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EVALUATION OF ADVANCED TOMATO MUTANTS BASED ON GROWTH, YIELD ATTRIBUTES AND YIELD

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Abstract: Field experiment was conducted during November 2009 to March 2010, to investigate growth and yield attributes of advanced tomato mutants (TM-110 and TM-219) along with three cultivars (BARI tomato-3, BARI tomato-14 and BINA tomato-5) following randomized complete block design with three replications. There were significant genotypic differences in respect of morpho-physiological characters (plant height, branch and leaf area, total dry mass, absolute growth rate and relative growth rate), biochemical parameter (nitrate reductase), reproductive characters (number of effective and non-effective flower cluster, number of flowers and reproductive efficiency), phenological characters (days to flowering start, days to first harvest and harvesting duration), yield attributes and fruit yield. In general high yielding genotypes showed superior performance in plant height, branch number, leaf area, total dry mass production, absolute growth rate, nitrate reductase activity and fruit size compared to low yielding ones. Relative growth rate, chlorophyll, photosynthesis, reproductive characters and fruit number had no relationship with fruit yield in tomato. The variety BARI tomato-14 showed the highest fruit yield (77.7 t ha^{-1}) due to its superiority in respect of morpho-physiological, biochemical and larger fruit sizes. In contrast, the mutant TM-110 and the variety BINA tomato-5 produced the lower fruit yield (average 51.2 t ha^{-1}) due to poor performance in growth characters and smaller size of fruits. However, TM-110 matured 4-15 days earlier than the other mutant/varieties. Further, harvesting duration was higher in high yielding genotypes than low yielding ones. The highest harvesting duration was recorded in BARI tomato-14 (28 days) followed by BARI tomato-3 (26 days). This information may be implicated in future plant breeding programme.

Keywords: Growth, yield, mutants, cultivars and genotypic

Introduction

Tomato (*Lycopersicon esculentum* Mill.) is one of the most important popular and nutritious vegetable crop in Bangladesh. It ranks next to potato and sweet potato in respect of production in the world (FAO, 2007). But in Bangladesh, it ranks 2nd which is next to potato (BBS, 2009) and top the list of canned vegetables. Its food value is very rich because of higher contents of vitamin A, B and C (Bose and Sam, 1990). It is a nutritious and delicious vegetable used in salad, soups and processed into stable products like ketchup, sauce, pickles paste, chutney and juice. The crop performs better under an average monthly temperature of 20-23 ^{0}C. But commercially, it may grow at temperature ranging from 15-27 ^{0}C (Haque *et al*., 1999). With the increase of population,

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the demand of tomato in our country is increasing day by day. Further, for the food processing industries (juice, ketchup, sauces, chutney etc.), more tomato production is necessary. So, by increasing tomato producing area, we can fulfil our demand. The principal constraint of tomato production is its low yield potential. About 40 to 70% of tomato flowers do not develop into mature fruits (BINA, 2009) indicating that potential fruit number is usually much higher than the number actually produced by the plant community. The number of fruits reaches to a maximum after maximum fruit growth stages (BINA, 2009) but during this period the plant is still growing vegetatively. Therefore, developing reproductive sinks are competing for assimilates with vegetative sinks. Increasing canopy photosynthesis during this period with elevated CO_2 level increased the number of fruits per unit area (Egli and Zhen-wen, 1991). It is evident that fruits per unit area are related to canopy photosynthesis during flowering and fruit set. However, biochemical properties are related to yield of tomato plant (Dutta, 2004). The higher chlorophyll, nitrate reductase activity and total sugar are helpful in increasing fruit yield in tomato (Dutta, 2004). Varietal improvement of tomato is essentially needed to increase fruit yield. The induced mutation breeding is an effective technique for creating substantial genetic variability in plant species. Many workers have attempted to exploit somaclonal variation for crop improvement through physical mutagens particularly gamma radiation (Begum, 2005). This technique has been successfully utilized by BINA and many other research institutes in the world. The mutation breeding can play an efficient role in developing an ideal plant type having superior physiological performance as well as high yield (Dutta, 2001). To increase productivity in tomato, it is therefore necessary to create variability and select desirable type with stable yield. Under these circumstances, the scientists of Plant Breeding Division of BINA have developed several promising mutants of tomato with high yield potentials. These mutants need to be assessed for their morphological and physiological maneuvering that takes place compared to the existing tomato cultivars. The present research work was designed to assess the performances of two tomato mutants along with three local improved varieties on the basis of morpho-physiological features and yield attributes; and to select better genotypes based on yield performance and other superior characters.

