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STUDY ON BIOPHYSICAL AND BIOCHEMICAL BASIS OF RESISTANCE AGAINST SPOTTED POD BORER, *MARUCA VITRATA* (FABRICIUS)

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ABSTRACT

Indian bean is a multi-purpose crop grown mainly as a vegetable. There are several insect-pest responsible for the lower productivity of this crop. Here, an attempt has been made to uncover the causes of resistance against spotted pod borer, *Maruca vitrata* F. To study the resistance and assess the causes of resistance 12 genotypes were collected from Mega Seeds, Pulses, and Castor Research Unit at Navsari and were sown in year 2022-23, at college farm of N. M. College of Agriculture at Navsari. Field was observed for spotted pod borer infestation. Ten mature green pods of each Indian bean genotypes per replication were brought laboratory for further studies. The results proved that, among the morphological parameters assessed, trichome density and pod wall thickness had a significant negative impact on pod damage. While, pod length and number of seeds/pod had a significant positive influence on pod damage, thus higher pod length and more number of seeds per pod corresponds to higher pod damage. The biochemical parameters such as moisture content, reducing sugar, protein content and nitrogen content showed significant positive relationship with pod damage, thus, pointing that higher the content of these biochemical, more susceptible is the crop. On the other hand, total phenol and potassium content negatively significant relationship, thus, can be considered responsible for resistance.

Key words : Indian bean, Resistance, Spotted pod borer, Morphological, Biochemical.

Introduction

Indian bean or field bean is one of the most popular and ancient perennial vegetable crops. It is a multi-purpose crop that is primarily grown for its green pods. It is consumed as vegetables pulse and forage. It is native to Sub-Saharan Africa and India, is cultivated throughout the tropics for food. It is commonly called Indian bean but has various names like hyacinth bean, Indian butter bean, lablab bean, *Dolichos* bean, waby beans, Egyptian kidney bean and Australian pea (Anonymous, 2022a). Normal area of field bean is 7.45 L ha, producing 9.10 L tonne with a productivity of 1222 kg/ha. In total field bean contributes 5% in area and 6% in production (Rajak *et al*, 2024). The ever highest area and production was 11 L ha and 10 Lt. for both during 2016-17 and productivity of 986 kg/ha during 2020-21 (Anonymous, 2022b). Increase in the production has also increased the pest incidences in these crop.

Maruca vitrata was first described by Johan Christian Fabricius in 1787. Bean pod borer or spotted pod borer (*M. vitrata*) is the new name for *M. testulalis* (Zhang, 1994). The larvae, which are photo-negative, emerge early in the evening and feed on the plant throughout the night. Losses in grain yield of 20 to 60% due to *Maruca* damage in grain legumes have been estimated (Sharma *et al.*, 1999).

Indian beans, being native to India, exhibit a wide range of wild varieties with distinct morphological and biochemical characteristics. Some of these traits have been observed to be effective against pod borers. This research seeks to fill this void by making an earnest attempt to unravel the basis of resistance present in Indian beans against the bean pod borer. By exploring the inherent characteristics of these plants, both morphological and biochemical, it aims to identify key factors that contribute to their resilience against *M. vitrata*.

Materials and Methods

Seeds of various genotypes viz., NIB-9, NIB-370, NIB-101, GNIB-21, NIB-107, 125-36, NIB-195, Guj. Wal-1, NIB-202, Guj. Wal-2, NIB-316 and GNIB-22, were collected from Mega Seeds, Pulses and Castor Research Unit at Navsari Agricultural University. The seed were sown in the field of College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari, as the experiment was in Randomized Block Design (RBD) with 3 replications, conducted during the *Rabi* seasons of the years 2022-23 and 2023-24. It is situated between 20° 57' N latitude and 72° 54' E longitudes, the location boasted an altitude of approximately 11.98 m above sea level and fell under the 'South Gujarat Heavy Rainfall Zone AES-III'. The gross plot was 5.6 × 2.4 m² and net plot: 4.2 × 1.5 m² with spacing of 60 × 30 cm². The genotypes under test were left unsprayed throughout the crop period, and all recommended agronomical practices were adhered to for raising the crop. 5 plants were randomly tagged for sampling from the net plot area. In order to maintain experimental rigor, each replication involved a systematic arrangement wherein an infested row of the susceptible variety was meticulously alternated with rows of different genotypes in each replication. The experiment was executed according to the following procedure.

