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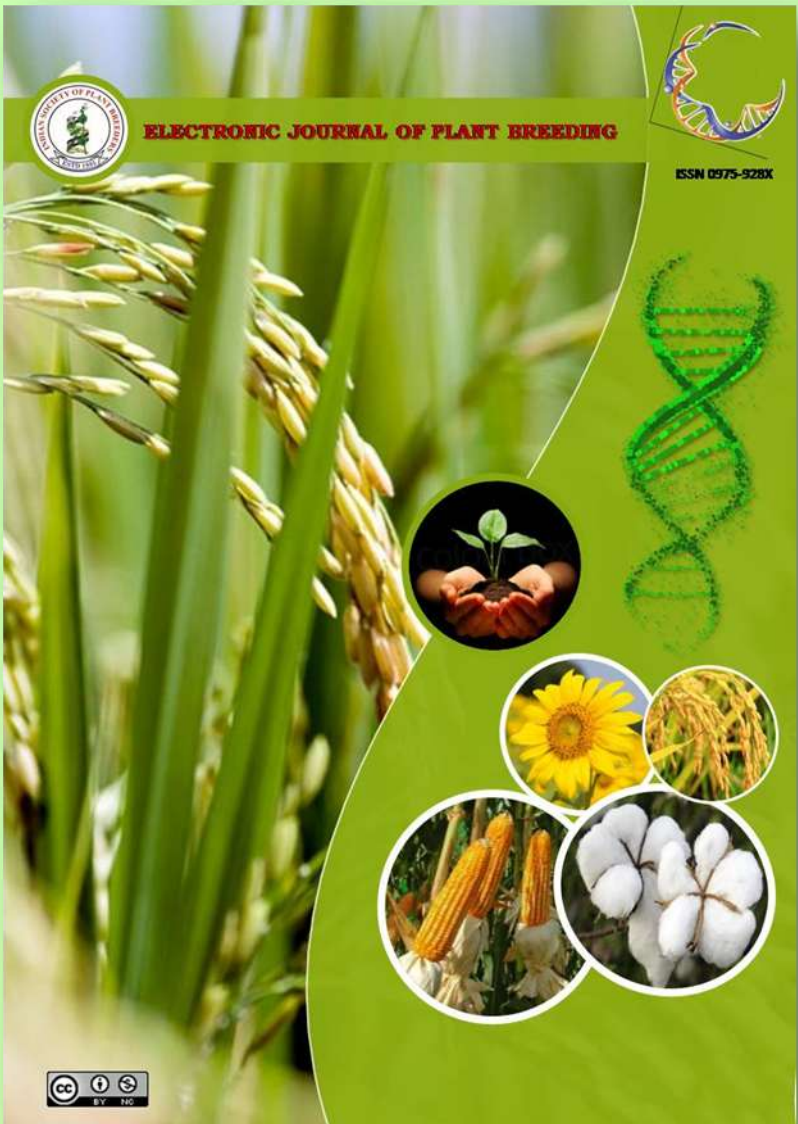

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Research Article

Screening of blackgram varieties and role of biophysical characters on damage potential of spotted pod borer, *Maruca vitrata* fabricius

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Abstract
Spotted pod borer, *Maruca vitrata* is one of the most serious lepidopteran pests in pulses which occurs from seedling to pod formation stage. The occurrence of *M. vitrata* depends upon various biophysical and biochemical characters of host plants. Plant characters *viz.,* plant height, number of branches, number of pods per cluster, pod length, pod width, angle between pods, number of seeds per pod, seed size, trichome density and trichome length in pods were studied to observe the association of different morphological traits with resistance or susceptibility to *M. vitrata* in nine blackgram varieties. Among the tested nine varieties, CO 5 and MDU 1 were considered susceptible having highest pod damage per cent of 14.38 and 13.70, respectively while VBN (Bg) 5 and VBN 6 have lowest pod damage per cent of 5.79 and 6.15, respectively. It was observed that highly susceptible variety CO 5 has less number of trichomes (2.13/mm$^{2)}$ and trichome length (3.95 mm) while the resistant variety VBN 6 has dense trichomes (4.13/mm^2) and trichome length (5.01 mm) which is considered to be the main factor to confer resistance in plants.