Materials and methods

In this chapter the details of different materials used and methodologies followed during the experimental period are presented under the following heads:

The experiment was carried out at the Field Laboratory, Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh, during the period from 15 October 2009 to 20 March 2010.The experiment consisted of two mutants along with three check varieties. They were TM-110, TM-219, BARI tomato-3, BARI tomato-14 and BINAtomato-5. For raising tomato seedlings, the soil was well prepared through mixing fertilizers and cowdung. The seeds of each genotype were sown in the seed bed on 15 October. The seed beds were prepared in iron sheet (50 cm x 60 cm).

The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The size of the unit plot was 3.0 m x 3.0 m. Distances between block to block and plot to plot were 1.0 and 0.5 meter, respectively. Plant to plant and row to row distances were maintained as 50 cm. Urea, triple super phosphate (TSP), muriate of potash (MP), gypsum and cowdung were applied at the rate of 280, 250, 180, 80 and 10000 kg ha^{-1}, respectively (BARC, 2005). Total amount of TSP, MP, gypsum and cowdung were applied as basal doses during final land preparation. Half of urea was applied as top dressing at 21 days after transplanting and rest half was applied at 45 days after transplanting. The 25-day old seedlings were transplanted in the experimental plot on 10 November 2009. Healthy seedlings were uprooted carefully from seed bed and transplanted maintaining the spacing of 50 cm x 50 cm.

Two irrigations were applied. The first irrigation was applied at 15 days after sowing (DAS) and second one at 50 DAS. Malathion 57 EC was sprayed two times with 10 days interval from 30 days of transplanting to save the crop against white fly and leaf cutter. Kormil 72 MZ WP @ 0.25% was sprayed at 50 and 75 DAT against fruit and shoot borer. To prevent the plants from fungal infection, Dithane M-45 was applied @ 2 g L^{-1} at 15 days interval from 30 DAT. After 30 DAT, each plant was staked with bamboo sticks to keep them erect. First harvest of ripe tomato started at 81 days after transplanting. At initial ripening stage, tomato was harvested at 5-days interval and after a few days, tomato was harvested at 2-days interval. All the harvests were completed by March 2010.

Morphological and growth parameters, Phenological parameters, Biochemical parameters, Reproductive characters and Yield and yield contributing characters were collected.

Absolute growth rate (AGR): Rate of dry matter production per unit of time per plant.

$$\text{i.e., } AGR = \frac{W_2 - W_1}{T_2 - T_1} \quad \text{g plant}^{-1} \text{ day}^{-1}$$

where W_2 and W_1 are the DM at time T_2 and T_1, respectively.

Relative growth rate: Rate of dry matter production per unit of dry matter per unit of time.

$$\text{i.e. } RGR = \frac{\ln W_2 - \ln W_1}{T_2 - T_1} \quad \text{g g}^{-1} \text{ day}^{-1}$$

where W_2 and W_1 are the DM at time T_2 and T_1, respectively.