Procedure

Pod damage percentage : Observations were taken at weekly intervals from the first week after sowing until harvest, and the percentage of pod damage was calculated using the following formula. Both total pods and damaged pods were counted at each picking from each plot.

$$\text{Per cent pod damage} = \frac{\text{Total number of damaged pods}}{\text{Total number of pods}} \times 100$$

Sampling procedure for assessment of causes of resistance

Ten mature green pods of each Indian bean genotypes per replication from the tagged plants were brought to the Department of Entomology, N. M. College of Agriculture, Navsari Agricultural University, Navsari for studies on various morphological and biochemical aspects. Samples were kept in marked brown paper bags having wax-coated inner sides and were brought to the laboratory for studying morphological variations of pods with respect to pod borer damage. Other plant parameters were calculated from the tagged five plants of each replication. The methodology for various parameters to be studied are as follows:

Morphological characters : The length of trichomes (mm/pod) and density of trichomes (per 0.5 mm²) on pods was measured using the ocular micrometer method (Jackai and Oghiakhe, 1989). Data were recorded on ten uniformly developed pods per replication, and the mean trichome length was obtained for each genotype. The pod length and pod width was assessed with the help of graph paper and expressed in centimeters per pod. The thickness of the pod wall (mm/pod) in ten pods from each genotype was measured using digital vernier calipers. The mean pod wall thickness was computed and correlated with pod borer incidence. While, the number of seeds per pod was counted manually. The mean number of seeds per pod was calculated and correlated with bean pod borer incidence.

Biochemical parameters and methodology : The various biochemical parameters were obtained according to the procedure standardized by the Central Laboratory, NMCA, NAU, Navsari. The observation of biochemical parameters was recorded during *Rabi* 2022 – 23. The details of biochemical parameters are given here under. The moisture content percentage was determined using hot air oven at 70-100°C for 12 hrs until the fresh samples are completely desiccated. Total soluble sugar content was estimated using Anthrone method and reducing sugar was performed according to the DNS method illustrated by Sadasivam and Manickam (1992) and were calculated by comparing the absorbance value with standard solution by plotting a graph and expressed as mg/g material. The non-reducing sugars in per cent were calculated by multiplying the differences of total and reducing sugars by factor of 0.95. The results were expressed as follows. The phenols estimation has been carried out by Folin-Ciocaltue Reagent (FCR) method and expressed as mg phenols/100g material. The phenols was expressed in terms of catechol equivalents that was used as standard. The nitrogen and protein analysis was done by Micro-Kjeldahl method as described in Sadasivam and Manickam (1992) with minor modification. The nitrogen estimated in this method was multiplied by the factor 6.25 to derive the protein content of the sample. For Phosphorus and Potassium estimation the samples were subjected to wet digestion method using of diacid HNO₃:HClO₄ (10:4) mixture. Phosphorus was estimated using vanadate-molybdate reagent. The method given by Jackson (1967) was used for estimating potassium. It was determined by using flame photometer and expressed in ppm.

Statistical analysis : The data obtained were analyzed using analysis of variance for RBD design. The observations of every biochemical and morphological parameter of each varieties and each replication was

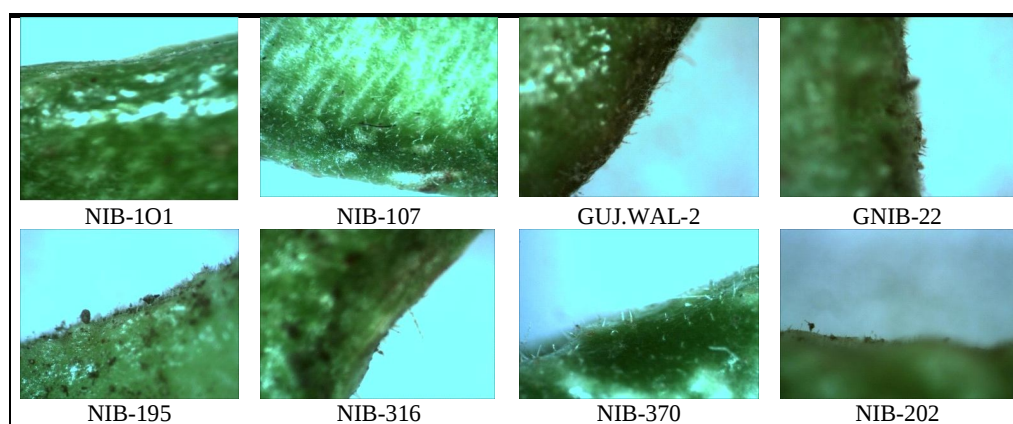


Plate 1 : Trichomes observed on pods of different varieties of Indian bean.

computed and then correlated with pod borer incidence.

