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FIELD SCREENING OF BRINJAL GERMPLASM FOR RESISTANCE AGAINST SHOOT AND FRUIT BORER

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ABSTRACT

Investigations on the screening of twelve brinjal germplasms namely, BD 7320, BD 7328, BD 9952, BD 10154, BD 10158, BARI Begun 1, BARI Begun 4, BARI Begun 5, BARI Begun 6, BARI Begun 7, BARI Begun 8 and BARI Begun 9 were conducted against shoot and fruit borer at the experimental plots of Bangabandhu Sheikh Mujibur Rahman Agricultural University, Gazipur, Bangladesh. The abundance and infestation of the shoot and fruit borer as well as its effect on the reproductive performance of the germplasms were studied. Infestation levels of the shoot and fruit borer on the germplasms differed significantly with different date of the season. The abundance of shoot and fruit borer larvae in the fruits of the germplasms varied significantly and the germplasms BD 9952, BARI Begun 6 and BARI Begun 4 showed statistically similar and the lowest result. BARI Begun 6 depicted the lowest level of infestation compared to other germplasms. Considering the infestation level, the germplasms BD 9952 and BARI Begun 6 were categorized as resistant. The studied germplasms showed variations in the duration of the reproductive growth stages, yield contributing characters of the fruits, yield and seed weight. The germplasm BD 7320 showed the shortest durations for maturity of fruits for marketing and seed production. The largest fruit, the highest yield and seed weight were found from the germplasms BARI Begun 6, BD 9952 and BARI Begun 4, respectively.

Keywords: Abundance, infestation, *Solanum melongena*, *Leucinodes orbonalis*, yield

Introduction

Brinjal *Solanum melongena* L., one of the important vegetables is widely cultivated in tropical and subtropical regions of the world (Thapa 2010, Harish *et al*. 2011). In Bangladesh, brinjal is cultivated year round but the yield is very low because of the infestation of shoot and fruit borer *Leucinodes orbonalis* (Patil 2010). The larvae of the shoot and fruit borer attack brinjal plants from seedling to harvesting stage and cause yield loss up to 70% (Jat and Pareek 2003, Jayaraj and Manisegaran 2010). The pest may cause 100% damage if no control measures are taken (Rahman *et al*. 2011).

Patnaik (2000) reported the incidence of *L. orbonalis* in July planted brinjals and found the peak infestation (59.2-75.5%) during September and October. Krishnaiah and Vijay (1975) found 1.8-23 % fruit damage that started at 1st week of January and gradually increased till the last week of March. During vegetative stage the larvae bore into tender shoots causing wilting and die back of the branch terminals. This reduces the fruit bearing capacity of plant. During the reproductive stage, tiny larva bores into the flower buds and fruits, the bored holes are invariably plugged with excreta and feed inside until they pupate (Mehto *et al*. 2015).

For successful brinjal production in Bangladesh, farmers look for the varieties that are not susceptible to shoot and fruit borer. However, development of a resistant variety through cross-breeding and genetic modification requires information on host-plant morphology and interactions between the host-plants and herbivore insect behavior and ecology. To implement the Integrated Pest Management (IPM) programs, germplasm screening should be the main focus. Therefore, The present study was conducted to screen brinjal germplasms for resistance against shoot and fruit borer, and to evaluate the yield performance of the germplasms.

Materials and Methods

Cultivation of brinjal germplasm: The study was conducted in the field and laboratory of the Department of Entomology, Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU), Gazipur, Bangladesh from September 2018 to March 2019 with the brinjal germplasms namely, BARI Begun 1, BARI Begun 4, BARI Begun 5, BARI Begun 6, BARI Begun 7, BARI Begun 8, BARI Begun 9, BD 7320, BD 7328, BD 9952, BD 10154 and BD 10158. The seeds of the germplasms were collected from the Plant Genetic Resource Centre (PGRC), Bangladesh Agricultural Research Institute (BARI). The seeds of germplasms were sown on 15 October 2018 in polythene bags for raising of seedlings. The seedlings were transplanted in the experimental plots on 14th November, 2018. Each plot measured an area of 3.0 m × 3.0 m. The study was conducted in randomized complete block with three replications. The spacing between block to block and plot to plot was 1.0 m and 1.0 m, respectively. Each plot had 3 rows and each row contained 5 plants. All the intercultural operations, except insect control measures, were undertaken based on necessity. Fertilizers were applied according to Fertilizer Recommendation Guide of Bangladesh Agricultural Research Council (FRG, 2018) (N = 40, P = 12.5, K = 30 and S = 5 kg ha^{-1}, and cow dung 5 ton ha^{-1}).

