



Impact of Biochemical Constitute Responsible for Resistance against *Maruca vitrata* (Fabricius) in Different Genotypes of Mungbean

Sushant Kumar^{1,2}, D.V. Singh¹, B. Shashikala³, Bipasha Datta⁴, Jay Nath Patel⁵

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ABSTRACT

Background: Green gram also known as mung bean (*Vigna radiata* L.) which is a versatile and drought resistant pulse crop widely grown for its high nutritional value and play an vital role in crop rotation. It can be cultivated in the diverse climates and soil types which makes it important cash crop for farmers.

Methods: The experiment was conducted during the *summer* 2021 and 2022 at the Crop Research Centre of S.V.P. University of Agriculture and Technology to investigate the presence of *M. vitrata* on the various promising varieties and genotypes mungbean. Samples were collected from the immature plants. The experiment was conducted to estimate the biochemical constituents *viz.* total soluble sugar, phenols, proteins and reduced sugar.

Result: Among all genotypes, Phenol content varied between 6.38 to 8.94. The maximum protein content was recorded in IPM-2-K-14-9(8.94 mg/g). Studies on the correlation between genotype's phenol content, *M. vitrata* damage ($r = -0.712^*$) and number of larvae ($r = -0.809^*$) had a significant negative correlation. The amount of protein content ranged between 11.09 to 18.95. KM-2328 (11.09 mg/g) had less amount of protein. The protein content with the number of larvae ($r = 0.581^*$) had a significant positive correlation. The percentage of pod damage was connected with protein content ($r = 0.550^*$) followed a similar pattern and had the significantly positive correlation. Sugar content of various genotypes varied between 10.52 to 19.76 mg/g. The maximum sugar content was recorded in SML-668 (19.76 mg/g) followed by the KM-2241 (19.47 mg/g), IPM-302-2 (19.01 mg/g), T-44 (18.42 mg/g) and K-851 (17.66 mg/g). The estimation range of reducing sugar content was 6.76 to 14.39 mg/g. The maximum reduced sugar was estimated in KM-2241(14.39 mg/g) and MH 421 (6.76 mg/g) had less amount of reducing sugar. The sugar was positively correlated with number of larvae and damage percentage done by *M. vitrata*.

Key words: Bio-chemicals, Correlation, Damage, Genotypes, *Maruca vitrata*.

INTRODUCTION

India is one of the leading producers, consumer and exporter of pulses globally. The major pulses cultivated in the country are chick pea, mung bean, pigeon pea, black gram, field pea and pea. Among these, mung bean or green gram [*Vigna radiata* (Linn.) Wilczek.] belonging to the family Leguminosae and sub-family Papilionaceae is a significant cash crop and hold substantial importance for farmers (Kumar *et al.*, 2023). It ranks third after chickpea and pigeon pea, in terms of production. The primary mung bean producing state in India are Madhya Pradesh, Uttar Pradesh, Maharashtra, Rajasthan, Andhra Pradesh and Karnataka, where it is predominantly grown as a rainfed crop in arid and semi-arid regions (Kumar *et al.*, 2024a). In North India, it is primarily cultivated during the *summer* and *kharif* seasons. Due to its short duration, adaptability to a wide range of soil types, suitability for crop rotation, brought tolerance and lower susceptibility to pest compared to soyabean (Radjit and Prasetyawati, 2012), mungbean can be cultivated throughout the year.

The productivity and production of crops are influenced by various factors that vary depending on the climatic condition of different regions. However, the primary determinants of yield reduction in crop are disease and

¹Department of Entomology, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut-250 110, Uttar Pradesh, India.

²Faculty of Agricultural Sciences, GLA University, Mathura-281 406, Uttar Pradesh, India.

³Division of Entomology, ICAR-Indian Agricultural Research Institute, New Delhi-110 012, India.

⁴College of Post Graduate Studies in Agricultural Sciences, Central Agricultural University (Imphal), Umiam-793 103, Meghalaya, India.

⁵School of Agricultural Sciences, K.R. Mangalam University, Gurugram-122 103, Haryana, India.

Corresponding Author: Sushant Kumar, Department of Entomology, Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut-250 110, Uttar Pradesh, India.

Email: sushant.kumar@gla.ac.in

ORCID: 0000-0002-0124-0124

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insect pest, which cause significant damage. Over 200 insect spp. from 48 families have been reported to infest

mung bean in the field, contributing to substantial yield losses. There are some important spp. of insect pests viz. Thrips, Whitefly, Jassid, Cutworm, Legume pod borer (*Maruca testulalis* F.), pod borer, green bug, aphid and blue beetle (Kumar *et al.*, 2024b). Large scale of insect pest of the different groups of insects appeared at different stages of crop growth which are responsible for the huge damage and poor yield (Dar *et al.*, 2002).

