Original Research Article
Evaluation of some tomato genotypes against tomato fruit borer infestation, growth parameters and some chemical constituents

ABSTRACT

A field experiment was conducted at Bangladesh Institute of Nuclear Agriculture (BINA) Farm, Mymensingh from October 2007 to March 2008 with a view to evaluate the physical and chemical properties, nutrient content and infestation rate of tomato fruit borer of different mutants and varieties. The treatments consisted of six mutants viz; TM-13, TM-105, TM-110, TM-133, TM-152, TM-155 and two varieties BARI tomato-7 and BINA tomato-5. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. The infestation of tomato fruit borer varied significantly among the mutants/varieties. The number of fruit borer was 2.15-5.98. The following growth parameters, yield contributing characters and chemical composition of the tomato mutants/varieties were studied which were 1.03-1.40 cm stem diameter, 14.9-19.5 cm^2 leaf area, 10.08-20.10 mm^{-2} leaf hair, 36.7-52.0 number of leaves $plant^{-1}$, 13.86-24.67 number of fruits $plant^{-1}$, 24.1- 60.2 g single fruit weight, 3.69-4.0 pH, 17.1 -25.2 mg 100 g^{-1} vitamin-C, 0.307-0.408% TA, 2.34-2.75% reducing sugar, 0.93-1.20% non-reducing sugar. Tomato fruit borer infestation was negatively correlated with leaf hair and number of fruit $plant^{-1}$ but positively correlated with stem diameter, leaf area, leaf number $plant^{-1}$ single fruit weight, non-reducing sugar, pH and titrable acidity. It is concluded that TM-133 and TM-13 mutants were the best among the tested verities respectively.

Keywords: Tomato, Tomato fruit borer, Heliothis armigera, Transmutants

1. INTRODUCTION

Tomato (*Solanum lycopersicum* L.) is one of the most popular and nutritious vegetable crops in Bangladesh, which belongs to the family Solanaceae. It is grown not only in Bangladesh but also in many countries of the world. It ranks next to potato and sweet potato in the world vegetable production [1]. Among the winter vegetable crops in Bangladesh, tomato ranks second in respect of production and third in respect of area [2]. Bangladesh produced approximately 389000 metric tons tomatoes in 27518 Ha of land in 2016-2017 [3]. Tomato is very much susceptible to insect attack from seedling to fruiting stage. All parts of the plant including leaves, stems, flowers and fruits are subjected to attack. This crop was attacked by different species of insects in Bangladesh. Among them, tomato fruit borer, *Helicoverpa armigera* (Hübner), is one of the serious pests. It has been reported to cause

damage to extent of about 50-60 per cent fruits [4]. Tomato fruit borer is highly polyphagous insect and perhaps the most serious pest of Indian Agriculture [5]. Tomato fruit borer is one of the major constraints of tomato production in the region. Generally, the farmers of Bangladesh control this pest by the application of insecticides. But the application of chemical has got many limitations and undesirable side effects [6, 7]. Indiscriminate use of synthetic chemicals for controlling pests of crop plants resulted in to hazardous effects causing serious problems including pest resistance, pest outbreak, pest resurgence and environmental pollution. Moreover, the farmers of Bangladesh are very poor and they have very limited access to buy insecticides and the spraying equipment [8]. It is also dangerous to use insecticides on vegetables because the farmers pluck the fruit after one or two days of application and sell it in the market. This may cause serious health hazards to the consumers. So, incorporation of resistant characteristics of tomato against one or more insect pests is desirable to minimize the cost of pesticide application and to reduce environmental pollution and health hazard. The use of resistant variety(s) of tomato in vegetable pest management programme is considered to be economical and safer compared to the chemical control. It is very essential to cultivate a resistant and tolerant variety against insect pests specially tomato fruit borer.

In view of this requirement, the present experiment was undertaken to identify the plant morphological characters and chemical characteristics influencing the infestation rate of tomato fruit borer and to analyse the nutrient status of different tomato mutants/varieties.

