INCIDENCE OF MAJOR INSECT PESTS AND NATURAL ENEMIES ON Bt AND NON-Bt BRINJAL (*SOLANUM MELONGENA* L.) VARIETIES

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ABSTRACT

Eight species of insect pests belonging to four orders and eight families were found to infest at different growth stages of brinjal crop in the experimental field, Sher-e-Bangla Agricultural University, Dhaka during October, 2018 to April, 2019. Among the insects, five namely, Brinjal shoot and fruit borer (BSFB), (*Leucinodes orbonalis*), epilachna beetle (*Epilachna dodecastigma*), jassid (*Amrasca biguttula biguttula*), aphid (*Aphis gossypii*) and whitefly (*Bemisiatabaci*) were recorded as the major pests and the rests were of minor pests. Four species of natural enemies namely, coccinellid beetles *Coccinella septempunctata, Coccinella transversalis, Menochilus sexmaculatus* and spider, *Argiope luzona* were also recorded in the experimental field. Among the pests, BSFB was borer and epilachna beetle was chewing pests and rests were considered as sucking pests of brinjal. Brinjal shoot and fruit borer (BSFB) infestation showed significant variation among the varieties. Most of the pest incidence was observed maximum in the 3rd week of April at the fruiting stage of the crop. The maximum shoot and fruit infestation (38.75% and 53.68%) recorded in non-Bt brinjal during 3rd week of April, 2019, while Bt brinjal suffered minimum shoot and fruit infestation (1.22% and 1.98%).Among the varieties BARI Bt begun-2 received the lowest BSFB incidence (0.92 in number) while the highest was 15.23 observed from Jashore local. Average healthy fruit yield of Bt and non-Btbrinjal were recorded 39.89 t ha^{-1} and 24.36 t ha^{-1}, respectively. While infested fruit yield of Bt and non-Bt brinjal were 1.19 t ha^{-1} and 11.88 t ha^{-1}, respectively.

Keywords: Bt and non-Bt brinjal varieties, major insect pests, natural enemies.

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INTRODUCTION

Brinjal (*Solanum melongena* L.) is an important and popular vegetable crop in Bangladesh. It grows all over the country and round the year. It also cultivated across the world. Brinjal is known as eggplant, aubergene, melongene, garden egg or guinea squash.It is easy to cultivate and ranked second after potato in context of production in Bangladesh. It is cultivated about 50,394 hectares of land in Bangladesh during 2016 (BBS 2017). Brinjal fruit contains vitamins, minerals and some exclusive antioxidants such as arginine, 5-HT, delphinidine-3 Bioside, solasodine, tryptophan etc. and these compounds made brinjal fruits to be ranked amongst the top ten vegetables in terms of antioxidant capacity (Cao *et al*. 1996).

Attack of different insect pests is the most limiting factors causes of low productivity of the brinjal (Rashid 1995). Only the caterpillars of Brinjal shoot and fruit borer (BSFB) cause 78.66% damage to top shoots in vegetative phase and then shifted to flowers and fruits with infestation reaching 67% at reproductive phase and yield reduction up to 90% (Islam and Karim 1991). In order to control such notorious pests, farmers apply insecticides about 140- 180 times indiscriminately which causes phyto-toxicity of the plant, environment pollution and human health hazards (Biswas *et al.* 1998). Bt brinjal, has been developed by India based Maharashtra Hybrid Seed Company (Mahyco) by using a soil bacterium, *Bacillus thuringiensis* cry1Ac gene to transform brinjal to be resistant against BSFB (Shelton *et al.* 2018). In 2013, Bangladesh Agricultural Research Institute (BARI) released four varieties of Bt brinjal that are named as BARI Bt Begun-1, BARI Bt Begun-2, BARI Bt Begun-3, and BARI Bt Begun-4. According to BARI annual reports for 2015 and 2016, fruit infestations in Bt brinjal ranging from 0.04-0.88% compared to 48-57% in non-Btbrinjal (Mondal*et al*. 2016).

Btbrinjal, in which the cry1Ac gene is genetically engineered into the brinjal, ensures a built-in resistance against the shoot and fruit borer larvae. As a result brinjal growers can use much less pesticides, thus potentially saving them time and money while also reducing their crop losses. It has also environmental benefits as well. Moreover, Bt brinjal is not designed to control sucking insect pests. Limited research have been done to answer the questions. It is notable that, no sufficient research work has been done in Bangladesh which compare the seasonal abundance of insect pests in Bt brinjal with its corresponding non-Bt variety. Therefore, the present study has been undertaken to know the incidence and infestation of major insect pests with their natural enemies and comparing the yield between Bt and non-Bt brinjal varieties.

