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Screening of yard long bean genotypes for resistance to legume pod borer, *Maruca vitrata* F.

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Abstract

The research work on the evaluation of yard long bean genotypes for resistance to legume pod borer, *Maruca vitrata* F. was carried out in two consecutive seasons viz., kharif 2015 and rabi 2015-16 in randomized complete block design (RCBD) in the field of the Department of Entomology, Bangladesh Agricultural University (BAU), Mymensingh and chemical analysis of sugar, protein and phenol of yard long bean were carried out at Bangladesh Institute of Nuclear Agriculture (BINA), Professor Mohammad Hossain Central Laboratory and laboratory of the Department of Biochemistry and Molecularbiology, Bangladesh Agricultural University (BAU), Mymensingh. Nine genotypes of yard long bean were evaluated and reacted distinctly to *M. vitrata* with significantly different levels of infestation to flowers, pods and yield. The genotype Long Red Mollika was categorized as moderately resistant to legume pod borer in both kharif and rabi seasons. Genotype YL 305 was found susceptible in both the seasons. The plant attributes, both vegetative and reproductive, of yard long bean did not show any significant correlation in favour of resistance to *M. vitrata*. Yard long bean genotypes also did not show resistant reaction to *M. vitrata* in respect of sugar and phenol but particularly protein showed antibiosis against *M. vitrata*.

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Introduction

Legumes are important sources of low-fat dietary protein, fiber, and micronutrients in the human diet (Messina, 1999) and therefore, considered as the `meat of the poor' (Heiser, 1990). In the farming system, legumes are planted in crop rotations to improve soil fertility by fixing atmospheric nitrogen, to control soil erosion, to break pest cycles, and to produce livestock fodder (Leikam *et al*., 2007). Amongst food legume, yard long bean (*Vigna unguiculata* sub sp. *sesquipedalis*) is one of the most popular vegetables in Bangladesh. It has potentiality for export of both fresh and frozen and can be grown all the year round (Rashid, 1999). It is extensively grown in kharif season when there is a shortage of vegetables supply in the market in Bangladesh.

There are many constrain including insect pests as vital one for the production of yard long bean. Among insect pests legume pod borer (LPB), *Maruca vittrata* (Fab.) is one of the major constraints to the production and productivity of grain legumes including yard long bean. Legume pod borer (LPB), *M. vitrata* Fabricius (Lepidoptera: Pyralidae), is also considered the most serious pest of yard long bean, mungbean, and soybean in Southeast Asia (Sharma 1998; Ulrichs *et al*., 2001; Soeun 2001). *M. vitrata* is a genetically complex species (Margam *et al.*, 2011; Periasamy *et al.*, 2015) due to an extensive host range, high damage potential and cosmopolitan distribution (Taylor, 1967; Sharma *et al.*, 1999; Margam *et al.*, 2011). The geographic range of *M. vitrata* extends from northern Australia and East Asia through sub-Saharan Africa (Ke *et al*., 1985; Sharma, 1998) to the Americas (Munroe, 1995). The larvae web the leaves and inflorescence, feed inside the flowers, flower buds, and pods. Typical infestations by *M. vitrata* can cause yield reductions of 20 to 80% (Atachi *et al.*, 2007). In the Philippines and Indonesia, pod damage in yard long bean was estimated about 80% and 25%, respectively (Ulrichs and Mewis, 2004; Hammig *et al.*, 2008). Yield losses of about 40% from *M. vitrata* damage have been reported in yard long bean and cowpea in Thailand (Phompanjai and Jamjanya, 2000; Yule and Srinivasan, 2013). In Bangladesh, pod borer damage has been estimated to be 54.4% during harvest in cowpea, (Ohno and Alam, 1989).

Several plant characters have been postulated to offer resistance to the pod borers (Tayo, 1988, Oghiakhe *et al.***,** 1991a, 1991b, 1992). However data on the role of plant characters that provide resistance to *M. vitrata* are inconclusive. The biochemical constituents present in quantities and proportion to each other in host plants have been reported to exert profound influence on the growth, survival and reproduction of insects in various ways (Painter, 1958; Panda and Khush, 1995). The secondary plant substances present in yard long bean which affect the plant suitability to other insects are also

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likely to affect the growth and development of *M. vitrata*. Sharma (1998) reviewed and concluded that significant progress in developing resistant varieties in cowpea and pigeon pea has been made in Africa. Although it is a highly nutritive vegetable, until now no commercial variety of yard long bean with high yield and better pod quality has been released in Bangladesh and no proper research thrust has been given for the improvement of this vegetable. Better knowledge on genetic diversity or genetic similarity could help to get long term selection gain in plants (Chowdhury *et al.*, 2002). For all these reasons, now it is essential to find out the resistant genotype(s) of yard long bean against legume pod borer, *M. vitrata* F.

