size and yield. Fruit length and breadth both were higher in hormone-treated plants than control treatments. In pericarp thickness, all hybrids were statistically identical except BARI Hybrid Tomato-4 meaning shelf life would be same in treated and untreated hybrids. Both minimum (2.90) and maximum (5.43) locule number were found from untreated hybrid 2 (V_2H_0) and hybrid 1 (V_1H_0), respectively. The highest amount of TSS (5.63 %) was carried by hybrid 5 with hormone treatment (V_5H_1) while minimum (4.80 %) from hybrids 3 without hormone application (V_3H_0). It is clear from the experiment that these five hybrids have possibilities for summer cultivation and found promising for summer tomato production in Sylhet region through with and without hormone application; though hormone-treated plants was showed a significant response to yield attributes.

4. CONCLUSION

From the research, new hybrids are adapted to Sylhet during summer condition and performance of TCH1 was better on yield attributes than other new hybrids. Hybrid DCH3 performed excellent on fruit size with and without hormone application and need further in-depth research to develop new variety among these combinations for Sylhet region in Bangladesh.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Table 1. Performance of tomato hybrids during summer season

Hybrids	Days to flower	Days to harvest	Number of fruits plant^{-1}	Individual fruit wt (g)	Fruit yield plant^{-1} (kg)	Fruit length (cm)	Fruit breadth (cm)	Pericarp thickness (mm)	Locule	TSS	Fruit yield (t ha^{-1})
BHT-4	51.17c	90.17	22.67a	39.35b	0.89a	3.91ab	2.76	6.88a	2.93b	5.32	30.26
DCH1	52.00bc	90.00	18.28b	41.66b	0.76bc	3.87abc	2.85	5.97b	4.77a	5.11	25.84
DCH2	51.67bc	89.83	17.89b	40.45b	0.72cd	3.63bc	2.90	6.19b	3.95a	5.01	24.48
DCH3	55.33a	91.83	13.62c	46.65a	0.63d	3.97a	2.84	6.19b	4.77a	5.17	21.42
TCH1	53.33abc	90.00	19.68ab	42.33b	0.84ab	3.79abc	2.93	5.80b	4.98a	5.40	28.56
TCH2	54.17ab	89.33	16.44bc	38.96b	0.64cd	3.58c	2.87	5.86b	4.60a	5.30	21.76
F-test	*	ns	**	**	**	**	ns	**	**	ns	
CV%	4.18	1.85	12.14	6.18	9.77	4.9	8.20	5.28	13.37	6.25	

Means bearing the same letter(s) in a column do not differ significantly at 1% level of probability, ns indicates there is no significant variations.
** indicates significant at 5% level of probability, ** indicates significant at 1% level of probability. CV = Co-efficient variation*

Table 2. Effect of hormone application on yield attributes during summer season

Hybrids	Days to flower	Days to harvest	Number of fruits plant^{-1}	Individual fruit wt (g)	Fruit yield plant $^{-1}$ (kg)	Fruit length (cm)	Fruit breadth (cm)	Pericarp thickness (mm)	Locule	TSS	Fruit yield (t ha^{-1})
H_1	52.89	88.94	19.25	43.08	0.82	4.00	3.12	6.26	4.23	5.03	27.88
H_0	53.00	91.44	16.94	40.06	0.68	3.58	2.60	6.04	4.44	5.13	23.12
F-test	**ns**	******	**ns**	******	******	******	******	**ns**	**ns**	**ns**	
CV%	4.18	1.85	12.14	6.18	9.77	4.9	8.20	5.28	13.37	6.25	

Means bearing the same letter(s) in a column do not differ significantly at 1% level of probability, ns indicates there is no significant variations,

** indicates significant at 5% level of probability, ** indicates significant at 1% level of probability, CV = Co-efficient variation*

Table 3. Effect of Interactions among tomato hybrids and hormone on yield attributes during summer season