2. MATERIAL AND METHODS

The experiment was conducted at the Bangladesh Institute of Nuclear Agriculture (BINA) farm, Mymensingh, Bangladesh. Eight tomato genotypes were used in the study. Among them, two varieties (BINA tomato-5 and BARI tomato-7) developed and released by Bangladesh Institute of Nuclear Agriculture (BINA) and Bangladesh Agricultural Research Institute (BARI) respectively and six transmutants (TM-13, TM-105, TM-110, TM- 133, TM-152 and TM- 155) were developed by Bangladesh Institute of Nuclear Agriculture (BINA). The experiment was laid out in a Randomized Complete Block Design (RCBD) with 3 replications. The plot size used was 4 m × 3 m. Prior planting, experimental plots was ploughed and cross-ploughed three times by power tiller followed by laddering to obtain desirable tilth. All the stubbles, crop residues and uprooted weeds were collected and removed from the plots before planting.

Data were recorded on individual plant basis from 10 randomly selected plants in each plot. Sampling was done at one stage of tomato plants. The pest was examined carefully in the tomato plants from canopy to bottom the observation was made very carefully on the stem and both side of the leaf. Other physical parameters (Plant height, Leaf area, Stem diameter, Leaf hair density, number of leaves plant $^{-1}$, Number of fruits plant^{-1} and Single fruit weight), chemical and biochemical parameters measured include Vitamin C content, pH, Titrable acidity, Reducing and non-reducing sugar contents were recorded. All chemical and physical parameter analyses were carried out at the Department of Agricultural Chemistry, and Central Laboratory, Department of Crop Botany and Department of Biochemistry, Bangladesh Agricultural University, Mymensingh, Bangladesh.

2.1. Statistical analyses

The data was analysed statistically by F-test [9]. Analysis of variance was done with the help of computer package M-STAT [10]. The mean comparisons of the treatments were separated by using DMRT (Duncan's Multiple Range Test) at 5% level of significance.

3. RESULTS AND DISCUSSION

3.1. Number of fruit borer plant^{-1}

The number of fruit borer infestation was statistically significant in different tomato varieties and genotypes. The result is presented in Table 1. The maximum fruit borer infestation (5.98) was observed in BARI tomato-7 and lowest was (2.15) in TM-133. The result was in agreement with the finding of Naik et al. [11], who reported that the lowest fruit borer infestation was observed on IIVR Sel-1, JKTH-3064 and Mani khamenu at 0.86, 0.86, 0.88 larvae plant^{-1}. TH-317 showed the lowest number of damage fruits on the other hand Ruby showed the highest fruit damage.

Table 1. Plant height, stem diameter, leaf area, leaf hair and number of leaves plant^{-1} and insect infestation rate of some tomato genotypes and varieties grown at Mymensingh

Tomato genotypes/ variety	Stem diameter (cm)	Leaf area (cm^2)	No. of leaf hair 10 mm^{-2}	No. of leaves plant^{-1}	No. of fruits plant^{-1}	Single fruit weight (g)	Fruit borer plants^{-1}
TM-13	1.17	16.49 bc	20.10 a	38. 7 bc	24.31 a	54.1 b	3.69 de
TM-105	1.40	19.48 a	14.57 b	47.0 ab	23.27 ab	50.2 c	3.70 de
TM-110	1.10	16.08 bc	16.07 b	39.01 bc	16.29 de	24.1 f	4.93 b
TM-133	1.03	18.09 ab	16.15 b	36.7 c	24.67 a	58.8 a	2.15 f
TM-152	1.09	17.08 abc	11.60 c	46.3 ab	18.82 cd	44.2 de	4.73 be
TM-155	1.36	14.90 c	16.15 b	43.7 abc	24.51 a	55.6 b	3.40 e
BARI tomato-7	1.37	18.06 ab	10.08 c	52.0 a	13.86 e	60.2 a	5.98 a
BINA tomato-5	1.16	16.40 bc	14.93 b	44.7abc	19.45 bc	46.0 d	4.17 cd
SE (±)	0.106	0.773	0.679	2.52	1.13	0.641	2.87
CV (%)	15.3	7.84	7.87	10.0	9.52	3.46	6.20

**Means having common letter in a column are not significantly different by DMRT at 5% level.*

3.2. Quantitative relationships of Tomato fruit borer and plant characters

Tomato fruit borer infestation was found to be positively correlated with the plant stem diameter (0.239), leaf area (0.216), number of leaves plant^{-1} (0.715), single fruit weight (0.034) but negatively correlated with number of leaf hair plant^{-1} (-0.905) and number of fruits plant^{-1} (-0.435). These results indicated that plant height, stem diameter, leaf area, number of leaves plant^{-1} and single fruit weight induced higher fruit borer infestation. The result is presented in Table 2. On the other hand, number of leaf hair plant^{-1} and number of fruits plant^{-1} reduced the infestation rate of tomato fruit borer. Tomato fruit borer infestation had significant correlation with number of leaves plant^{-1} and number of fruits plant^{-1} at 1% level. The result was similar with the finding of Rath and Nath [12] who found that leaf hair density;

leaf area, leaf density and fruit diameter were showed positively correlated with insect infestation rate but negatively correlated with single fruit weigh.