The major species of the pod borer in mungbean is *Maruca vitrata* formerly known as *Maruca testulalis* (G.) (Lepidoptera: Pyralidae). Defoliation in the early stage of crop is the damage of these symptoms and the larvae of the insect thrust its head inside the pod and rest body hanging out. The larva of *Maruca* infested the terminal shoots, flower buds and pods of mung bean, causing damage to the reproductive structure by binding them with silken threads and faecal matters. The infestation leads to significant damage with 21.3% damage caused to inflorescence and 13.9% to the pods, particularly in late planted varieties compared to early planted varieties (Gahukar and Reddy, 2018). Zahid *et al.* (2008) also reported 20-30% pod damage in mungbean. The pest is known to cause economic losses of 20-25% and yield reductions ranging from 2 to 84% in mung bean.

For the management of spotted pod borer, various types of tools are used by the farmers. Most of the Indian farmers have to use insecticides for the management of *M. vitrata*, therefore, it is recommended to use the resistant varieties for the minimization of usage of chemical insecticides. Mostly plant contains biochemical and biophysical constituents in adequate quantities and proportion which have been reported to exert profound influence on growth, development, survival and reproduction of the insects in various ways (Painter, 1958).

Using resistant varieties is one of the improved techniques to reduce the yield losses by insect pests. Resistance in plants refers to the ability to with stand or repel insect attack due to specific phenotypic, genotypic or biochemical characteristics that exert detrimental effect on the insects. Biochemical factors of plant play an important role by providing resistance against *Maruca vitrata* in mungbean. Knowledge of the various parameters which provide the resistance can be extremely useful to the entomologist and the seed breeders. Development of varieties with the various mechanism of resistance plays a vital role in slowdown the development of insect biotypes. In view of the above facts, the present investigation was carried out.

MATERIALS AND METHODS

The investigation was carried out at Crop Research Center of Sardar Vallabhbhai Patel University of Agriculture and technology, Meerut (U.P.) during the *summer* season of 2021 and 2022. The study aimed to assess the presence of *Maruca vitrata* on 20 potential mung bean varieties and genotype, which were acquired from the ICAR-IIPR and C.S.A. University of Agriculture and Technology, Kanpur

(U.P.). Each variety was sown in the plot of 3×0.75 m² area, keeping row to row and plant to plant distance of 30 cm and 10 cm, respectively. All the varieties/genotypes were planted in randomized block design (RBD) with three replications. All the recommended agronomic practices were applied for population build-up of insect pest complex in mung bean. The bulk plot was kept in untreated condition throughout the crop growth period.

The population density of pod borer was counted by randomly selected 10 plants per plot of each variety at weekly interval. The percentage of pod borer damage was taken till harvesting while the observations were made on the characteristics of pod borer/exit hole on the pod. After that % was worked out through the given formula, for the pod damage.

$$\text{Damaged pod (\%)} = 100 \times \frac{\text{Number of damaged pod}}{\text{Total number of selected pod}}$$

This study has been done at the IRRI laboratory, Department of Soil Science and Agricultural Chemistry. To study the biochemical constituents, sample of the whole plant from each plot was collected at 40 days after sowing during *summer* 2021-22. These samples were brought and washed with distilled water and kept in open air under shade for drying. After that these samples were dried in hot air oven at 35°C for 48 hours. Dried material was cut into pieces, grounded with the blender, and were passed through 1 mm sieve and stored in zip lock plastic bags in refrigerator for further analysis. The biochemical constituents analyzed and correlated with the damage of pod borer to determine their role towards resistance/susceptibility. The procedure adopted for the analysis of biochemical constituents viz. phenols, proteins, sugar and reducing sugar of different genotypes describe as under-

- 1. Phenol content (Malick and Singh, 1980):** Estimated using Folin-Ciocalteu reagent in an alkaline medium, forming a blue complex measured spectrophotometrically.
- 2. Protein content (Lowry *et al.*, 1951):** Measured via the Lowry method using copper ions and Folin-Ciocalteu reagent, quantified by colorimetric analysis.
- 3. Total sugar (Hedge and Hofreiter, 1962):** Determined with anthrone reagent under acidic conditions, producing a measurable green complex.
- 4. Reducing sugar (Nelson, 1944; Somogyi, 1952):** Estimated by the Nelson-Somogyi method, where reducing sugars form a coloured complex with arsenomolybdate reagent.