Keywords
Maruca vitrata, black gram, morphological traits, trichomes and resistance mechanism

Introduction

India is one of the major pulse growing countries in the world, which produces 25.23 million tonnes from 29 million hectares of area with a productivity of 841 kg/ha (Pulses revolution from food to nutritional security, 2018). One of the reasons for this low productivity is insect pest complex under diverse agro-ecological conditions. Blackgram (*Vigna mungo* L.) is one of the most important pulses in tropical countries especially in India. Higher amounts of lysine make blackgram an excellent complement to rice in terms of balanced human nutrition. In tropical and sub-tropical regions, the growers are facing serious yield losses in edible legume crops because of the flower and pod-feeding lepidopteran pests. Spotted pod borer, *Maruca vitrata* Fabricius (Lepidoptera: Crambidae) is considered one of the voracious legume pests because of its broad host range, high degree of damage and worldwide distribution. In addition to this, *M. vitrata* is a genetically complex species and the control of this pest is tedious (Ashigar and Umar, 2016). *M. vitrata* larva causes damage during all the growing stages starting from seedling to pod formation stages, however the flowering stage is more susceptible (Rouf and Sardar, 2011). They feed voraciously on stems, peduncles, flowers and pods of various pulse crops. Typical yield loss due to *M. vitrata* varies from 20-88% (Jayasinghe *et al.,* 2015) and in some place the yield loss is recorded upto 100% (Rouf and Sardar, 2011). The larva continuously feeds by remaining inside the webbed mass of flowers and pods (Rachappa *et al.*, 2015) which results in heavy yield losses at pod harvesting stage. Sole dependence on the chemical control pave the way for deletorious effects on living atmosphere and human health and does not provide promising control of pests (Jayasinghe *et al.*, 2015). Thus it becomes essential to understand the factors responsible for resistance to strengthen the on-going IPM strategies. Various morphological characters of the plants like plant height, number of branches, number of pods per cluster, pod length, pod width, angle between pods, number of seeds per pod, seed size, trichome density and trichome length in pods play an important role in developing resistance against spotted pod borer, *M. vitrata* (Halder and Srinivasan, 2011). Therefore the present study was carried out to understand the role of plant morphological characters to the pod damage by *M. vitrata*.

Materials and Methods

Screening was carried out at National Pulses Research Centre (NPRC), Vamban, Pudukkottai, Tamil Nadu on nine promising varieties of blackgram against spotted pod borer, *M. vitrata* during *kharif* 2018. The varieties used for screening includes VBN (Bg) 5, VBN 6, VBN 7, VBN 8, CO 5, MDU 1, KKM 1, ADT 5 and ADT 6. Observations were recorded on five randomly tagged plants on mean number of larva per plant from each plot at fortnight intervals from bud initiation to pod maturing stage. The observation on pod damage was made by counting total number of pods harvested from five tagged plants and number of *M. vitrata* damaged pods from each varieties and replication. Per cent pod damage was calculated using the formula,

Per cent pod damage = (Number of damaged pods/ Total number of pods) × 100

The morphological characters of the plant were observed at pod development stage (45 days after sowing) *viz.*, plant height, number of branches, number of pods per cluster, pod length, pod width, angle between pods, number of seeds per pod, seed size, trichome density and trichome length in pods and these traits were recorded in order to study the role of these characters with susceptibility or resistance to spotted pod borer (Halder and Srinivasan, 2011).

For observing plant height, randomly selected ten plants from each plot were measured in centimeters using measuring scale. Twenty five number of matured blackgram pods were plucked randomly from each variety and the pod length and pod width was measured using graph paper and expressed in centimeters. With the help of protractor, the angle between the two adjacent pods in cluster was measured and expressed in degrees. Seeds of each variety were collected individually and the seed size (seed length) was measured using graph sheet and expressed in centimeters. Number of branches in each plant, number of pods per cluster and number of seeds per pod was determined from randomly selected ten plants of each variety by visual observation.

Trichome density and trichome length from blackgram pods were recorded from ten uniformly developed pods per replication. The pods were cut into pieces and the number of trichomes per square millimeter was counted from the epidermal layer of pods under binocular microscope. The trichome density per square millimeter was measured by placing graph sheet under the pods. The trichome length on the pods was measured by gently pressing the sticky transparent tape on the pod surface and the trichomes which adhered to the sticky surfaces were fixed on the glass slides and measured under binocular microscope (Sunitha *et al.*, 2008). The observed data on biophysical characters of the different blackgram varieties were analyzed using ANOVA and each parameter was correlated with percent pod damage through simple linear regression (Gomez and Gomez, 1984).