Table 2. Correlation matrix between plant characters and tomato fruit borer

Plant characters	Stem diameter (cm)	Leaf area (cm^2)	No. of leaf hair ($10\ mm^{-2}$)	No. of leaves $plant^{-1}$	No. of fruits $plant^{-1}$	Single fruit weight (g)
Leaf area (cm^2)	0.356	-				
No. of leaf hair $10\ mm^{-2}$	-0.197	-0.269	-			
No. of leaves $plant^{-1}$	0.365	0.184	-0.580*	-		
No. of fruits $Plant^{-1}$	-0.311	-0.333	0.270	-0.455	-	
Single fruit weight (g)	0.087	-0.164	-0.066	0.121	-0.164	-
Fruit borer $plant^{-1}$	0.239	0.216	-0.905**	0.715**	-0.435	0.034

**P <0.05 **P<0.01*

3.3. Tomato fruit borer and fruit chemical constituents

Tomato fruit borer infestation was found to be positively and negatively correlated with chemical constituent (Table 3). Positively correlated with the vitamin-C (0.156) and reducing sugar (0.119) content but negatively correlated with non-reducing sugar (-180), pH (-0.300), titrable acidity (-0.547) and protein (-0.677) content. These results indicated that vitamin-C and reducing sugar induced higher fruit borer infestation. On the other hand, non-reducing sugar, pH, titrable acidity and protein content of tomato fruits reduced the infestation of tomato fruit borer. Tomato fruit borer infestation had significantly correlated with vitamin-C and protein at 5% level.

Table 3. Correlation matrix between tomato fruit borer and fruit chemical constituents

Characters	pH	Vitamin-C (mg $100\ g^{-1}$)	Reducing sugar (%)	Non-reducing sugar (%)	Titrable acidity (%)	Protein (%)
Vitamin-C (mg $100\ g^{-1}$)	0.346	-				
Reducing sugar (%)	0.516*	0.277	-			
Non-reducing sugar (%)	0.553*	0.491	0.272	-		
Titrable acidity	0.299	0.155	-0.138	0.268	-	
Protein (%)	0.537*	0.002	0.184	0.242	0.281	-
Fruit borer $plant^{-1}$	-0.300	0.156	0.119	-0.180	-0.547*	-0.677*

**P <0.05 **P<0.01*

3.4. Chemical characteristics

3.4.1. Vitamin-C content

Vitamin C content showed statistically significant variation among the different genotypes and varieties. The result is presented in Fig. 1. The content of vitamin-C ranged from 17.1 to 25.2 mg 100 g^{-1}. Considering all the genotypes and varieties, TM-133 has the highest (25.20 mg 100 g^{-1}) vitamin-C content which was statistically similar with TM-152 (mg $100g^{-1}$), BARI tomato-7 (24.36 mg 100^{-1}g) and BINA tomato-5 (24.12 mg 100 g^{-1}).The lowest (17.10 mg 100^{-1}g) vitamin-C content was observed in TM-110 which was statistically identical with TM-105 (17.07 mg 100 g^{-1}). These results are supported by Dod and Kale [13] and they reported that vitamin-C content in tomato ranging from 14.20 to 25 mg 100 g^{-1}.