Observation of the durations of the developmental stages of the germplasm: After transplanting the seedlings of the germplasms, weekly observations were done to collect data. Every observation day, five plants were randomly selected and the data of the durations for fruit initiation, fruit elongation, marketable maturity of fruit and seed production were recorded.

Observation of fruit infestation and abundance of larvae: During fruiting stage, the plants of each germplasm were checked weekly interval to collect the data of the total number of fruits and the number of infested fruits per plant. Then the fruit infestation levels of the plants were calculated in to percentage. Ten infested fruits for each germplasm were exposed to count the abundance of larvae per fruit.

Categorization of the germplasms based on infestation level: The tested germplasms were graded into different categories of resistance. The resistance categories include tolerant, moderately tolerant, susceptible and highly susceptible corresponding fruit infestation of < 15%, 16-25%, 26-40% and >40%, respectively (Subbaratnam and Butani 1981).

Yield and yield contributing characteristics: The mature fruits of each plot were harvested and weighed using a digital balance (CANRY, China) and the plot wise yield was converted in to t/ha. Some yield contributing characteristics such as number of fruits per plant, fruit weight, length and diameter, and thousand seed weight were measured. Fruit length was measured using meter scale and slide calipers was used to measure the diameter of the fruits. The measurements were replicated ten times for each parameter. Sun dried thousand seed weight of each germplasm was taken using the digital balance.

Statistical analysis: Multivariate analysis of variance (MANOVA) was used to analyze the seasonal infestation of the fruits. A one-way analysis of variance (ANOVA) was applied for determining the abundance of pest, variation of plant developmental phenomena, infestation percentage and yield of the tested germplasm. The mean values were separated according to Tukey HSD posthoc test. All the analyses were performed using IBM SPSS 21.0 (IBM SPSS Statistics, Armonk, NY, USA).

Results and Discussion

The occurrence of shoot and fruit borer was observed from 09 January to 27 March 2019 on the tested brinjal germplasms (Table 1). All the germplasms revealed the lowest infestation level on 9 January and the infestation increased thereafter. The findings showed conformity with Krishnaiah and Vijay (2013), who reported increasing trend of infestation from the first week of January to last week of March. The rate of fruit infestation by shoot and fruit borer tended to increase with the increase of fruit age. Javed *et al*. (2011) reported 4.8% to 58.6% infestation among different cultivars.

The abundance of larvae in the tested germplasms ranged from 1.1±0.1 to 2.6±0.2 per fruit and the results differed significantly (Table 2). BD 9952, BARI Begun 6 and BARI Begun 4 showed statistically similar and the lowest abundance compared to other germplasms. Considering the fruit infestation, the germplasms BD 9952 (14.6%) and BARI Begun 6 (14.0%) were categorized as resistant, because their infestation rate was within the range of 0% to 15% (Table 2). Rest of the germplasms was categorized as moderately resistant as their infestation were within the range of 16–25%.

Table 1. Seasonal infestation level (%) of shoot and fruit borer larvae in the fruits of the brinjal germplasms during January to March 2019

Observation date	Brinjal germplasms											
	BD 7320	BARI Begun 5	BD 7328	BD 9952	BARI Begun 1	BARI Begun 6	BARI Begun 4	BARI Begun 7	BARI Begun 8	BARI Begun 9	BD-10158	BD10154
09 January	00.0c	00.0b	00.0c	00.0c	00.0d	00.0c	00.0c	00.0b	00.0c	00.0b	00.0e	00.0d
15 January	00.0c	00.0b	00.0c	5.6bc	16.4cd	00.0c	00.0c	12.4ab	00.0c	00.0b	00.0e	00.0d
24 January	10.0bc	17.6a	9.6bc	10.0abc	25.8ab	00.0c	18.0ab	21.6ab	4.0bc	12.0ab	7.0de	10.0cd
31 January	16.0ab	21.4a	12.8ab	10.2abc	16.8cd	8.0ab	5.8bc	7.8ab	11.0abc	16.8ab	12.6cde	16.8abcd
07 February	20.0ab	29.0a	20.0ab	18.2ab	16.0cd	10.0ab	14.2abc	33.2a	13.6abc	18.0ab	17.0bcd	13.2bcd
14 February	20.2ab	24.8a	19.8ab	21.0a	10.6d	13.0ab	28.0a	6.8ab	24.4ab	13.6ab	21.0abc	16.6abcd
21 February	17.3ab	18.0a	22.0a	22.4a	14.6cd	16.7ab	16.2ab	13.6ab	30.7a	17.4ab	26.7ab	19.6abc
28 February	21.3ab	19.4a	20.1ab	14.2ab	21.2abc	19.3ab	16.8ab	20.2ab	30.7a	22.4ab	28.2ab	29.9ab
05 March	18.8ab	28.4a	20.2ab	19.0ab	21.6abc	20.7bab	19.6ab	11.6ab	23.3ab	26.6a	28.2ab	31.9a
12 March	24.6a	16.6a	22.2a	18.0ab	16.0cd	23.9ab	20.2ab	16.0ab	19.0abc	25.4a	23.8abc	25.0abc
19 March	21.7a	19.6a	22.2a	17.8ab	25.8ab	26.7ab	19.2ab	21.7ab	21.6abc	28.6a	31.0a	34.6a
27 March	20.4ab	29.4a	18.2ab	18.4ab	27.5a	30.0a	19.0ab	31.0a	25.8ab	29.6a	25.1abc	27.9abc