Correlation studies

Correlations between the biochemical constituents and damage % of mungbean of each genotype was calculated through the following formula:

$$X_1 Y_1 = \frac{\sum XY - \frac{(\sum X_1)(\sum Y_1)}{N}}{\sqrt{\sum X_1^2 - \frac{(\sum X_1)^2}{n}} \sqrt{\sum Y_1^2 - \frac{(\sum Y_1)^2}{n}}}$$

Where,

X_1Y_1 = Simple correlation coefficient.

X_1 = Biochemical parameters.

Y_1 = Damage %.

N = Number of observations.

RESULTS AND DISCUSSION

Mean larval population and pod damage percentage on various genotypes of mung bean

The data presented in Table 1 revealed that infestation of *Maruca vitrata* ranged between 0.50 to 1.48 larvae/plant. Out of fifteen greengram genotypes screened against *M. vitrata*, 1.48 larvae were found on SML-668 which followed by the T-44 and IPM-312-20 with 1.33 and 1.29 larvae/plant. IPM-302-2 (1.29) was the next genotype in series of larvae/plant followed by KM-2241, K-851, PDM-11, IPM-410-3 and SML-1815 with the 1.10, 1.08, 0.94, 0.94 and 0.77 larvae/plant, respectively. The mean number of larvae/plant for the rest of genotypes was found below the ETL level which was less than 1 larvae, viz. KM-2328 (0.77), PM-6 (0.65) and IPM-2-K-14-9 (0.59). IPM-99-125 (0.50) and IPM-2-14 (0.54) and MH-421 (0.99) were found with the least number of larvae/plant.

The pooled data on per cent pod damage, presented in table 1 revealed that the pod infestation by *Maruca vitrata* ranged from 4.41 to 34.88 per cent during Summer 2021 and 2022. Among all the genotypes, the SML-668 was found to be susceptible genotype with the maximum pod infestation of 34.88 per cent during Summer 2021 and 2022. 23.51 per cent pod damage was recorded in the

T-44 genotype followed by IPM-312-20, IPM-410-3, PDM-11 and KM-2241 with 22.54 per cent, 21.28 per cent, 20.63 per cent and 20.84 per cent which were categorized as the moderately susceptible (MS) genotypes. Whereas, five genotypes viz. K-851, IPM-302-2, KM-2328, IPM-2-14 and SML-1815 were observed with pod infestation 17.77, 16.04, 13.71, 11.20 and 11.07 per cent, respectively and these genotypes found to be tolerant (T) against *Maruca vitrata*. However, remaining four genotypes viz. PM-6 (9.44 per cent), IPM 2-K-14-19 (8.26 per cent), MH-421 (4.41 per cent) and IPM-99-125 (3.04 per cent) were found moderately resistant (MR) with respect to pod damage (<10 per cent pod damage) against *Maruca vitrata* in mung bean.

Almost similar procedures were adopted by Umbarkar and Parsana (2013) who revealed that minimum number of larvae were recorded 1.35 larvae/plant in GM-2K-5 which was at par with GM-2K-3 (1.72 larvae/plant) and GM-9926 (1.81 larvae/plant).

Biochemical constitute responsible for resistant against *Maruca vitrata*

Insect resistant is largely imparted by biochemical components in plant parts. The difference in these biochemical constitute concentrations determines whether a genotype is vulnerable or resistant. In order to comprehend the molecular underpinnings of resistant against *M. vitrata*, the biochemical components of mung bean (Phenols, protein, total sugar and reducing sugar) were examined on the 45-day-old plant. Additionally, these biochemical components have effects on resistant and susceptibility and were evaluated in relation to *M. vitrata*

Table 1: Pooled quantity (mg/g) of biochemical constitute responsible for resistance against *Maruca vitrata* (Fabricius) in different genotypes during Summer-2021 and 2022.