Results and Discussion

Morphological parameters

According to the data in Table 1, significantly largest trichomes (0.143 mm) were found on NIB-101 which was at par with Guj.Wal-1 (0.138 mm). Smallest trichomes were measured on Guj.Wal-2 (0.077 mm), which was at par with NIB-9 (0.079 mm), NIB-370 (0.079 mm) and GNIB-22 (0.082 mm). Trichome density was significantly higher in NIB-107 with 406.27/0.5 cm², which was also at par with NIB-202 (394.80/0.5 cm²). Significantly least trichome density was observed in 125-36 with 213.40/0.5 cm² density. Significantly highest pod length of 5.90 cm was observed in NIB-316. This was

sequentially followed by 125-36, GNIB-21, NIB-101, NIB-9, NIB-107, NIB-370, Guj.Wal-2, NIB-195 and Guj.Wal-1 with 5.60, 5.57, 5.33, 5.18, 5.02, 4.81, 4.76, 4.58 and 4.57 cm, respectively. Smallest pods were of 3.93 cm length measured in NIB-202 and GNIB-22. The value of pod width varied from 2.07 to 1.09 cm. a significantly higher pod width of 2.07 cm was measured in NIB-107. Smallest pod width was obtained in NIB-202 with (1.09 cm), which was at par with GNIB-22 (1.15 cm). The range of pod wall thickness varied from 1.056 to 0.548 mm. The highest significant pod wall thickness was 1.056 mm in NIB-107. The second highest thickness was 0.821 mm measured in Guj.Wal-1. Least thickness of 0.543 was measured in 125-36 that was at par with GNIB-21 (0.559 mm) and NIB-9 (0.568 mm).

Table 1 : Data of morphological parameters of different Indian bean genotypes with per cent pod damage to determine basis of resistance against *M. vitrata* infesting Indian bean.

Treatment	Genotypes	Trichome Length (mm)	Trichome Density (No./0.5cm ²)	Pod Length (cm)	Pod width (cm)	Pod wall thickness (mm)	No. of seeds/pod	Pod damage (%)
T ₁	NIB-9	0.079 ^f	299.33 ^d	5.18 ^{de}	1.97 ^b	0.568 ^h	3.57 ^{bcd}	41.50
T ₂	NIB-101	0.143 ^a	294.60 ^{de}	5.33 ^{cd}	1.93 ^b	0.722 ^c	3.50 ^{cd}	43.11
T ₃	NIB-107	0.099 ^d	406.27 ^a	5.02 ^{ef}	2.07 ^a	1.056 ^a	2.80 ^e	28.93
T ₄	NIB-195	0.099 ^d	329.33 ^c	4.58 ^g	1.42 ^g	0.663 ^{de}	3.40 ^d	31.38
T ₅	NIB-202	0.089 ^e	394.80 ^a	3.93 ^h	1.09 ^h	0.640 ^{ef}	3.00 ^e	26.59
T ₆	NIB-316	0.109 ^c	239.27 ^f	5.90 ^a	1.47 ^{fg}	0.548 ^h	4.03 ^a	46.87
T ₇	NIB-370	0.079 ^f	361.47 ^b	4.81 ^{fg}	1.62 ^e	0.683 ^d	3.40 ^d	37.76
T ₈	GNIB-21	0.114 ^c	252.87 ^f	5.57 ^{bc}	1.49 ^f	0.559 ^h	3.80 ^{ab}	44.89
T ₉	125-36	0.122 ^b	213.40 ^g	5.60 ^b	1.75 ^c	0.543 ^h	4.07 ^a	50.30
T ₁₀	Guj.Wal-1	0.138 ^a	369.07 ^b	4.57 ^g	1.67 ^{de}	0.821 ^b	2.90 ^e	31.15
T ₁₁	Guj.Wal-2	0.077 ^f	359.20 ^b	4.76 ^{fg}	1.69 ^d	0.611 ^{fg}	2.80 ^e	38.45
T ₁₂	GNIB-22	0.082 ^f	280.07 ^e	3.93 ^h	1.15 ^h	0.600 ^g	3.73 ^{bc}	45.47
S.Em.± (T)		0.002	4.98	0.09	0.02	0.01	0.09	-
CD at 5 % (T)		0.006	14.62	0.25	0.06	0.03	0.27	-
CV%		3.26	2.73	3.03	2.04	2.52	4.59	-

Note: Treatment means with common letter(s) are/is not significant at 5% level of significance by DNMRIT.