MATERIALS AND METHOD

The research work was conducted in the central farm of Sher-e-Bangla Agricultural University (SAU), Dhaka, during the period from November 2018 to April 2019 (rabi season). The experiment was laid out in Randomized Complete Block Design (RCBD) with three (3) replications. Each replication was divided into seven (7) unit plots. Thus, the total no. of plots were 21. Each plot was 5 m length and 3 m breadth. Block to block distance was 1 m. The spacing was 1.0 m × 0.75 m. The experimental plot was ploughed and cross-ploughed several times followed by laddering to obtain good tilth in the 1st week of November 2018. The total area of the experimental field was 30 m × 20 m (600 m^2). The land was fertilized with cow dung, urea, TSP, MoP and gypsum @ 10000, 450, 350, 250 and 110 kg ha^{-1}, respectively. The total amounts of cow dung, TSP, gypsum, 1/3rd urea and MoP were applied in pit one week before transplanting. Rest of urea and MoP were applied in four equal installments 15 days after planting, flowering, fruiting, and harvesting stage. Seven brinjal varieties namely, BARI Bt begun-2, BARI Bt begun-4, Jashore local (Chega), BARI begun-4, BARI begun-5, BARI begun-6 and BARI begun-8 were used. Healthy and uniform brinjal seedlings were uprooted separately from the seed bed and were transplanted in the experimental plots in the afternoon of 5th November, 2018. This allowed an accommodation of 12 plants in each plot. Irrigation, weeding and other intercultural operations were done as and when necessary. But no insecticide or plant protection measures were used during the study.

Observations on the population of different insect pests were recorded from seedling to maturity stages of the crop. Data on different species of insects were recorded from randomly selected 5 plants in each plot. Soon after noticing the *L. orbonalis* infestation, the shoot infestation was judged by counting healthy plants and plants having shoots infested by shoot and fruit borer of 5 randomly selected plants per plot. Similarly, fruit infestation by *L. orbonalis* was recorded by counting the number of total healthy fruits and damaged fruits by shoot and fruit borer using five plants per plot. After each observation damage shoots and fruits were recorded and percentage of shoot and fruit infestations were calculated using the following formula:

$$\text{Shoot or fruit infestation (\%)} = \frac{\text{Number of shoots or fruits damage}}{\text{Total number of shoots or fruits observed}} \times 100$$

Numbers of damaged leaves/five plants were observed to record data of *E. dodecastigma*. The number of *B. tabaci A. gossypii* and *A. biguttula biguttula* were

counted on six leaves (each from 2 upper, middle and lower leaves per plant) by examining each leaf carefully during early morning hours. To begin with, leaf sucking pest on upper surface of the leaves were counted and then the leaf was tilted carefully to count population on the lower surface (Ramrao 2012).Natural enemies were also counted following similar method carefully. The insects were identified and counted as disenabled by Nayar*et al*. (1995), Atwal and Dhaliwal (1997) and Biswas *et al.* (1998). Recorded data were put and compiled on MS excel spread sheet. Later on, data were analyzed by using STATISTICS 10 software for analysis of variance. ANOVA was made by F variance test and the mean value comparisons were performed by DMRT.

RESULTS AND DISCUSSION

Eight species of insect pests belonging to four orders and eight families were found to infest at different growth stages of brinjal crop in the experimental field, SAU, Dhaka. The major pests were BSFB (*Leucinodes orbonalis*), epilachna beetle (*Epilachna dodecastigma*), jassid (*Amrasca biguttula biguttula*), aphid (*Aphis gossypii*), whitefly (*Bemisia tabaci*) and the minor pests were eggplant mealybug (*Centrococcus insolious*), mite (*Tetranychus* sp.) green leaf hopper (*Nephotettix virescens*). Four species of natural enemies namely, coccinellid beetles *Coccinella septempunctata, Coccinella transversalis, Menochilus sexmaculatus* and spider, *Argiope luzona* were also recorded in the experimental field. Among the pests, BSFB was borer and epilachna beetle as chewing pests and rests were considered as sucking pests of brinjal. BSFB bore into the shoot and fruit at vegetative to fruiting stages. All the natural enemies were found to prey different insect pests (Table 1). During the study period, the highest mean temperature and relative humidity were 32.5°C and 79.5% in the 3rd week of April, 2019. The lowest mean temperature and relative humidity were 10.2°C and 37.9% in the 1st week of January, 2019. During the cropping period, the maximum mean rainfall was 85.1 mm recorded in 3rd week of April, 2019 and the minimum was 8.47 mm recorded in 3rd week of November, 2018 (Fig. 1).