Chlorophyll estimation: Chlorophyll was estimated following the procedure of Yoshida *et al*. (1976). 50 mg fresh leaf sample was extracted in 10 ml of 80% acetone and the extract was centrifused for 5 minutes at 5000 rpm. Aborbence of supernatant was recorded at 663 and 645 nm in a UV-VIS spectrophotometer. Chlorophyll content was estimated as follows: Total chlorophyll (mg g^{-1}fw) = $[20.2 \times A_{645} - 8.02 \times A_{663}] \times 0.2$

Nitrate reductase (NRase) activity: NRase was estimated following the procedure of Stewart and Orebanjo (1979). (i) 0.05 g chapped leaf sample was taken in 5 ml Assay Solution in a 20 ml vial. (ii) The solution was infiltrated into the leaf sample by shaking and vaccuming for 10 minutes. (iii) The vials containing sample and solutions incubated in a water bath at 25 ^{0}C for an hour. (iv) One ml sulphanylic acid was taken in a 10 ml test tube. (v) One incubated solution was pipetted in the test tube containing 1% sulphanylic acid and then it was shaken. (vi) 1 ml 0.02% NEED was added and allowed for colour development for 15 minutes. (vii) Absorbance of the coloured solutions recorded at 520 nm in a UV-VIS spectrophotometer. NRase measurement was estimated as follows:

NRase = Correction factor × dilution factor × optical density x incubating time. Photosynthetic rate: Photosynthetic rate was determined by photosynthetic meter (Model LI 1400, USA).

Statistical analysis: The collected data were analyzed statistically following the analysis of variance (ANOVA) technique and the mean differences were adjudged by Duncan's New Multiple Range Test (DMRT) using the statistical computer package program, MSTAT-C (Russell, 1986).

Results and discussion

The results of the study on the genotypic effect on morpho-physiological, yield and yield contributing characters of tomato are presented and possible interpretations are made in this chapter.

Morphological and growth parameters

Plant height: Plant height of tomato mutants/varieties differed significantly at three growth stages (Table 1). The plant height increased with age in all the mutants/varieties. The tallest/taller plant was recorded in BARI tomato-14 at three growth stages (66.5 cm, 91.2 cm and 103.9 cm for 40, 60 and 80 DAT, respectively). At 80 DAT, the tallest plant in BARI tomato-3 (108.1 cm) and the shortest plant were recorded in TM-110 (70.8 cm). Kabir (2004) studied morphological parameters in 14 tomato genotypes and reported that plant height differed significantly among the studied genotypes.

Number of branches plant^{-1}: Number of branches plant^{-1} had shown high variability amongst the studied mutants/varieties at all growth stages (Table 1). Results showed that branch number increased with plant age till 80 DAT. The highest number of branches plant^{-1} was recorded in the mutant, TM219 at all growth stages (3.50, 4.20 and 4.46 plant^{-1} for 40, 60 and 80 DAT, respectively) followed by BARI tomato-14 (3.00, 4.25 and 4.43 plant^{-1} for 40, 60 and 80 DAT, respectively) with same statistical rank. The lowest branches plant^{-1} was recorded in the mutant TM-110 (2.44, 3.00 and 3.16 plant^{-1}). The above results of variability in branching were in full agreement with the earlier workers (Bahar, 2002; Halim, 2002; Mohanty, 2003; Hidayatullah *et al*., 2008). The differential response of branching in the genotypes could be attributed to its genetic potentiality.

Table 1: Effect of mutants/varieties on plant height and branch production in tomato

Mutants/ varieties	Plant height (cm) at			Number of branches plant^{-1} at		
	40 DAT	60 DAT	80 DAT	40 DAT	60 DAT	80 DAT
TM-110	44.3 d	65.3 d	70.8 d	2.44 c	3.00 c	3.16 b
TM-219	50.0 c	72.1 c	84.4 c	3.50 a	4.20 a	4.46 a
BARI tomato-3	60.4 b	89.0 a	108.1 a	3.10 b	4.00 a	4.20 a
BARI tomato-14	66.5 a	91.2 a	103.9 a	3.00 b	4.25 a	4.43 a
BINA tomato-5	58.1 b	81.1 b	91.4 b	2.95 b	3.90 b	4.00 a
F-test	**	**	**	**	**	**
LSD (0.05)	3.40	3.60	4.63	0.30	0.35	0.43
CV (%)	5.10	3.50	2.68	5.07	5.20	5.66