The number of seeds per pod ranged from 4.07 to 2.80. Highest number of seeds per pod (4.07 seeds/pod) was found in 125-36 variety. It was also at par with NIB-316 (4.03 seeds/pod) and GNIB-21 (3.80 seeds/pod). This was followed by GNIB-22, NIB-9, NIB-101, NIB-195 and NIB-370 with 3.73, 3.57, 3.50, 3.40 and 3.40 seeds/pod, respectively. NIB-202, Guj.Wal-1, Guj.Wal-2 and NIB-107 with 3.00, 2.90, 2.80, 2.80 seeds/pod, respectively, were significantly different from other varieties, but at par with each other.

As presented in Table 3, a non-significant but positive correlation ($r = -0.15$) was derived between trichome length and per cent pod damage. Sai *et al.* (2018) also suggested that trichome length was a non-significant character regarding resistance against spotted pod borer in pigeon pea. The correlation of trichome density in association with pod damage was found to be highly significant negative with $r = -0.92$. Thus, trichome density has a greater impact on the resistance against spotted pod borer. Negative relationship means that more the trichome density, less damage, therefore higher level of resistance. The result of trichome density indicates similarity with the findings by Halder (2004) in cowpea, mung bean and urd bean cultivars, Jat *et al.* (2018) and Sai *et al.* (2018) in pigeon pea. The correlation between pod length and per cent pod damage was significant positive correlation with coefficient $r = 0.60$. According to the correlation obtained, it can be conferred that the impact of pod length on pod damage is such that, larger the pod length, more chance of the higher pod damage. The researchers such as Kamakshi and Srinivasan (2008), Paikra (2018) and Bharathi *et al.* (2020) showed the similar results in pod length versus pod damage relation in different genotypes of Indian bean. A non-significant, but positive correlation ($r = -0.06$) was found with the association between pod width and per cent pod damage. The correlation indicates that, there is negligible effect of pod width on the pod damage. Bharathi (2020) derived similar relation of per cent pod damage and pod width. The correlation between pod wall thickness and per cent pod damage was $r = -0.65$, which was found to be significant and negative. Therefore, it could be said that thicker pod wall imparts greater resistance. Kamakshi and Srinivasan (2008), Paikra (2018) and Bharathi *et al.* (2020) also found such similar results with negatively significant association of pod damage and pod wall thickness. The correlation coefficient of the association between number of seeds per pod and per cent pod damage was $r = 0.85$. Thus, this correlation was highly significant and positive. Thus it could be concluded that more the number of seeds per pod more pod damage is observed. Bharathi *et al.* (2020)

also found number of seeds per pod showed significant positive correlation with $r = 0.79$. The present result can be confirmed using the findings of Rashmi *et al.* (2020), who observed almost same correlation of pod damage in Indian bean with that of trichome density, pod length, pod width and pod wall thickness.

Biochemical parameters

The data obtained during the biochemical analysis are as presented in Table 2. Based on the data obtained from the analysis, the moisture percentage varies from 86.91 to 73.82 per cent. Highest moisture percentage (86.91%) was obtained from 125-36, which was also at par with NIB-101 (83.88%) and GNIB-21 (83.36%). While the lowest moisture percentage was 73.82 per cent of NIB-107, followed by Guj.Wal-2 (73.89%), NIB-370 (74.81%), Guj.Wal-1 (76.88%) and NIB-202 (78.10%), which were at par with each other. According to the analyzed data, the total soluble sugar (TSS) range from 2.11 to 1.17 mg/g. Highest TSS value (2.11 mg/g) was obtained from NIB-316 and NIB-195. This value was at par with 2.06 and 2.03 of GNIB-21 and 125-36, respectively. The significantly lowest TSS value was recorded from Guj.Wal-1 (1.17 mg/g). The reducing sugar in Indian bean varieties fluctuate between 1.30 mg/g-0.5 mg/g. Among the genotypes, significantly highest amount of reducing sugar (1.30 mg/g) was found in 125-36. While, lowest content of reducing sugar in Guj.Wal-1 was 0.5 mg/g, it was at par with NIB-202 (0.51 mg/g). The non-reducing sugar of genotypes varied from 0.67 to 1.39 mg/g. Significantly highest non-reducing sugar content *i.e.* 1.39 mg/g was obtained from GNIB-21, which was also at par with NIB-202 (1.22 mg/g). The lowest non-reducing sugar content was 0.67 mg/g of Guj.Wal-1, followed by 125-36, NIB-107, NIB-101 and NIB-9 with 0.73, 0.78, 0.80, 0.81 mg/g, respectively. The phenol content of these varieties stretched from as higher as 3.52 mg/g of Guj.Wal-1 to as low as 2.10 mg/g of 125-36. Phenol content of 3.42 mg/g was recorded in NIB-202 which was at par to Guj.Wal-1. The nitrogen content fluctuated between 4.97-4.12 per cent. While, significantly highest nitrogen content was in 125-36 (4.97%), lowest was obtained from NIB-195 (4.12%) that was at par with Guj.Wal-1 (4.14%). The range of protein content was 30.93 - 25.79 per cent. Significantly higher protein content (30.93%) was found in 125-36 variety. NIB-195 and Guj.Wal-1 with 25.79 and 25.89 per cent, respectively, was of lowest protein content, were significantly different from other varieties, but at par with each other. Based on the data, the phosphorus (P) content was highest in NIB-101 with 0.94 per cent and was at par with NIB-195, GNIB-22, which had equal phosphorus content