Data expressed as mean ± SE. Means within a column followed by common letter(s) are not significantly different by Tukey HSD posthoc statistic at < 0.05.

Table 2. Abundance (number/fruit) and infestation (%) of shoot and fruit borer larvae and the category of resistance of the brinjal germplasms

Germplasms	Abundance	Fruit infestation (%)	Category of resistance
BD 7320	1.3±0.2 cd	15.9±1.0 ab	Moderately resistant
BARI Begun 5	2.6±0.2 a	18.7±1.2 ab	Moderately resistant
BD 7328	1.5±0.2 bcd	15.6±1.0 ab	Moderately resistant
BD 9952	1.2±0.1 d	14.6±0.8 ab	Resistant
BARI Begun 1	2.5±0.2 a	19.3±0.9 a	Moderately resistant
BARI Begun 6	1.1±0.1 d	14.0±1.2 b	Resistant
BARI Begun 4	1.2±0.1 d	14.8±0.8 ab	Moderately resistant
BARI Begun 7	1.4±0.2 bcd	16.3±0.9 ab	Moderately resistant
BARI Begun 8	2.1±0.2 ab	17.0±1.2 ab	Moderately resistant
BARI Begun 9	2.0±0.2 abc	17.5±1.2 ab	Moderately resistant
BD 10158	2.3±0.2 a	18.4±1.1 ab	Moderately resistant
BD 10154	2.4±0.2 a	18.8±1.2 ab	Moderately resistant

Data expressed as mean ± SE. Means within a column followed by common letter(s) are not significantly different by Tukey HSD posthoc statistic at < 0.05.

The studied brinjal germplasm showed significant variations in the durations of the reproductive growth stages (Table 3). In case of fruit initiation and fruit elongation, BARI Begun 1 showed the lowest results (52.8±0.4 and 58.0±0.3 days, respectively). BD 7320 showed the shortest durations for marketable maturity and seed production maturity of fruits (86.8±0.4 and 107.2±0.4 days, respectively). The studied germplasms were cultivated in a homogenous environmental and soil conditions but they differed in their durations of vegetative and reproductive growth stages, which are their inherent characteristics and may be the effect of shoot infestation.

The yield contributing characteristics of the fruits of the germplasms differed significantly (Table 4). BARI Begun 6 and BD 7320 showed significantly the lowest and highest result in case of fruit per plant. The germplasm BARI Begun 7 revealed the longest fruit and highest diameter and weight was found on BARI Begun 6.

Table 3. Durations (days after transplanting) required for attaining different growth stages of the fruits of the brinjal germplasms exposed to shoot and fruit borer infestation

Germplasms	Durations required for different growth stages of fruit			
	Initiation	Elongation	Marketable maturity	Seed production
BD 7320	70.8±0.7 ab	76.0±0.7 a	86.8±0.4 f	107.2±0.4 g
BARI Begun 5	67.0±0.4 cd	72.0±0.5 bc	89.2±0.4 de	108.2±0.4 fg
BD 7328	65.2±0.4 de	70.2±0.6 cd	88.8±0.4 e	109.8±0.4 cf
BD 9952	57.4±0.6 f	62.8±0.4 e	91.8±0.4 b	109.0±0.4dg
BARI Begun 1	52.8±0.4 g	58.0±0.3 f	89.8±0.4 ce	111.0±0.4bd
BARI Begun 6	64.0±0.3 e	69.4±0.5 d	97.8±0.4 a	112.4±0.5ab
BARI Begun 4	68.8±0.3 bc	73.6±0.5 b	92.0±0.4 b	108.8±0.4eg
BARI Begun 7	71.0±0.4 a	76.0±0.5 a	91.2±0.4 bc	109.8±0.4cf
BARI Begun 8	65.2±0.4 de	69.8±0.4 cd	96.2±0.4 a	111.4±0.5 ac
BARI Begun 9	68.2±0.4 c	73.2±0.4 b	90.8±0.4 bd	110.6±0.4be
BD 10158	65.0±0.4 de	70.0±0.3 cd	96.0±0.4 a	113.4±0.5 a
BD 10154	68.2±0.4 c	73.4±0.5 b	97.0±0.4 a	111.6±0.5 ac