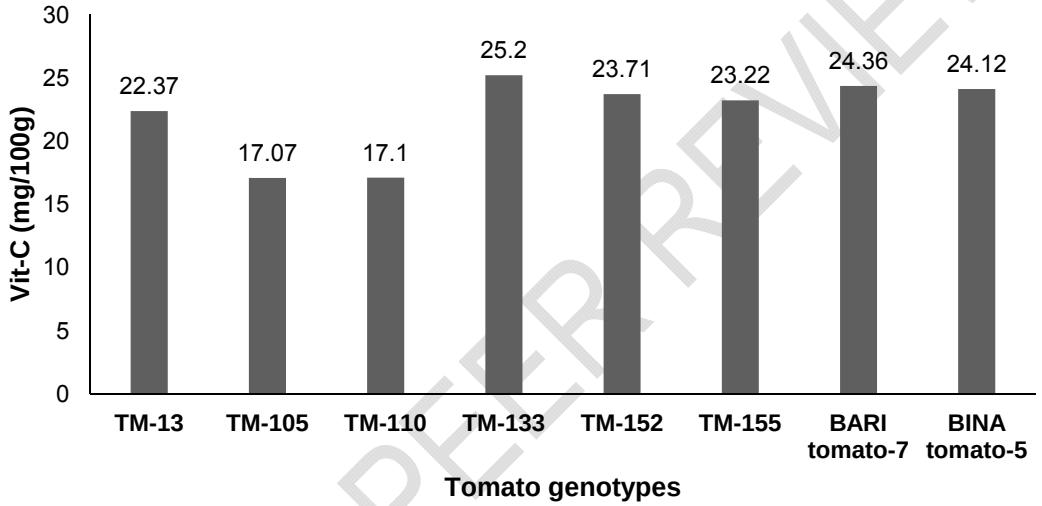

Fig.1. Vitamin-C content of different varieties and genotypes of tomato

3.4.2. pH

The pH value of all varieties and genotypes showed significant variation. Among the all the varieties and genotypes TM-133 gave the height (4.00) pH value, which was statistically similar TM-13 (3.84) and TM-152 (3.84). The lowest (3.75) pH value was obtained from TM-155 which was statistically identical with TM-110 (3.71), BARI tomato-7 (3.73), BINA tomato-5 (3.72) and TM-105 (3.69). The results were in agreement with that of Saimbhi *et al.* [14] who reported that pH value in tomato should be less than 4. These results have been presented in Table 4.

3.4.3. Titrable acidity

There was no statistically difference of titrable acidity among the genotypes and varieties. The result presented in Table 4 showed that TM-13 gave the height (4.08%) titrable acidity and the lowest (0.307%) acidity was obtained in TM-105 genotypes. The result was very much similar with the finding of Young [15] who state that the variation of titrable acidity ranged from 0.30 to 0.056 %.

Table 4. pH, reducing sugar, non-reducing sugar, and titrable acid contents of some tomato genotypes and varieties

Tomato genotypes/varieties	pH	Reducing sugar (%)	Non-reducing sugar (%)	Titrable acidity (%)
TM-13	3.84 ab	2.51	1.03	0.408 a
TM-105	3.69 b	2.46	0.93	0.307 b
TM-110	3.71 b	2.49	0.99	0.343 ab
TM-133	4.00 a	2.75	1.20	0.375 ab
TM-152	3.84 ab	2.46	1.04	0.320 b
TM-155	3.75 b	2.34	1.00	0.351 ab
BARI tomato-7	3.73 b	2.73	1.02	0.322 ab
BINA tomato-5	3.72 b	2.63	1.00	0.356 ab
SE (±)	0.058	0.115	0.060	0.028
CV (%)	2.64	7.86	0.061	14.1

**Means having common letter in a column are not significantly different by DMRT at 5% level.*

3.4.4. Reducing sugar content

Reducing sugar content showed no statistically significant variation among the genotypes and varieties and ranged from 2.34 to 2.75% (Table 4). Considering all the genotypes and varieties TM-133 had the highest (2.75%) reducing sugar content and TM-155 (2.34%) had the lowest (2.34%) reducing sugar content.

3.4.5. Non-reducing sugar content

Non-reducing sugar content showed no significant difference among the genotypes. Non reducing sugar content ranged from 0.93 to 1.20%. Among the all genotypes and varieties TM-133 showed the highest (1.20%) non-reducing sugar content, while TM-105 exhibited the lowest (0.93%) non-reducing sugar content. Kallo [16] conducted an experiment in India and obtained that total sugar content in tomato ranging from 2.50-4.50% and reducing sugar content ranging from 1.50-3.50%. The result is presented in Table 4.

4. CONCLUSION

Considering all the genotypes and varieties, TM-133 produce the highest vitamin-C content, pH value, titrable acidity, reducing sugar content, non-reducing sugar content. Besides Fruit borer population was also found lowest in number. From the study it could be concluded that TM-133 and TM-13 mutants were the best among the test entries irrespective of physical parameters, insect infestation rate, chemical composition and other nutrient contents of tomato fruits. Further studies at different locations of Bangladesh should be under taken to confer the results of our studies before final conclusion and releasing the genotypes as varieties.

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