Varietal performance on the number of major insect pests during the study period:

Brinjal shoot and fruit borer (BSFB) infestation showed significant variation among the varieties. The lowest number of BSFB was 0.92 observed from BARI Bt begun-2 which was statistically identical with BARI Bt begun-4. While the highest BSFB

Table 1. Insect pests and their natural enemies recorded in brinjal varieties during the study period at the experimental field in SAU, Sher-e-Bangla Nagar, Dhaka 1207

Name of tfhe insect	Scientific name	Family	Order	Status	Nature of damage
Brinjal shoot and fruit borer	*Leucinodesorbonalis* (Guen.)	Pyralidae	Lepidoptera	Major	Shoot and fruit borer
Epilachna beetle	*Epilachna dodecastigma*(Wied.)	Coccinellidae	Coleoptera	Major	Leaf eater
Whitefly	*Bemisia tabaci* (Genn.)	Aleyrodidae	Hemiptera	Major	Sap sucker
Aphid	*Aphis gossypii* (Glover)	Aphidae	Hemiptera	Major	Sap sucker
Jassid	*Amrasca biguttula biguttula*(Ishida)	Cicadellidae	Hemiptera	Major	Sap sucker
Eggplant Mealy bug	*Centrococcus insolious (Green)*	Pseudococcidae	Hemiptera	Minor	Sap sucker
Green Leaf hopper	*Nephotettix virescens*	Cicadellidae	Hemiptera	Minor	Sap sucker
Mite	*Tetranychus sp.*	Tetranychidae	Acarina	Minor	Sap sucker
Ladybird beetle	*Coccinella septempunctata*	Coccinelidae	Coleoptera	Predator	Predation
Ladybird beetle	*Menochilus sexmaculatus*	Coccinelidae	Coleoptera	Predator	Predation
Ladybird beetle	*Coccinella transversalis*	Coccinelidae	Coleoptera	Predator	Predation
Spider	*Argiopeluzona*	Argiopidae	Acarina	Predator	Predation

infestation was 15.23 observed from Jashore local which was statistically identical with BARI begun-4. The number of Jassid, Aphid and Whitefly showed significant variation among the brinjal varieties. The highest number of Jassid, Aphid and Whitefly were 16.50, 16.94 and 16.33, respectively were recorded in Jashore local. Whereas, the lowest number of Jassid 9.36 recorded in BARI begun-4. On the other hand, the lowest number of Aphid and Whitefly 9.01 and 9.32, respectively were observed in BARI begun-5. Similarly, the incidence of Epilachna beetle showed significant variation. The highest number of Epilachna beetle (16.48) was recorded in BARI begun-4 and the lowest was 11.87 observed in BARI begun-6 in (Table 2). These findings are accordance with the findings of Mathur *et al.* (2012) and Prasad & Logiswaran (1997).