Genotypes	Phenol content (mg/g)	Protein content (mg/g)	Total sugar content(mg/g)	Reducing sugar (mg/g)	Mean (Larval population)*	% Pod damage**
K-851	6.58	18.95	17.66	13.00	1.08 (1.44)	17.77 (4.33)
KM-2328	8.35	11.09	12.48	8.49	0.77(1.32)	13.71(3.83)
KM-2241	6.78	12.29	19.47	14.39	1.10(1.44)	20.84(4.66)
IPM-2-K-14-9	8.94	11.57	12.53	8.36	0.59(1.26)	8.26(2.98)
IPM-2-14	8.00	13.42	16.99	11.30	0.54(1.24)	11.20(3.44)
IPM-99-125	8.24	12.81	14.50	9.24	0.50(1.20)	3.04(1.90)
MH 421	8.05	11.17	10.92	6.76	0.99(1.24)	4.41(2.28)
IPM-302-2	6.39	16.53	19.01	13.63	1.29(1.41)	16.04(4.10)
IPM-312-20	7.48	13.06	17.40	11.27	1.29(1.51)	22.54(4.81)
IPM-410-3	6.86	12.98	16.47	10.19	0.94(1.39)	21.28(4.72)
PM-6	8.50	13.40	14.23	7.47	0.65(1.28)	9.44(3.17)
PDM-11	8.17	15.09	16.94	12.87	0.94(1.39)	20.63(4.61)
SML-668	6.38	16.56	19.76	12.60	1.48(1.57)	34.88(5.99)
SML-1815	7.97	11.78	10.52	7.32	0.77(1.33)	11.07(3.43)
T-44	6.97	17.39	18.42	11.27	1.33(1.52)	23.51(4.95)
CD at 5%	0.176	0.287	2.139	0.218	0.054	0.995
SE(m) ±	0.060	0.098	0.735	0.075	0.054	0.342

*Figures in the parentheses are square root transformed values.

**Figures in the parentheses are arcsine transformed values.

population and damage. The next sub section includes a description of the outcomes and correlation data has been revealed in Table 2.

Phenol content

Phenol content of various genotypes during *Summer*, 2021 and 2022 (Pooled), varied between 6.38 to 8.94. The maximum protein content was recorded in IPM-2-K-14-9 (8.94) followed by the PM-6 (8.50), KM-2328 (8.35), IPM-99-125 (8.24), PDM-11 (8.17) and MH-421 (8.05). The genotypes of mung bean IPM-2-14 (8.00), SML-1815 (7.97), IPM-312-20 (7.48), T-44 (6.97) and IPM-410-3 (6.86) recorded a moderate level of phenol content (mg/g) whereas rest of the genotypes such as SML-668 (6.38) followed by IPM-302-2 (6.39), K-851 (6.58) and KM-2241 (6.78) had comparatively less amount of protein.

The current findings are consistent with those of Singh and Singh (2021), who reported significantly higher phenol content in resistant mungbean genotypes compared to susceptible ones, which exhibited lower phenolic compound.

Protein content (mg/g)

Protein content of various genotypes during *Summer*, 2021 and 2022 (Pooled), varied between 11.09 to 18.95. The maximum protein content was recorded in K-851 (18.95) followed by the T-44 (17.39), SML-668 (16.56), IPM-302-2 (16.53) and PDM-11 (15.09). The genotypes of mung bean as IPM-2-14 (13.42), PM-6 (13.40), IPM-312-20 (13.06), IPM-410-3 (12.98), IPM-99-125 (12.81) and KM-2241 (12.29) were recorded as moderate level of protein content (mg/g), whereas, rest of the genotypes such as KM-2328 (11.09) followed by MH-421 (11.17), IPM-2-K-14-9 (11.57) and SML-1815 (11.78) had comparatively lesser amount of protein.

These findings concur with those of Halder and Srinivasan (2007), who found that resistant mungbean varieties had low protein content and high protein content in susceptible varieties. The current findings were also corroborated by Sujithra and Srinivasan (2012).

Total sugar content (mg/g)

Total sugar content of various genotypes during *Summer*, 2022 and 2021 (pooled), varied from 10.52 to 19.76.

The maximum total sugar content was recorded in SML-668 (19.76), followed by the KM-2241 (19.47), IPM-302-2 (19.01), T-44 (18.42) and K-851 (17.66). The genotypes of mung bean followed by the PDM-11 (16.94), IPM-2-14 (16.99), IPM-312-20 (17.40), IPM-410-3 (16.47), IPM-99-125 (14.50) and PM-6 (14.23) were recorded to have moderate level of total sugar content (mg/g). Whereas rest of the genotypes such as SML-1815 (10.52), MH-421 (10.92), IPM-2-K-14-9 (12.53) and KM-2328 (12.48) had less amount of total sugar. These results are consistent with Halder and Srinivasan's studies from 2006 and 2007, which showed that resistant mungbean cultivars have lower sugar content than susceptible types and vice versa.

Reducing sugar content (mg/g)

Reducing sugar content of various genotypes during *Summer*, 2022 and 2021 (pooled), varied between 6.76 to 14.39. The maximum reducing sugar content was recorded in KM-2241 (14.39) followed by the IPM-302-2 (13.63), K-851 (13.00), SML-668 (12.60), PDM-11 (12.87) and IPM-2-14 (11.30). The genotypes of mung bean such as IPM-312-20 (11.27), T-44 (11.27), IPM-410-3 (10.19), IPM-99-125 (9.24), KM-2328 (8.49) and IPM-2-K-14-9 (8.36) were recorded as moderate level of reducing sugar content (mg/g). Whereas rest of the genotypes such as MH-421 (6.76), SML-1815 (7.32) and PM-6 (7.47) had less amount of reducing sugar. These findings support studies conducted in 2006 and 2007 by Halder and Srinivasan that shown resistant mungbean cultivars have lower sugar contents than susceptible varieties.