In a column, figure (s) with same letter dot not differ significantly at $P \leq 0.05$; **, Significant at 1% level of probability; DAT = Days after planting

Leaf area plant^{-1}: The leaf area plant^{-1} at 40 and 60 DAT differed significantly among the mutants/varieties (Table 2). The highest leaf area at 40 and 60 DAT was recorded in BARI tomato-3 (2136 and 4369 cm^2 plant^{-1} for 40 and 60 DAT, respectively) followed by BARI tomato-14 (2070 and 3433 cm^2 plant^{-1} for 40 and 60 DAT, respectively). The mutant TM-110 produced the lowest leaf area plant^{-1} (1062 and 2656 cm^2 plant for 40 and 60 DAT, respectively). Result revealed that high yielding genotypes also had higher leaf area plant^{-1}. Genotypic variation in leaf area was also reported by Begum (2005) and BINA (2008).

Total dry matter production plant^{-1}: The effect of mutants/variety on total dry matter (TDM) production at 40 and 60 DAT was significant (Table 2). The TDM was greater at 60 DAT than 40 DAT. BARI tomato-3 showed the highest TDM both at 40 and 60 DAT (35.8 and 58.6 g plant^{-1} for 40 and 60 DAT, respectively) followed by BARI tomato-14 (19.6 and 44.4 g plant^{-1} for 40 and 60 DAT, respectively). The lowest TDM production was recorded in BINAtomato-5 (19.8 and 32.0 g plant^{-1} for 40 and 60 DAT, respectively) followed by TM-110 (21.42 and 34.6 g plant^{-1} for 40 and 60 DAT, respectively) with same statistical rank. Increased TDM in BARI tomato-3 was possibly due to higher leaf area. Many workers reported that yield was positively correlated with TDM (Dutta *et al.*, 1995; Das *et al.*, 1998; Kabir, 2004; Islam, 2006). It means high yield genotypes produced high TDM.

Absolute growth rate: Absolute growth rate (AGR) was recorded between 40 and 60 DAT. There was a significant variation in AGR among the studied mutants/varieties (Table 2). BARI tomato-14, the high yielding variety showed the highest AGR (1240 mg plant^{-1} day^{-1}) followed by BARI tomato-3 (1140 mg plant^{-1} day^{-1}). The higher AGR in BARI tomato-14 and BARI tomato-3 might be due to production of higher TDM plant^{-1}. On the other hand, BINA tomato-5 showed the lowest AGR (610 mg plant^{-1} day^{-1}) might be due to production of lower LA and TDM plant^{-1} (Table 2). This result is consistent with BINA (2008) in tomato.

Relative growth rate: Relative growth rate (RGR) showed significant differences among the studied mutants/varieties (Table 2). The highest RGR was observed in BARI tomat-3 (28.6 mg g^{-1} d^{-1}) followed by TM-219 (25.3 mg g^{-1} d^{-1}). In contrast, the lowest RGR was recorded in TM-110 and BARI tomato-14 (24.0 mg g^{-1} d^{-1}). However, BARI tomato-14 though a high yielding variety but showed lower RGR. This result indicates that fruit yield had no relation with RGR in tomato.

Table 2: Effect of mutants/varieties on growth characters in tomato

Mutants/ varieties	Leaf area plant^{-1} (cm^2) at		Total dry mass plant^{-1} (g) at		Absolute growth rate† (mg plant^{-1} day^{-1})	Relative growth rate (mg g^{-1} d^{-1})
	40 DAT	60 DAT	40 DAT	60 DAT		
TM-110	1062 d	2656 d	21.4 bc	34.6 cd	659 cd	24.0 b
TM-219	1428 c	2855 cd	22.3 b	36.9 c	732 c	25.3 ab
BARI tomato-3	2136 a	4369 a	35.8 a	58.6 a	1140 b	28.6 a
BARI tomato-14	2070 ab	3433 b	19.6 d	44.4 b	1440 a	24.0 b
BINA tomato-5	1910 b	3120 bc	19.8 c	32.0 d	610 d	24.6 b
F-test	**	**	**	**	**	*
LSD (0.05)	190.2	344.6	3.10	6.17	112.1	3.34
CV (%)	4.64	5.57	7.13	6.36	6.86	7.02

In a column, figure (s) with same letter dot not differ significantly at $P \leq 0.05$; **, * Significant at 1% and 5% level of probability, respectively; AGR and RGR was taken at during flowering start (40 DAT) to fruiting stages (60 DAT).