Data expressed as mean ± SE. Means within a column followed by common letter(s) are not significantly different by Tukey HSD posthoc statistic at < 0.05.

Table 4. Yield contributing characteristics of the fruits of the brinjal germplasms when exposed to shoot and fruit borer infestation

Germplasms	Yield contributing characteristics of the brinjal fruits			
	Number/ plant	Weight (g)	Length (cm)	Diameter (cm)
BD 7320	12.6±1.7 a	59.0±6.2 d	23.0±1.6 bc	23.4±1.8 e
BARI Begun 5	4.4±0.5 bd	263.4±20.2 b	9.0±0.3 f	87.0±4.3 ab
BD 7328	10.8±0.8 a	74.8±4.8 d	24.0±0.2 b	23.4±1.2 e
BD 9952	5.0±0.5 bc	204.6±24.3 bc	9.8±0.2 ef	77.7±3.0 b
BARI Begun 1	6.8±0.5 b	86.2±6.7 d	14.5±0.4 de	36.8±1.0 cd
BARI Begun 6	1.4±0.2 d	426.0±41.9 a	11.1±0.7 ef	90.6±1.5 a
BARI Begun 4	4.0±0.5 bd	132.4±20.5 cd	19.1±0.8 cd	40.8±1.2 c
BARI Begun 7	2.6±0.4 cd	76.6±11.1 d	29.0±1.1 a	24.8±0.7 e
BARI Begun 8	3.2±0.4 cd	93.2±10.1 d	27.3±1.3 ab	23.6±1.2 e
BARI Begun 9	4.0±0.3 bd	238.8±34.9 b	9.0±0.3 f	81.2±3.9 ab
BD 10158	5.6±0.2 bc	83.8±7.3 d	18.9±0.7 cd	33.6±1.4 ce
BD 10154	3.8±0.4 bd	101.0±9.3 d	26.7±2.2 ab	28.5±0.9 de

Data expressed as mean ± SE. Means within a column followed by common letter(s) are not significantly different by Tukey HSD posthoc statistic at < 0.05.

The yield of the tested germplasms ranged from 6.6±2.8 to 15.1±2.3 t/ha and the results differed significantly (Figure 1). The germplasm BD 9952 showed the lowest level of infestation and the highest yield. The thousand seed weight of germplasms showed significant differences and the highest seed weight was recorded from BARI Begun 4 (19.3 ± 1.1g/1000 seeds) (Figure 2). The lowest seed weight was recorded from BD 9952 (14.0 ± 10 g/1000 seeds).

Variations of small and tight calyxes, hairiness on the corolla, shoot thickness, pith and compact vascular system of the germplasms affect the abundance and infestation of the phytophagous insects (Chelliah and Srinivasan 1983, Malik *et al.* 1986, Mishra *et al.* 1988).

In conclusion, our finding showed variations in the abundance and infestation of shoot and fruit borer, and revealed differences in the production of the number of