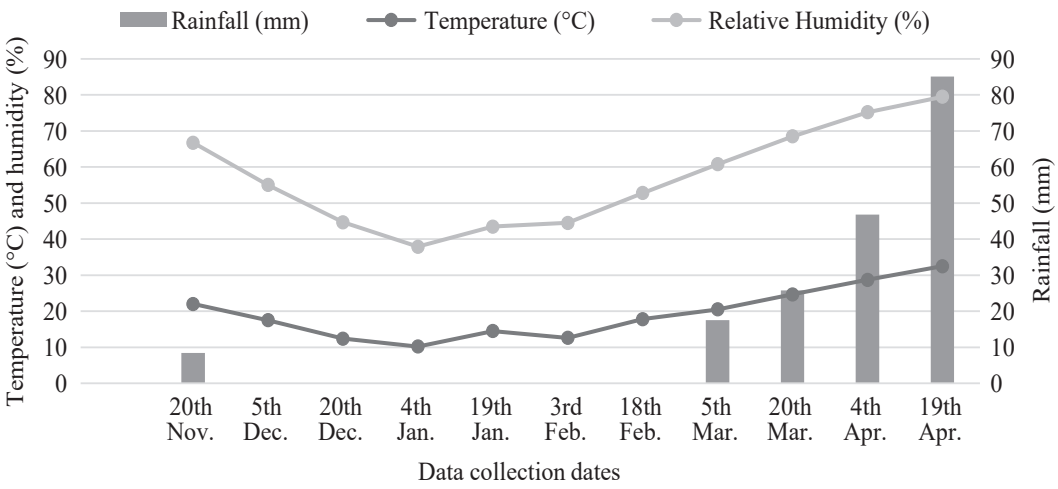

Fig. 1. Weather parameters during November, 2018 to April, 2019 recorded in mean of previous 15 days of that month in Sher-e-Bangla Agricultural University (SAU), Sher-e-Bangla Nagar, Dhaka-1207

Table 2. Number of major insect pests recorded in different brinjal varieties in SAU experimental field, Sher-e-Bangla Nagar, Dhaka

Brinjal varieties	Number of BSFB/plant	Number of insect pests recorded on six leaves/plant			
		Jassid	Aphid	Whitefly	Epilachna beetle
V_1 (BARI Bt begun-4)	0.97 f	12.93 d	12.28 d	10.44 d	14.64 c
V_2 (BARI Bt begun-2)	0.92 f	14.01 c	14.76 c	9.63 e	12.44 d
V_3 (Jashore local)	15.23 a	16.50 a	16.94 a	16.33 a	15.50 b
V_4 (BARI begun-4)	14.06 b	9.36 f	15.35 b	14.53 b	16.48 a
V_5 (BARI begun-5)	11.46 c	15.02 b	9.01 f	9.32 e	12.36 d
V_6 (BARI begun-6)	11.84 cd	12.89 d	14.40 c	11.25 c	11.87 e
V_7 (BARI begun-8)	10.52 e	10.96 e	9.84 e	11.14 c	14.20 c
LSD 0.05	0.522	0.634	0.722	0.514	0.403
CV (%)	7.351	8.43	7.566	8.366	6.522

[*In columns, each mean is the average of three replicates and the same letter with means indicated the statistically similar with each other at 5% level of significance by DMRT.]

Varietal performance on the number of natural enemies during the study period:

Abundance of Ladybird beetle and Spider showed significantly variation. The lowest number of Ladybird beetle was 4.25 observed in BARI begun-4 which was statistically identical with Jashore local and the highest was 8.44 observed in BARI

Bt begun-4. On the other hand, the lowest number of Spider was 4.88 observed in BARI begun-5 and the highest was 7.56 observed in BARI Bt begun-2 which was statistically identical with BARI Bt begun-4. (Table 3). Almost similar findings were recorded from the study of Chandrakumar *et al.* (2008).

Infestation percent of Shoot and fruit borer (BSFB) in Bt and non-Bt brinjal

Shoot infestation was not recorded in Bt brinjal upto last week of March but less infestations were found in April at fruiting stage. However, shoot infestation on non-Bt brinjal started from the 3rd week of December, 2018 and then it was gradually increased up to last week of January. In the 1st week of February, the shoots infestation were decreased and then gradually increased up to the 3rd week of April, 2019. The highest shoot infestation was 38.75% recorded in non-Bt brinjal during the 3rd week of April, 2019. Bt brinjal suffered lower shoot and fruit infestation (1.22% and 1.98%) during the 3rd week of April, 2019. Where as, a significant highest fruit infestation was recorded in case of non-Bt brinjal. From the fruiting stage, the infestation started at its first harvest (5.78%) i.e., 1st week of February and then it gradually increased up to the 3rd week of April. The highest fruit infestation (53.68%) was found in the 3rd week of April, 2019 (Fig. 2). In non-Bt brinjal, lower temperature (< 20°C) and % RH (< 45%) probably reduced the shoot infestation by BSFB. After gradual increase of temperature and % RH might be conductive

Table 3. Number of natural enemies in different brinjal varieties recorded in SAU experimental field, Dhaka

Brinjal varieties	Number of natural enemies (six leaves/plant)	
	Ladybird beetle	Spider
V_1 (BARI Bt begun-4)	8.44 a	7.33 a
V_2 (BARI Bt begun-2)	7.38 b	7.56 a
V_3 (Jashore local)	4.33 e	5.36 d
V_4 (BARI begun-4)	4.25 e	6.17 b
V_5 (BARI begun-5)	7.60 b	4.88 e
V_6 (BARI begun-6)	7.06 bc	5.97 c
V_7 (BARI begun-8)	6.75 d	6.50 b
LSD 0.05	0.303	0.423
CV (%)	4.78	6.274

[* In columns, each mean is the average of three replicates and the same letter with means indicated the statistically similar with each other at 5% level of significance by DMRT.]