Some physiological and biochemical characters

Photosynthetic rate: Non-significant variation on photosynthetic rate was observed in tomato during flowering and fruiting stage (60 DAT) (Table 3). This result disagrees with Sandri *et al.* (2003) who reported that there was a significant variability in photosynthesis among the studied genotypes.

Chlorophyll content in leaf: The chlorophyll content in leaves was recorded at 60 DAT i.e at flowering and fruiting stage and genotypic variation in chlorophyll content was non significant

(Table 3). This result disagreed with BINA (2008) who studied morpho-physiological parameters in 12 tomato mutants/varieties and reported that there was a significant variation in chlorophyll content in leaves that disagrees the present experimental results.

Nitrate reeducates activity: There was a significant variation in NR among the studied mutants/varieties (Table 3). The high yielding genotypes, in general, had shown higher NR value than low yielding ones. The highest NR activity was observed in BARI tomato-3 (8.22 µ mol g^{-1}fw) followed by BARI tomato-14 (7.80 µ mol g^{-1}fw) with same statistical rank. In contrast, the lowest NR activity was recorded in TM-110 (6.96 µ mol g^{-1}fw). Kabir (2004) reported significant variability in NR activity among the genotypes in tomato.

Table 3: Variations in biochemical attributes in tomato mutants/varieties

Mutants/ varieties	Photosynthetic rate (µmol CO_2 dm^{-2} s^{-1})	Chlorophyll (mg/gfw)	Nitrate reductase (µmol NO_2^- /gfw)
TM-110	17.22	2.33	6.96 c
TM-219	17.00	2.26	7.24 bc
BARI tomato-3	16.84	2.43	8.22 a
BARI tomato-14	16.93	2.38	7.80 ab
BINA tomato-5	16.41	2.36	7.14 bc
F-test	NS	NS	*
LSD (0.05)	1.65	0.27	0.69
CV (%)	5.19	6.09	4.92

In a column, figure (s) with same letter dot not differ significantly at $P \leq 0.05$; * Significant at 5% level of probability; NS: Not significant

Reproductive characters

Number of effective flower cluster plant^{-1}: The number of effective flower cluster plant^{-1} was significantly different among the mutants/varieties (Table 4). The mutant TM-110 produced the highest number of effective flower cluster plant^{-1} (10.6) followed by TM-219 (9.46). The lowest number of effective flower cluster plant^{-1} was recorded in BAR tomato-3 (7.60) followed by BARI tomato-14 (8.20) with same statistical rank. BARI tomato-14, a high yielding variety, produced fewer effective flower clusters plant^{-1} while reverse trend was observed in TM-110. This result indicates that number of effective flower clusters plant^{-1} is not obligatory for getting high fruit yield. This result disagrees with Kabir (2004) and Alam (2008) who stated that the yield was positively related with effective flower cluster number plant^{-1}.

Number of non-effective flower cluster plant^{-1}:The non-effective flower clusters plant^{-1} differed significantly among the mutants/varieties (Table 4). The highest number of non-effective flower clusters plant^{-1} was recorded in BARI tomato-3 (13.8) and the lowest was recorded in TM-110 (5.06). This result is conformity with Bhangu and Singh (1993) who reported that genotypic variation in non-effective flower cluster plant^{-1} was observed in tomato genotypes.