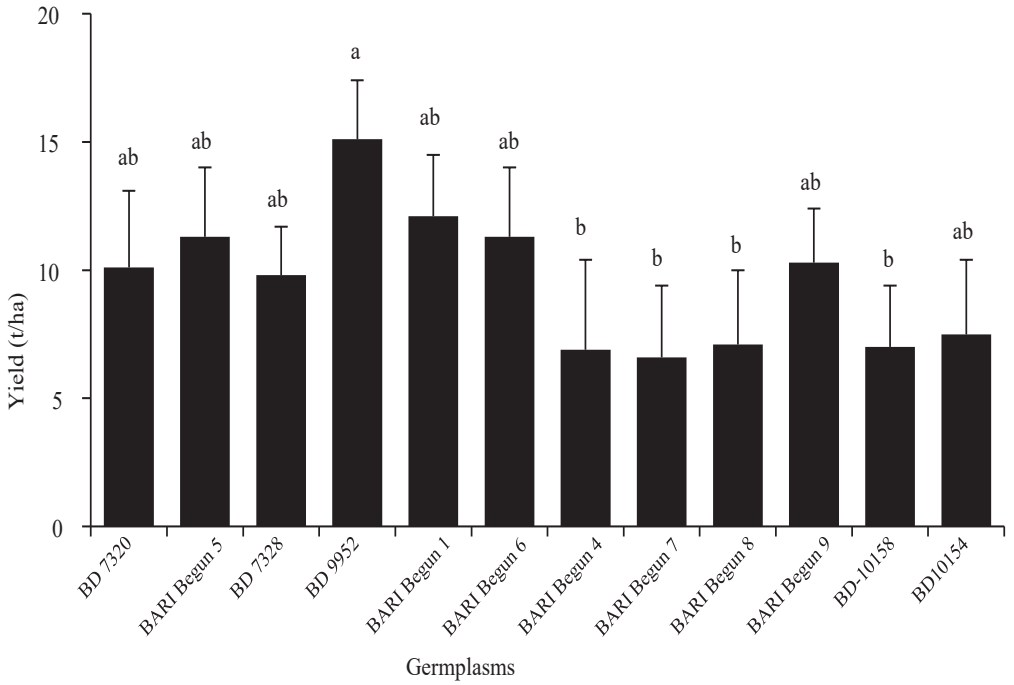

Figure 1. Yield of the brinjal germplasms when exposed to shoot and fruit borer infestation. Data expressed as mean ± SE. Bars with common letter(s) are not significantly different by Tukey posthoc statistic at $p < 0.05$.

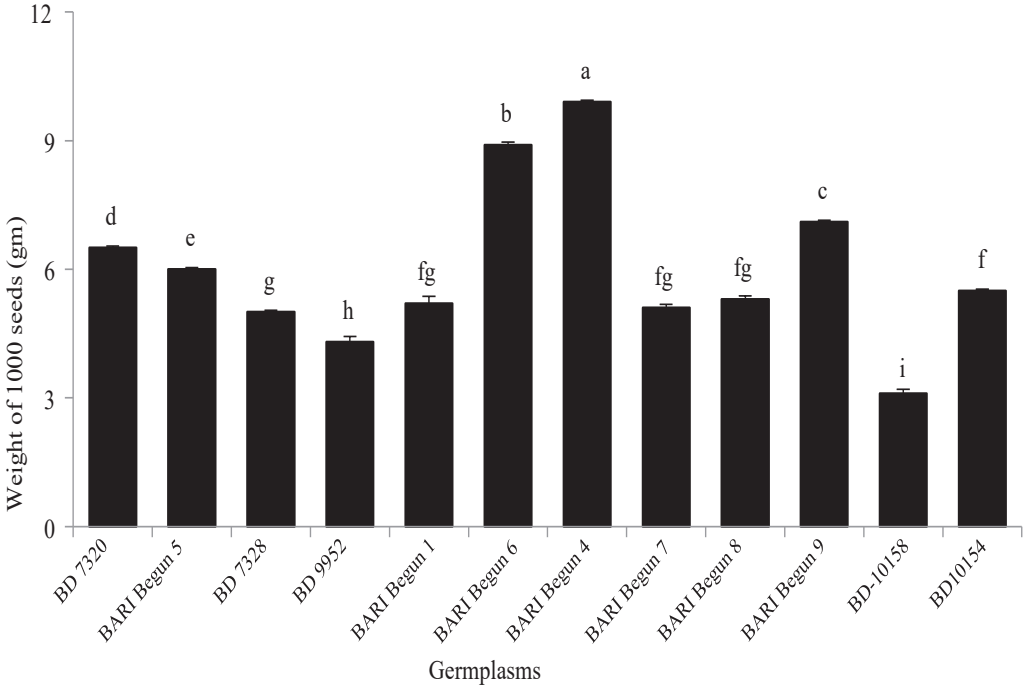

Figure 2. Thousand-seed weight of the brinjal germplasms when exposed to shoot and fruit borer infestation. Data expressed as mean ± SE. Bars with common letter(s) are not significantly different by Tukey posthoc statistic at $p < 0.05$.

fruit/plant, fruit size, yield and seed weight. The germplasm BARI Begun 6 and BD 9952 exerted the lowest level of infestation and the highest yield, respectively. These germplasms could be cultivated in the areas where shoot and fruit borer is the major pests of brinjal, and BD 9952 could be a resource for development of resistant variety.

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