Materials and Methods

The research was conducted at the field of Department of Entomology and laboratory of the Department of Biochemistry and Molecular Biology, Professor Mohammad Hossain Central Laboratory, Bangladesh Agricultural University, Mymensingh and Bangladesh Institute of Nuclear Agriculture (BINA). Nine promising yard long bean genotypes were selected to find out the varietal resistance against the legume pod borer. The list of genotypes with their source of collection is shown in Table 1.

Table 1. List of yard long bean genotypes with their source

Sl. No.	Genotypes	Place/source of collection
01.	Green Mollika	Mollika Seed Company
02.	Long Red Mollika	Mollika Seed Company
03.	Sabuj Sanket	ACI Limited
04.	YL 305	ACI Limited
05.	Shornolata	United Seed Company
06.	Toki	Lal Teer Seed Industry Limited
07.	SB Quick Long	SB Crop Care Industries Limited
08.	BARI Borboti 1	Bangladesh Agricultural Research Institute (BARI)
09.	Kegarnatki	Bangladesh Agricultural Development Corporation (BADC)

The experiment was conducted in two consecutive seasons viz., kharif 2015 and rabi 2015-16. The seeds were sown on May 17, 2015 and October 22, 2015. The experiment was laid out in a randomized complete block design with three replicates. The distance of plot to plot and replicate to replicate was 1.0m and 2.0m, respectively. Each plot measuring 2.65m x 1.2m had 20 plants. Intercultural operations were done as and when needed. No insecticides were applied. Two kinds of data like morphological and bio chemical parameters of yard long bean were investigated for their resistance.

Morphological observations of yard long bean genotypes

Data on the morphological characters of tested genotypes, namely number of leaves per plant, leaf area, number of branches per plant, plant height (cm), days to first flowering and harvesting, pod length (cm), pod girth (cm), number of pods (fresh and infested) per plant, pod wall thickness (mm), number of seeds per pod, 100 seeds weight (g), surface area of seed (mm^2) and pod yield (g) per plant were observed and recorded from twenty plants from each plot and correlated with incidence of *M. vitrta.*

Percent flower infestation

The intensity of flower infestation was recorded from 10 rachis selected randomly per plot starting from flower initiation to the end of the study at 7 days intervals. The number of healthy flowers and infested flowers were counted and the percent flower infestation for each genotype was calculated by using the following formula:

$$\%\,\text{Flower infestation} = \frac{\text{Number of infested flower}}{\text{Total number of flower}} \times 100$$

Percent pod infestation

Observations on pod infestation were recorded during each harvesting time at four days intervals. The pod damage was recorded from twenty plants from each replication. Each pod was examined for *M. vitrata* injury. The number and weight of healthy pods and infested pods were counted and the percent pod infestation for each treatment was calculated and expressed as percentage.

$$\%\,\text{Pod infestation} = \frac{\text{Number of infested pod}}{\text{Total number of pod}} \times 100$$

Based on the per cent pod damage, the damage score for each genotype was calculated and was given the resistance rating 1–5 as suggested by Jackai (1982).

Table 2. Pod damage (%) score resistance rating

Pod damage (%)	Score	Resistance rating
0-20	1	Highly resistant
21-40	2	Moderately resistant
41-60	3	Intermediate
61-80	4	Susceptible
81-100	5	Highly susceptible

Biochemical observations of yard long bean genotypes

Flowers of yard long bean genotypes were collected at 50% flowering stage and pods collected at immature stage. Those flowers and pods were freeze dried in a life lyophilizer at -80^{0}C for 72 hours, powdered with the help of a grinder and analyzed for the total sugar, protein and phenol.