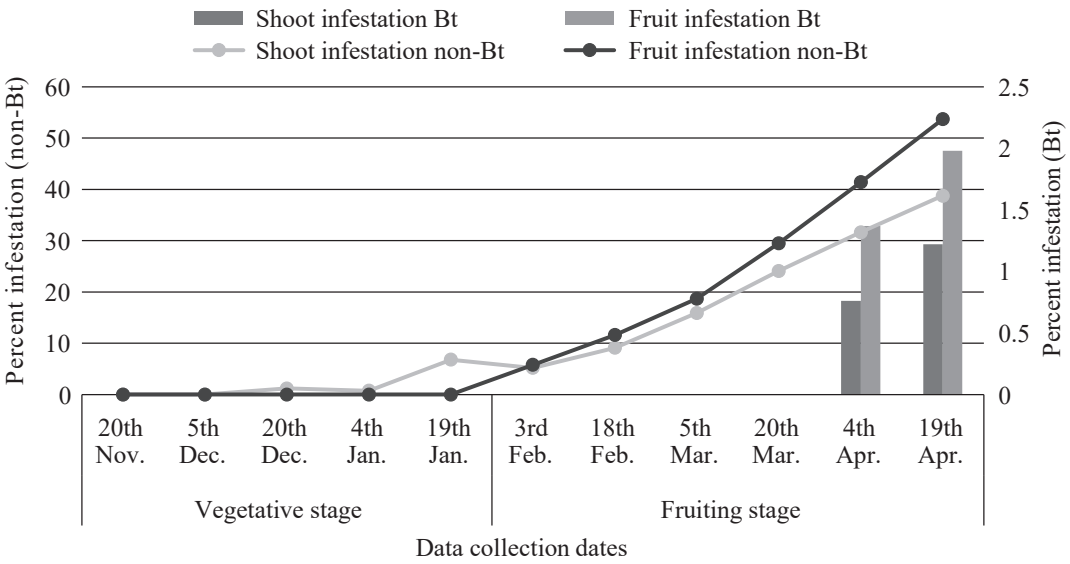

Fig. 2. BSFB (*L. orbonalis*) infestation rate in Bt and non-Bt brinjal recorded on different dates from November, 2018 to April, 2019 in SAU experimental field, Dhaka

for shoot and fruit infestation intensification. These findings were agreed with the findings of Ghosh and Senapati (2009). They reported that the average temperature 21.4 to 31.80 C, average relative humidity 45 to 86% have been found congenial for the multiplication and development of BSFB in India.

Yield performance of seven (7) brinjal varieties during the study period

The highest healthy brinjal yield was 42.96 t ha^{-1} was recorded in BARI Bt Begun-2 which was significantly different from others whereas the lowest healthy fruit yield was 18.72 t ha^{-1} recorded in BARI Begun-8. Similarly, the lowest infested fruit yield was 1.12 t ha^{-1} recorded in BARI Bt Begun-2 which was statistically identical with BARI Bt Begun-4 whereas the highest infested fruit yield was 16.20 t ha^{-1} recorded in Jashore local. Among the seven (7) brinjal varieties the highest total fruit yield was 45.87 t ha^{-1} recorded in BARI Begun-4 which was significantly identical to that of Jashore local and BARI Bt Begun-2 varieties whereas the lowest total fruit yield was 5.92 t ha^{-1} recorded was in BARI Begun-8. The lowest fruit infestation was 2.54% recorded in BARI Bt Begun-2 which was statistically identical with BARI Bt Begun-4 whereas the highest fruit infestation was 35.62% recorded in Jashore local variety (Table 4).