Hybrids	Days to flower	Days to harvest	Number of fruits plant^{-1}	Individual fruit wt (g)	Fruit yield plant^{-1} (kg)	Fruit length (cm)	Fruit breadth (cm)	Pericarp thickness (mm)	Locule	TSS	Fruit yield (t ha^{-1})
V_1H_1	51.33	89.33	25.67a	40.31	1.03a	4.34a	3.06	7.47a	2.97	5.28	35.02
V_1H_0	51.00	91.00	19.67cd	38.39	0.75cd	3.49c	2.47	6.30b	2.90	5.36	25.50
V_2H_1	52.00	88.00	18.61cde	44.16	0.83bc	4.01ab	3.09	5.93b	4.10	5.16	28.22
V_2H_0	52.00	92.00	17.95ef	39.16	0.69d	3.72bc	2.60	6.00b	5.43	5.06	23.46
V_3H_1	51.67	88.33	17.77ef	40.67	0.72cd	3.68bc	3.00	6.07b	4.33	5.22	24.48
V_3H_0	51.67	91.33	18.01de	40.23	0.72cd	3.58c	2.80	6.32b	3.57	4.80	24.48
V_4H_1	55.00	90.33	14.20gh	50.41	0.71d	4.27a	3.28	6.35b	4.67	5.04	24.14
V_4H_0	55.67	93.33	13.03h	42.90	0.56e	3.67bc	2.40	6.04b	4.87	5.29	19.04
V_5H_1	53.00	89.67	21.77bc	42.50	0.92b	4.00ab	3.27	5.74b	4.95	5.63	31.28
V_5H_0	53.67	90.33	17.60ef	42.16	0.77cd	3.58c	2.60	5.85b	5.00	5.16	26.18
V_6H_1	54.33	88.00	17.47ef	40.42	0.70d	3.70bc	3.02	6.00b	4.33	5.47	23.18
V_6H_0	54.00	90.67	15.40gh	37.49	0.58e	3.45c	2.72	5.72b	4.87	5.12	19.72
F-test	ns	ns	*	ns	**	*	ns	*	ns	ns	
CV%	4.18	1.85	12.14	6.18	9.77	4.9	8.20	5.28	13.37	6.25	

Means bearing the same letter(s) in a column do not differ significantly at 1% level of probability, ns indicates there is no significant variations,
** indicates significant at 5% level of probability, ** indicates significant at 1% level of probability, CV = Co-efficient variation, V_1=BARI Hybrid Tomato-4, V_2=DCH1, V_3=DCH2, V_4=DCH3, V_5=TCH1, V_6=TCH2, H_1= with hormone application, H_0= without hormone application*

Appendix III. Analysis of variance of data to observe influence of hybrids and hormone application on yield of tomato during summer season

Source of variation	Mean sum of square						
	Character d.f	Days to first flower	Days to first Harvest	No.of fruit per Plant	Individual fruit weight (g)	Fruit weight per plant (kg)	Length of fruit (cm)
Replication	2	3.111	32.028	3.557	8.848	0.007	0.093
Hybrids (A)	5	15.644*	4.361*	55.565**	47.335**	0.066**	0.148**
Hormone (B)	1	0.111	56.250**	47.771	82.174**	0.175**	1.575**
A x B	5	0.311	2.050	8.300*	11.749	0.013**	0.110*
Error	22	4.899	2.785	4.826	6.596	0.005	0.034

** indicates significant at 1% level of probability, *indicates significant at 5% level of probability

Appendix III. Continued

Source of variation	Mean sum of square				
	Character	Breadth of fruit	Pericarp thickness	Locule number	TSS %
	d.f	(cm)			
Replication	2	0.120	0.034	0.935	0.237
Hybrids (A)	5	0.021	0.942**	3.558**	0.126
Hormone (B)	1	2.454**	0.449	0.412	0.255
A X B	5	0.093	0.396*	0.727	0.128
Error	22	0.055	0.106	0.335	0.106

** indicates significant at 1% level of probability, *indicates significant at 5% level of probability

Appendix I. Mean of monthly weather data during May 2015 to September 2015

Month	Average temperature (^{0}c)		Average rainfall (mm)
	Max. Temperature(^{0}c)	Min. Temperature(^{0}c)	
May	36.1	20.2	26.95
June	36.6	21.4	28.60
July	36.2	24.5	29.25
August	35.4	24.4	28.50
September	37.8	23.6	25.05

Source: Weather Yard of Sylhet Meteorological Division, Sylhet-3100