Results and Discussion

The results obtained from the field studies revealed that none of the genotypes of yard long bean was found to be completely resistant to *M. vitrata* (Table 3). However, the lowest flower and pod damage and the highest yield were obtained in Long Red Mollika and the highest flower and pod damage and the lowest yield were found in YL 305. In both kharif and rabi seasons the lowest flower (25.45 & 20.00%) and pod damage (37.04 & 29.39%) were obtained in Long Red Mollika and the highest flower (46.85 & 40.00%) and pod damage

(70.44 & 61.22%) were found in YL 305 (Table 3). In both seasons the highest pod yield was found from Long Red Mollika (11.93 ton per hectare in kharif and 10.43 ton per hectare in rabi) and the lowest pod yield was recorded from YL 305 (7.14 ton per hectare in kharif and 6.20 ton per hectare in rabi) (Table 4). Based on the percent pod damage the genotypes were given the resistance rating 1 to 5 as suggested by Jackai (1982). Based on the damage score, in kharif season, the genotype Long Red Mollika was categorized as moderately resistant. The genotypes Green Mollika, Sabuj Sanket, Shornolata, SB Quick Long, BARI Borboti 1, Toki and Kegarnatki were grouped under intermediate type. The susceptible genotype was YL 305. In the rabi season, the percentage of infested flower and pod of all genotypes decreased. The genotypes Long Red Mollika, BARI Borboti 1 and Shornolata were categorized as moderately resistant. Green Mollika, Sabuj Sanket, SB Quick Long, Toki and Kegarnatki were grouped under intermediate type and the susceptible genotype was YL 305.

The intensity of flower and pod damage by *M. vitrata* was found to be higher in the kharif, 2015 than in the rabi 2015–16. The higher temperature, relative humidity and rainfall in kharif, 2015 season compared to the rabi 2015–16 season influenced the flower and pod damage by this insect. It was observed that the population abundance of *M. vitrata* increased when temperature, relative humidity and rainfall increased and again the population abundance decreased when temperature, relative humidity and rainfall decreased. Similar results were reported by Sahoo and Bahera (2001) and Reddy *et al*. (2001) who observed the positive correlation between population of *M. vitrata* and minimum, maximum and average of temperature and relative humidity on pigeon pea in India.

The plant attributes both vegetative and reproductive, of yard long bean did not show any significant correlation in favour of resistance to *M. vitrata*. However, biochemical factor might exhibit resistance to *M. vitrata.* Biochemical factors are likely to affect the growth and development of *M. vitrata.* There is influence on nutritional value in different genotypes for the growth and development of larvae. Low sugar, less protein and high phenol content has been found to offer resistance to pigeon pea because it influences the feeding habit of *M. vitrata* (Maxwell and Jennings, 1980). In present study it was found that protein content in pods and flowers were significantly higher (29.46 and 22.46%) in susceptible YL 305 compared to moderately resistant Long Red Mollika (21.00 and 15.17%) (Table 5). Sunitha *et al*. (2008) also observed similar trend that protein content in pods was significantly higher (25.5%) in susceptible ICPL 88034 compared to resistant ICPL 98003 (16.5%) against the *M. vitrata* in short duration pigeonpea cultivars. Phenol and sugar compounds in the flower and green pods of the yard long bean are not found to contribute resistance against the insect *M. vitrata* (Table 5). This confirms the report of Oghiakhe *et al*. (1993) who could not find any significant correlation between the sugar and phenolic concentration in pods of wild and cultivated *Vigna* species and damage by *M. vitrata*. However, phenol is known to play important defensive roles against some other cowpea pests (Baker *et al*., 1989).

Yard long bean genotypes did not show resistant reaction to *M. vitrata* in respect of sugar and phenol but particularly protein showed antibiosis against *M. vitrata.*

Among the genotypes of yard long bean, Long Red Mollika in spite of its some susceptibility performed much better in respect of flower and pod damage and yield. It was found as a moderately resistant/tolerant and the others were susceptible to intermediate to *M. vitrata*. Hence, the genotype Long Red Mollika may be recommended for cultivation.