Table 4. Yield performance of seven (7) brinjal varieties considering infested and healthy fruit caused by major insect pest of brinjal recorded in SAU experimental field, Dhaka

Brinjal varieties	Yield of brinjal varieties (t/ha)			Percent of fruit infestation
	Healthy fruit yield	Infested fruit yield	Total fruit yield	
V_1 (BARI Bt begun-4)	36.82 b	1.25 e	38.07 b	3.28 e
V_2 (BARI Bt begun-2)	42.96 a	1.12 e	44.08 a	2.54 e
V_3 (Jashore local)	29.29 c	16.20 a	45.49 a	35.62 a
V_4 (BARI begun-4)	30.98 c	14.89 b	45.87 a	32.46 c
V_5 (BARI begun-5)	20.36 e	10.47 c	30.83 d	33.96 b
V_6 (BARI begun-6)	22.47 d	10.63 c	33.10 c	32.11 c
V_7 (BARI begun-8)	18.72 f	7.20 d	25.92 e	27.78 d
LSD 0.05	1.032	1.007	1.231	0.875
CV (%)	8.759	6.189	10.246	9.371

[*In columns, each mean is the average of three replicates and the same letter with means indicated the statistically similar with each other at 5% level of significance by DMRT.]

Yield in Bt and non-Bt brinjal during the study period

Average healthy fruit yield of Bt and non-Bt brinjal were recorded 39.89 t ha^{-1} and 24.36 t ha^{-1}, respectively. While, infested fruit yield of Bt and non-Bt brinjal were 1.19 t ha^{-1} and 11.88 t ha^{-1}, respectively in the experimental field (Fig. 3). Result revealed that Bt brinjal produced higher yield with less infestation compared to non-Bt brinjal. Bt brinjal receiving Bt gene which is resistant against BSFB. These findings are similar to Mondal *et al*. (2016) in Bangladesh.

CONCLUSION

The research findings give additional information on the insect pests of brinjal crop over the previous reports in Bangladesh. The present information on the status and diversity of the insect pests of brinjal crops with their natural enemies' ecosystems in Bangladesh will help to formulate the priority research strategies by researchers or academicians. Introduction of Bt brinjal (resistant in BSFB) in Bangladesh is a good

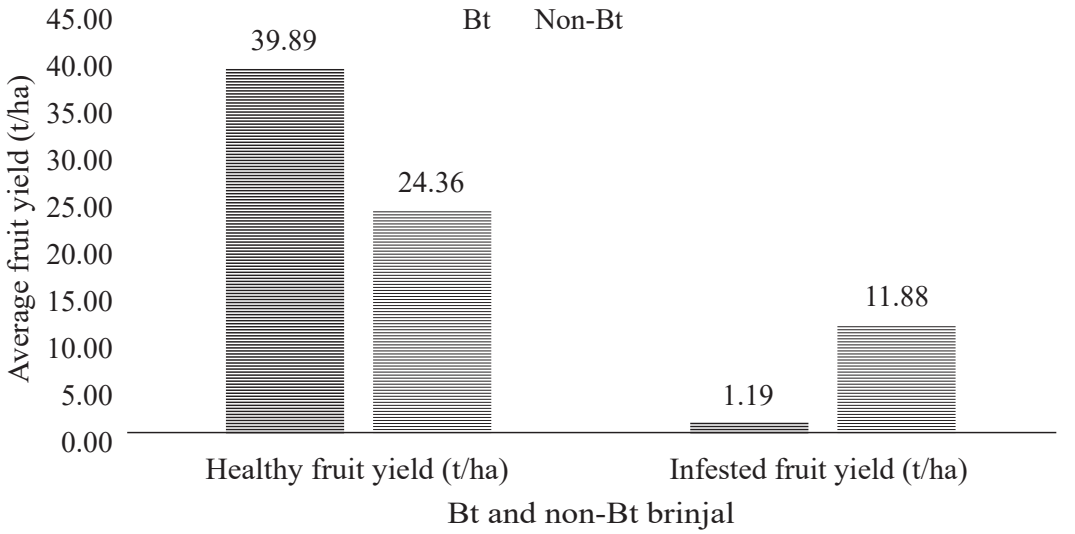

Fig. 3. Fruit yield (healthy and infested) of Bt and non-Bt brinjal recorded in experimental field SAU, Sher-e-Bangla Nagar, Dhaka 1207

job. The knowledge on pest biodiversity in Bt and non-Bt brinjal crop ecosystems will also help the extension workers in deciding the suitable management strategies. The farmers will be benefited by mass cultivation of bt brinjal varieties both in economically and eco-friendly in the country.

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