Number of flowers plant^{-1}: There was a significant variation in flower production plant^{-1} amongst the mutants/varieties (Table 4). Results revealed that there had no relation in flower production with fruit yield. TM-219 and BARI tomato-3, the medium yielded genotypes showed higher number of flowers plant^{-1} (57.1-60.2) while BARI tomato-14, a high yielding variety, produced lower flowers plant^{-1} (40.1). This result indicates that increased flower production plant^{-1} may not be desirable in achieving high fruit yield in tomato.

Reproductive efficiency: Reproductive efficiency (RE) varied significantly due to mutants/variety (Table 4). Result revealed that RE did not show any regular pattern with fruit yield like plant height or branches. The mutant, TM-110 and variety BINA tomato-5, the low yielding genotypes, showed higher RE with being the highest in TM-110 (67.6%). BARI tomato-3, the medium yielded variety showed the lowest RE (30.3). Genotypic variation in RE was observed by BINA (2007) in tomato that supported the present experimental results.

Table 4: Effect of mutants/varieties on reproductive characters in tomato

Mutants/ varieties	Effective flower clusters $plant^{-1}$ (no.)	Non- effective flower clusters $plant^{-1}$ (no.)	Flowers $plant^{-1}$ (no.)	Reproductive efficiency (%)
TM-110	10.6 a	5.06 c	44.8 b	67.6 a
TM-219	9.46 b	8.06 b	57.1 a	39.6 c
BARI tomato-3	7.60 c	13.8 a	60.2 a	30.3 d
BARI tomato-14	8.20 c	7.53 b	40.1 bc	48.1 b
BINA tomato-5	9.20 b	5.20 c	38.4 c	62.7 a
F-test	**	**	**	**
LSD (0.05)	0.69	1.02	5.31	5.02
CV (%)	4.09	6.80	7.76	6.08

In a column, figure (s) with same letter dot not differ significantly at $P \leq 0.05$; ** Significant at 1% level of probability.

Some phenological characters in tomato

Days to flowering start: The effect of mutants/variety on days required to flowering start was significant (Table 5). The maximum days required to first flowering in BARI tomato-14 (59.0 days). TM-110 had shown the earliest flowering (50.2 days) and it was statistically indifferent from BINA tomato-5 (52.0 days). This result was in agreement with Kabir (2004) who reported first flowering start between 35 and 45 days after transplanting in tomato.

Days to first harvest: Days required to first harvest ranged from 81 to 96 days among the mutants/varieties (Table 5). Of the genotypes, TM-110 had shown the earliest harvest (81 days) and it was significantly different from the remainder. In contrast, the maximum days of fruit harvesting occurred in BARI tomato-14 (96 days) followed by TM-219 and BARI tomato-3 (94 days). This result was in agreement with Karim (2005) and Kabir (2004) who reported first harvest between 85 and 95 days after transplanting in tomato.

Picking duration: Picking duration had significant variability amongst the studied mutants/varieties (Table 5). The highest picking duration was recorded in BARI tomato-14 (28 days) followed by BARI tomato-3 (26 days). In contrast, the lowest picking duration was recorded in TM-110 (21 days) This result was in full agreement with Karim (2005) who observed harvesting duration varied between 16 to 35 days in tomato.

Table 5: Genotypic variation in phenological characters in tomato

Mutants/ varieties	Days to flowering start	Days to first harvest	Harvesting duration (days)
TM-110	50.2 c	81 c	20.1 c
TM-219	55.4 b	94 a	24.3 b
BARI tomato-3	56.2 b	94 a	26.0 ab

BARI tomato-14	59.0 a	96 a	28.0 a
BINA tomato-5	52.0 c	89 b	24.0 b
F-test	**	**	**
LSD (0.05)	2.85	2.92	2.89
CV (%)	3.22	1.72	7.50

In a column, figure (s) with same letter dot not differ significantly at P ≤ 0.05; ** Significant at 1% level of probability.