Table 3. Percent infestation of legume pod bore, *M. vitrata* to flowers and pods of yard long bean obtaining in different genotypes in two seasons (kharif, 2015 and rabi, 2015–16)

Genotypes	Infested flower (%)		Infested pod (%)		Score 1–5	
	Kharif, 2015	Rabi, 2015–16	Kharif, 2015	Rabi, 2015–16	Kharif, 2015	Rabi, 2015–16
Green Mollika	32.36 bd	24.99 (29.93) b	51.00 bc	42.75 bc	3	3
Sabuj Sanket	34.20 bd	26.65 (31.06) ab	58.96 ab	47.96 ab	3	3
Shornolata	30.69 bd	23.51 (28.99) b	43.02 bc	37.72 bc	3	2
Kagornatki	35.97 bc	28.38 (32.11) ab	53.39 ac	42.32 bc	3	3
SB Quick Long	38.17 ab	28.40 (32.19) ab	54.62 ac	40.36 bc	3	3
Long Red Mollika	25.45 d	20.00 (26.49) b	37.04 c	29.39 c	2	2
BARI Borboti 01	28.48 cd	21.31 (27.44) b	43.04 bc	37.01 bc	3	2
Toki	38.46 ab	30.01 (33.19) ab	55.93 ab	46.19 ac	3	3
YL 305	46.85 a	40.00 (39.16) a	70.44 a	61.22 a	4	4
Level of significance	0.01	0.01	0.01	0.01	-	-
CV (%)	10.60	10.28	12.97	15.27	-	-

Figures in the parentheses are the arcsin transformed mean values for infested flowers of Rabi (2015–16)
Means in a column having same letter(s) are not significantly different by DMRT

Table 4. Percentage of Pod infestation (by weight) and yield of different yard long bean genotypes in two seasons (kharif, 2015 and rabi, 2015–16)

Genotypes	% Pod infestation (by weight)		Yield (T/ha)	
	Kharif, 2015	Rabi, 2015-16	Kharif, 2015	Rabi, 2015-16
Green Mollika	49.92 bc	42.28 ab	9.36 ab	7.16 ab
Sabuj Sanket	57.29 ab	48.17 ab	7.27 b	5.70 b
Shornolata	44.38 bc	37.50 b	9.18 ab	7.82 ab
Kagornatki	54.47 ab	42.65 ab	6.85 b	5.74 b
SB Quick Long	54.52 ab	40.57 b	8.01 b	7.09 ab
Long Red Mollika	36.85 c	29.33 b	11.93 a	10.43 a
BARI Borboti 01	42.21 bc	36.84 b	10.08 ab	9.30 ab
Toki	56.85 ab	46.34 ab	7.32 b	6.55 b
YL 305	68.84 a	60.87 a	7.14 b	6.20 b
Level of significance	0.01	0.01	0.01	0.01
CV (%)	12.92	17.27	16.41	18.33

Means in a column having same letter(s) are not significantly different by DMRT.

Table 5. Percent of total sugar, total protein and total phenol in flower and pods of different yard long bean genotypes

Genotypes	Total sugar (%)		Total protein (%)		Total phenol (%)	
	Flower	Pod	Flower	Pod	Flower	Pod
Green Mollika	18.94	10.60	18.67 b	24.79 bc	5.07	6.91
Sabuj Sanket	19.74	10.99	19.25 b	25.96 b	4.99	6.92
Shornolata	18.54	10.46	17.79 bc	25.08 bc	5.08	7.05
Kagornatki	19.47	10.46	18.08 bc	25.96 b	5.06	6.94
SB Quick Long	18.54	10.99	19.25 b	26.83 ab	4.96	6.87
Long Red Mollika	18.94	10.20	15.17 c	21.00 d	5.11	7.07
BARI Borboti 01	18.81	10.07	16.92 bc	22.46 cd	5.16	7.10
Toki	18.94	10.60	19.54 ab	24.21 bc	5.04	6.90
YL 305	18.94	11.13	22.46 a	29.46 a	4.97	6.89
Level of significance	NS	NS	0.01	0.01	NS	NS
CV (%)	3.46	5.94	6.72	5.16	1.96	1.40

Means in each column followed by the same letter(s) are not significantly different by DMRT, NS = Non Significant

Conclusion

Nine genotypes of yard long bean reacted distinctly to *M. vitrata* with significantly different levels of infestation to flowers, pods and yield. None of the genotypes was found to be completely resistant to *M. vitrata*. However, the genotype Long Red Mollika was categorized as moderately resistant to legume pod borer in both kharif and rabi seasons. BARI Borboti 1 and Shornolata were also categorized as moderately resistant in the rabi season. YL 305 was the susceptible genotype in both the seasons. The plant attributes, both vegetative and reproductive, of yard long bean did not show any significant correlation in favour of resistance to *M. vitrata*. Yard long bean genotypes also did not show resistant reaction to *M. vitrata* in respect of sugar and phenol but particularly protein showed antibiosis against *M. vitrata.*

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