Results and Discussion

Biophysical parameters of different blackgram varieties were investigated to determine the role of these parameters in mechanism of resistance against spotted pod borer, *M. vitrata* in blackgram. Among the nine varieties, highest pod damage was observed on CO 5 (14.38%) followed by MDU 1 (13.70%). And also the mean larval population was reported highest on MDU 1 (1.55 larva/plant) followed by CO 5 (1.47 larva/plant). The length and width of the pods from nine varieties was recorded and the highest pod length was observed in MDU 1 (5.43 cm) followed by CO 5 (5.27 cm). The correlation between the pod length and pod damage was significant and positive. While, negative correlation was observed between pod width and pod damage. The variety VBN 8 and KKM 1 (0.61 cm) showed more pod width and lowest in CO 5 (0.44 cm). Halder *et al.*, 2006 also reported similarly that lengthy pods were found more susceptible to *M. vitrata* and the correlation between incidence of pod borer and pod length was significantly positive. He also reported that significant but negative correlation was observed between pod width and pod damage.

The number of pods per cluster was more in the variety CO 5 (3.03 nos.) which showed that the clustered pods were more susceptible to pod borer than wider pods. The correlation between number of pods per cluster and pod damage was positive and significant. Among the nine varieties of blackgram, MDU 1 (118.27^0) observed low angle between two pods which has more pod infestation.

The pod angle of VBN 6 was 134.77^0 and it has less pod damage. A significant negative correlation was observed between pod angle and pod infestation. Halder and Srinivasan (2011) also reported that the cultivars with pods apart were less damaged than narrow angled pods. He also stated that during migration from one pod to another considerable amount of energy was expended.
The height of the plant was highest with 35.37 cm in CO 5 followed by 34.63 cm in MDU 1 which has high incidence of pod damage. The number of branches per plant and the borer infestation was more in MDU 1. Similarly, MDU 1 (7.97) has more number of seeds per pod than other varieties. The correlation of plant height, number of branches per plant and number of seeds per pod with pod damage was positive and significant. Sujay *et al.*, 2017 reported that significantly positive correlation was observed in relation to plant height and number of branches per plant with pest incidence. The seed size *i.e* length of the seed was observed more in MDU 1 (0.50 cm) followed by KKM 1 (0.48 cm) which were more susceptible to pod borers. Negative and significant correlation was existed between seed size and pod infestation by *M. vitrata*.

It was observed that the increased number of trichomes in VBN 6 ($4.13/mm^2$) and the trichome density was low in CO 5 ($2.13/mm^2$). And also the length of the trichome was low in CO 5 (3.95 mm) and observed highest in VBN 8 (5.89 mm). A significant negative correlation was observed between trichome density and pod damage and also between trichome length and pod damage. Halder and Srinivasan (2011) also reported that negative correlation was observed between pod damage and trichome density. Similar observations were also reported by Sunitha *et al.,* 2008 that significant negative correlation was observed between both trichome length and trichome density with pod damage. Kulkarni *et al.,* 2015 reported that more trichome density was the main factor contributing resistance. Similar finding were also reported by Latha and Hunumanthraya, 2018.

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Table 1. Biophysical characters of different blackgram varieties with percent pod damage