Yield contributing characters and yield in tomato

Number of fruits plant^{-1}: Fruit number, the most important yield attribute, was significantly different among the mutants/varieties (Table 6). The mutant TM-110 produced the highest number of fruits plant^{-1} (30.3) that was significantly different from the others but this mutant showed lowest fruit yield due to production of smaller size fruit. In contrast, BARI tomato-3 and BARI tomato-14 produced the lower number of fruits plant^{-1} (18.3-19.3) but showed the highest/higher fruit yield plant^{-1} due to larger fruit size. This result is consistent with Begum (2005) and Golok (2006) in tomato.

Single fruit weight: Single fruit weight differed significantly among the studied mutants/varieties (Table 6). BARI tomato-14 produced the highest single fruit weight (104.4 g) followed by BARI tomato-3 (94.7 g). The lowest single fruit weight was found in TM-110 (53.3 g). This variability in single fruit weight agreed with the results of Halim (2002) and Kabir (2004) who observed a wide range of variability in fruit weight among the studied tomato genotypes.

Fruit yield: There was a remarkable difference in respect of fruit yield plant^{-1}, fruit yield plot^{-1} and fruit yield ha^{-1} (Table 6). The variety BARI tomato-14 produced the highest fruit yield plant^{-1} (2.01 kg) and it was similar to BARI tomato-3 (1.74 kg) and TM-219 (1.83 kg). The fruit yield was higher in BARI tomato-14, BARI tomato-3 and TM-219 because of producing larger fruits. In contrast, TM-110 produced the lowest fruit yield plant^{-1}(1.61 kg) due to the production of smaller fruits. Most of the researchers reported that fruit yield in tomato mostly depended on fruit number and fruit size (Dutta *et al.*, 1995; Das *et al.*, 1998; Islam *et al*., 1999; Kabir, 2004; Karim, 2005; Hidayatullah *et al*., 2008) that supported the present experimental results.

In case of fruit yield plot^{-1}, results showed that the highest fruit yield plot^{-1} was recorded in BARI tomato-14 (65.12 kg). The fruit yield plot^{-1} was higher in BARI tomato-14 because of producing higher fruit yield plant^{-1}. The lowest fruit yield plot^{-1} was recorded in TM-110 (52.16 kg) followed by BINA tomato-5 (54.76 kg) with same statistical rank. The fruit yield hectare^{-1} was the converted value of fruit yield plot^{-1}. So the yield performance of per hectare was similar to per plot yield.

Table 6: Yield attributes and yield in five tomato mutants/varieties

Mutants/ varieties	Fruits plant^{-1} (no.)	Single fruit weight (g)	Fruit yield plant^{-1} (kg)	Fruit yield plot^{-1} (kg)	Fruit yield (t ha^{-1})
TM-110	30.3 a	53.3 e	1.61 b	52.16 c	50.6 c
TM-219	22.6 bc	81.0 c	1.83 ab	59.29 b	68.6 b
BARI tomato-3	18.3 d	94.7 b	1.74 ab	53.38 c	66.6 b
BARI tomato-14	19.3 cd	104.4 a	2.01 a	65.12 a	77.7 a
BINA tomato-5	24.1 b	70.0 d	1.69 b	54.76 c	51.8 c
F-test	**	**	*	**	**
LSD (0.05)	5.53	6.16	0.27	4.22	5.49
CV (%)	10.2	4.05	8.02	4.55	4.62

In a column, figure (s) with same letter dot not differ significantly at $P \leq 0.05$; **, * Significant at 1% and 5% level of probability, respectively.

Conclusion

From this study, it could be concluded that, among the studied mutants/varieties, the mutant TM-110 performed the lowest in case of morphological, biochemical, growth and fruit yield but matured 15 days earlier than the highest yielding variety, BARI tomato-14. The other mutant TM-219 performed second highest fruit yield. The variety, BARI tomato-14 performed the best in regarding fruit yield with large size fruits. The fruits of the mutant TM-110 matured 15 days earlier than BARI tomato-14 with considerable fruit yield. So, TM-110 can be recommended as variety for commercial cultivation.

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