Association of biochemical constitute for resistance against *Maruca vitrata* in pod of mungbean

Correlation between phenol content with the number of larvae over the both *Summers* was -0.809. This had a significant negative correlation with the phenol content. While pod damage (per cent) during the *Summers* followed similar pattern and pooled results were correlated with phenol content, which was -0.712. Singh and Singh (2014) provided evidence in support of these findings, stating that the phenol content in resistant genotype was found significantly higher than other genotypes whereas, the least phenolic compound was recorded as susceptible genotype.

Table 2: Correlation coefficient between biochemical constituents and mean *M. vitrata* population and mean per cent pod damage on different genotypes during *Summer* 2021 and 2022 (pooled).

Variables	Correlation coefficient (r)*	Regression equation	R ² value
Phenol (x ₁) Vs mean <i>M. vitrata</i> population (y ₁)	-0.809	y = -0.297x + 3.204	0.655
Phenol (x ₁) Vs per cent pod damage (y ₂)	-0.712	y = -7.078x + 69.54	0.507
Protein (x ₂) Vs mean <i>M. vitrata</i> population (y ₁)	+ 0.581	y = 0.073x - 0.073	0.338
Protein (x ₂) Vs per cent pod damage (y ₂)	+ 0.550	y = 1.89x - 10.31	0.303
Total sugar (x ₃) Vs mean <i>M. vitrata</i> population (y ₁)	+ 0.641	y = 0.064x - 0.072	0.411
Total sugar (x ₃) Vs per cent pod damage (y ₂)	+ 0.749	y = 2.043x - 16.41	0.561
Reducing sugar (x ₄) Vs mean <i>M. vitrata</i> population (y ₁)	+ 0.584	y = 0.073x + 0.180	0.341
Reducing sugar (x ₄) Vs per cent pod damage (y ₂)	+ 0.669s	y = 2.261x - 7.935	0.447

*Significant at 5% level.

Halder *et al.* (2006) also supported our studies by stating same verdict.

Correlation between protein content with the number of larvae seen over the *Summers* and pooled data was +0.581*. This had a significant positive correlation with the protein content. The percentage of pod damage during the *Summers* that was correlated with phenol content was +0.550*. As proof for the current findings, Barad *et al.* (2016) noted that protein showed a significant positive association with the percentage of pod damage caused by *Maruca vitrata* and the population of larvae/plant.

Studies on the correlation of *M. vitrata* damage and number of larvae found to be favorable correlation with genotype's sugar content. The total sugar content with the number of larvae seen over the *Summers* and pooled data was +0.641*. This was a significant positive correlation with the protein content during the *Summer* of 2021 and 2022 and with aggregated data. The percentage of pod damage during the *Summers* that was connected with sugar content followed a similar pattern and pooled results were correlated with sugar content, which was +0.749. Singh and Singh (2014) provided evidence in support of our findings, stating that the resistant genotypes exhibited significantly higher total sugar content, whereas susceptible genotypes recorded the lowest. The maximum number of larvae and pod damage found those the genotypes which had the highest content of total sugars.

Studies on the relationship between sugar content and the number of larvae observed during the *summers* found that the correlation was +0.584*. The proportion of pod damage during the *summers* that was related to sugar content followed a similar pattern and the pooled findings were correlated with sugar content, which was +0.669*, respectively. This had a strong favorable relation. Sujithra and Srinivasan (2012) provided evidence for the current findings by showing that highly susceptible cultivars have higher levels of reducing sugar than tolerance cultivars. The amount of larvae and reducing sugars with pod damage were significantly positively correlated.

CONCLUSION

The result of present investigation reported that *Maruca vitrata* damage was reduced in mungbean genotypes and varieties with higher content of phenol and lower total protein, sugar and reduced sugar content in immature beans. The source of resistance in mungbean for *Maruca vitrata* can therefore be found by using these biochemical parameters as markers. Molecular tagging and marker assisted selection programme can be planned to introduce the resistance gene from the donor to the high yielding genotypes.

Ethical approval

This study was approved by SVP University of Agriculture and Technology, Meerut (U.P.) India.

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Statement of consent

Consent was obtained before conducting the investigation, including permission for the publication of all data included herein.

Data availability statement

Data will be made available on request.

Conflict of interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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