Variety	Mean No. of Larva/ Plant	Percent Pod Damage (%)	Plant Height (cm)	No. of Branches	No. of Pods /Cluster	Pod Length (cm)	Pod Width (cm)	Angle Between Pods (^{0})	No. of Seeds /Pod	Seed Size (cm)	Trichome Density in Pods (no /mm2)	Trichome Length in Pods (mm)
VBN (Bg)5	0.51 (0.71)^{a}	5.79 (2.41)^{a}	33.13 (5.76)^{d}	2.07 (1.44)^{bc}	2.33 (1.53)^{bc}	4.50 (2.12)^{b}	0.54 (0.74)^{c}	131.17 (11.45)^{bc}	6.03 (2.46)^{a}	0.40 (0.64)^{a}	3.00 (1.73)^{d}	4.78 (2.19)^{e}
VBN 6	0.57 (0.75)^{ab}	6.15 (2.48)^{a}	25.23 (5.02)^{a}	1.87 (1.37)^{b}	2.47 (1.57)^{c}	4.17 (2.04)^{a}	0.53 (0.73)^{c}	134.77 (11.61)^{c}	6.00 (2.45)^{a}	0.56 (0.75)^{e}	4.13 (2.03)^{f}	5.01 (2.24)^{f}
VBN 7	0.82 (0.91)^{bc}	8.04 (2.84)^{b}	26.03 (5.10)^{ab}	1.93 (1.39)^{b}	2.27 (1.51)^{bc}	4.56 (2.13)^{bc}	0.52 (0.72)^{c}	131.07 (11.45)^{bc}	6.10 (2.47)^{a}	0.45 (0.67)^{bc}	3.57 (1.89)^{e}	5.18 (2.28)^{f}
VBN 8	1.31 (1.14)^{de}	11.55 (3.40)^{d}	34.13 (5.84)^{d}	1.93 (1.39)^{b}	2.23 (1.49)^{b}	4.66 (2.16)^{bc}	0.61 (0.78)^{d}	118.87 (10.90)^{a}	6.00 (2.45)^{a}	0.50 (0.71)^{d}	2.93 (1.71)^{cd}	5.89 (2.43)^{g}
CO 5	1.47 (1.21)^{e}	14.38 (3.79)^{e}	35.37 (5.95)^{d}	2.07 (1.44)^{bc}	3.03 (1.74)^{d}	5.27 (2.29)^{e}	0.44 (0.66)^{a}	126.87 (11.26)^{b}	7.03 (2.65)^{b}	0.40 (0.64)^{a}	2.13 (1.46)^{a}	3.95 (1.99)^{a}
MDU 1	1.55 (1.24)^{e}	13.70 (3.70)^{e}	34.63 (5.89)^{d}	2.33 (1.53)^{c}	1.93 (1.39)^{a}	5.43 (2.33)^{f}	0.47 (0.69)^{b}	118.27 (10.88)^{a}	7.97 (2.82)^{c}	0.50 (0.70)^{d}	2.60 (1.61)^{bc}	4.51 (2.12)^{cd}
KKM 1	0.77 (0.88)^{abc}	8.04 (2.84)^{b}	33.20 (5.76)^{d}	1.07 (1.03)^{a}	2.47 (1.57)^{c}	4.91 (2.22)^{d}	0.61 (0.78)^{d}	128.03 (11.32)^{b}	5.97 (2.44)^{a}	0.48 (0.69)^{cd}	2.70 (1.64)^{bcd}	4.37 (2.09)^{bc}
ADT 5	1.43 (1.20)^{e}	13.03 (3.61)^{de}	28.13 (5.30)^{bc}	2.03 (1.43)^{b}	2.33 (1.53)^{bc}	4.56 (2.14)^{c}	0.47 (0.69)^{b}	127.73 (11.30)^{b}	5.97 (2.44)^{a}	0.43 (0.66)^{ab}	2.97 (1.72)^{cd}	4.57 (2.14)^{d}
ADT 6	0.98 (0.99)^{cd}	9.76 (3.12)^{c}	28.66 (5.35)^{c}	1.93 (1.39)^{b}	1.97 (1.40)^{a}	4.97 (2.23)^{d}	0.48 (0.69)^{b}	126.43 (11.24)^{b}	6.97 (2.64)^{b}	0.43 (0.65)^{ab}	2.43 (1.56)^{ab}	4.22 (2.05)^{b}
S.Em.±	0.087	0.646	0.119	0.043	0.034	0.014	0.009	0.137	0.028	0.010	0.055	0.019
C.D at 5%	0.184	1.370	0.253	0.090	0.072	0.030	0.019	0.291	0.059	0.022	0.116	0.040
C.V %	10.64	4.33	2.63	3.79	2.74	0.79	1.49	1.49	1.33	1.83	3.92	1.07

Data presented in parentheses are square root transformed values.

Table 2. Correlation studies of different variables on pod damage of blackgram

Variables	Correlation Coefficients	Regression Equations
Plant height (X) Vs Pod damage (Y)	0.470	Y = -2.015 + 0.390 X
No. of branches (X) Vs Pod damage (Y)	0.418	Y = 2.515 + 3.934 X
No. of pods/cluster (X) Vs Pod damage (Y)	0.104	Y = 7.602 + 1.0468 X
Pod length (X) Vs Pod damage (Y)	0.710	Y = -17.569 + 5.777 X
Pod width (X) Vs Pod damage (Y)	-0.514	Y = 24.122 - 27.161 X
Pod angle (X) Vs Pod damage (Y)	-0.708	Y = 63.606 - 0.422 X
No. of seeds/pod (X) Vs Pod damage (Y)	0.592	Y = -7.356 + 2.699 X
Seed size (X) Vs Pod damage (Y)	-0.205	Y = 15.983 - 12.879 X
Trichome density (X) Vs Pod damage (Y)	-0.651	Y = 20.390 - 3.517 X
Trichome length (X) Vs Pod damage (Y)	-0.279	Y = 17.407 - 1.560 X