Original Research Article
Evaluation of some tomato genotypes in respect of tomato fruit borer infestation, growth parameter 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 aphid and fruit borer of different mutants and varieties. The experimental treatment includes 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 a Randomized Complete Block Design (RCBD) with three replications. Three different insects were observed in the tomato field. The infestation of tomato fruit borer and aphid varied significantly among the mutants/varieties. The number of fruit borer and lady bird beetle plant^{-1} were 2.15-5.98 and 0.88-3.18 respectively. The number of aphid infestation plant^{-1} was 0.700-1.16. 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 one among the tested verities respectively physical parameters, insect infestation rate and chemical composition of tomato fruits.

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

1. INTRODUCTION

Tomato (*Lycopersicon esculentum*) 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, *Heliothis armigera,* is one of the serious pests. This 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 the major constraint in the production of tomato in the region. Generally, the farmers of Bangladesh control this pest by the application of chemical insecticides. But the application of chemical insecticides has got many limitations and undesirable side effects [6, 7]. Indiscriminate use of synthetic chemicals for controlling pests of crop plants resulted 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, 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 genotypes of tomato were used as study materials. 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) are developed by Bangladesh Institute of Nuclear Agriculture (BINA). The experiments were laid out in a Randomized Complete Block Design (RCBD) with 3 replications. The size of the unit plot was 4 m × 3 m. Before planting, the land of the experimental fields was ploughed with a power tiller. Later on, the land was ploughed and cross-ploughed three times followed by laddering to obtain desirable tilth. After ploughing and laddering all the stubbles, crop residues and uprooted weeds were collected and removed from the main field and the land was ready. Whole experimental land was divided into unit plots maintaining the desired spacing.

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 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) and chemical and biochemical parameters (Vitamin C content, pH, Titrable acidity, Reducing and non-reducing sugar contents) was 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 were analysed statistically by F-test [9]. The ANOVA for each character is shown in appendix section. Analysis of variance was done with the help of computer package M-STAT [10]. The mean comparisons of the treatments were evaluated by DMRT (Duncan's Multiple Range Test).

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. These results have been 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 results were 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 Tomato fruit borer and plant characters

Experimental information on correlation coefficient is particularly useful for measuring the relationship among the variables. These results have been presented in Table 2. 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 indicate that plant height, stem diameter, leaf area, number of leaves plant^{-1} and single fruit weight induced higher fruit borer infestation. 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 identical with the finding of Rath and Nath [12] who found that leaf hair density; leaf area, leaf density and fruit diameter showed positively correlated with insect infestation ratel 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

Experimental information on correlation coefficient is particularly useful for measuring the relationship among the variables. 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 (%)	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

The concentration of vitamin C in tomato is very important chemical characteristics. Vitamin C content showed statistically significant variation among the different genotypes and varieties. These results have been 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] (1997) and they reported that vitamin-C content in tomato ranging from 14.20 to 25 mg 100 g^{-1}.

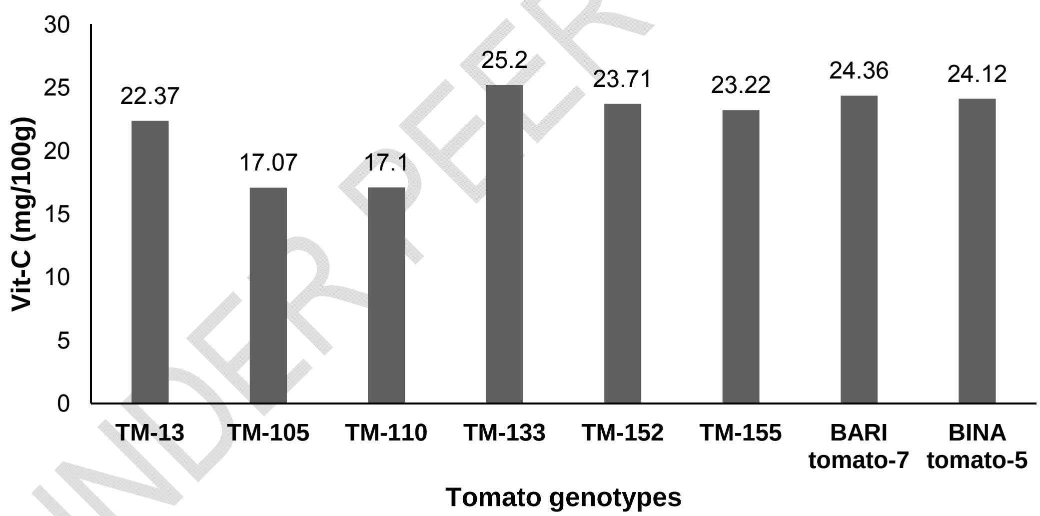

Fig.1. Vitamin-C content of different varieties and genotypes of tomato

3.4.2. pH

The pH value of all varieties and genotypes showed significant variation. These results have been presented in Table 4. 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.

3.4.3. Titrable acidity

There was no statistically difference of titrable acidity among the genotypes and varieties. The results have been presented in Table 4. Considering all the varieties and genotypes, TM-13 gave the height (4.08%) titrable acidity and the lowest (0.307%) titrable acidity was obtained in TM-105 genotypes. These results were very much identical 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 statistically insignificant variation among the genotypes. The results have been presented in Table 4. 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%.

4. CONCLUSION

Fruit borer was maximum in BARI tomato-7 and minimum in TM-133 ranging from 5.98-2.15 to 116-0.700. Considering all the genotypes and varieties, TM-133 produce the highest (25.20 mg 100^{-1} g) vitamin-C content and TM-110 showed the lowest (17.10 mg 100^{-1} g) vitamin-C content. Among all the varieties and genotypes TM-133 gave the highest pH value (4.00) and TM-105 gave the lowest pH value (3.69). TM-133 produces the highest (0.408%) titrable acidity; while TM-105 had the lowest (0.307) titrable acidity. TM-133 had the highest reducing sugar content (2.75%) and TM-155 had the lowest reducing sugar content (2.34%).

Among the all genotypes and varieties TM-133 had the highest non reducing sugar content (1.20%) and TM-105 had the lowest non reducing sugar content (0.93%). 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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