Table 2 : Data of biochemical parameters of different Indian bean genotypes with per cent pod damage to determine basis of resistance against *M. vitrata* infesting Indian bean.

Treatment	Genotypes	Moisture (%)	TSS (mg/g)	Reducing Sugar (mg/g)	Non-reducing sugar(mg/g)	Total phenol (mg/g)	Protein (%)	Nitrogen (%)	Phosphorus (%)	Potassium (%)	Pod damage (%)
T ₁	NIB-9	81.08 ^{bcd}	1.50 ^c	0.69 ^{ef}	0.81 ^{de}	2.47 ^d	28.73 ^{cd}	4.60 ^{cd}	0.88 ^b	2.05 ^d	41.50
T ₂	NIB-101	83.88 ^{ab}	1.52 ^c	0.72 ^{ef}	0.80 ^{de}	2.47 ^d	28.36 ^d	4.54 ^d	0.95 ^a	1.98 ^{def}	43.11
T ₃	NIB-107	73.82 ^f	1.30 ^d	0.53 ^g	0.78 ^e	3.06 ^b	27.11 ^f	4.33 ^f	0.68 ^{de}	2.32 ^b	28.93
T ₄	NIB-195	81.01 ^{bcd}	2.11 ^a	1.18 ^b	0.93 ^{cd}	2.71 ^c	25.79 ^g	4.12 ^g	0.94 ^a	1.90 ^{fg}	31.38
T ₅	NIB-202	78.10 ^{cdef}	1.73 ^b	0.51 ^g	1.22 ^b	3.42 ^a	26.82 ^f	4.29 ^f	0.78 ^c	2.34 ^b	26.59
T ₆	NIB-316	79.50 ^{bcde}	2.11 ^a	1.06 ^c	1.05 ^c	2.30 ^e	29.55 ^b	4.74 ^b	0.64 ^e	1.88 ^{gh}	46.87
T ₇	NIB-370	74.81 ^{ef}	1.78 ^b	0.75 ^e	1.04 ^c	3.11 ^b	27.04 ^f	4.33 ^f	0.48 ^f	2.21 ^c	37.76
T ₈	GNIB-21	83.36 ^{abc}	2.06 ^a	0.66 ^f	1.39 ^a	2.46 ^d	29.09 ^c	4.66 ^c	0.82 ^c	1.95 ^{efg}	44.89
T ₉	125-36	86.91 ^a	2.03 ^a	1.30 ^a	0.73 ^e	2.10 ^f	30.93 ^a	4.97 ^a	0.91 ^{ab}	1.80 ^h	50.30
T ₁₀	Guj. Wal -1	76.88 ^{def}	1.17 ^e	0.50 ^g	0.67 ^e	3.52 ^a	25.89 ^g	4.14 ^g	0.71 ^d	2.59 ^a	31.15
T ₁₁	Guj. Wal -2	73.89 ^f	1.73 ^b	0.84 ^d	0.89 ^d	2.52 ^d	27.64 ^e	4.42 ^e	0.78 ^c	2.00 ^{de}	38.45
T ₁₂	GNIB-22	81.64 ^{bcd}	1.98 ^a	1.07 ^c	0.91 ^{cd}	2.50 ^d	28.41 ^d	4.54 ^d	0.94 ^a	2.20 ^c	45.47
S.Em.± (T)		1.65	0.04	0.02	0.05	0.04	0.15	0.02	0.02	0.03	-
CD at 5% (T)		4.84	0.12	0.06	0.14	0.11	0.44	0.06	0.05	0.08	-
CV%		3.59	4.21	4.57	8.73	2.29	0.92	0.80	4.00	2.23	-

Note: Treatment means with common letter(s) are/is not significant at 5% level of significance by DNMRT.

(0.94%) and 125-26 (0.91%). Significantly lower P content was found in NIB-370 with 0.48 per cent. Data of potassium content revealed that the range lied between 2.59 and 1.80 per cent. While, 2.59 per cent was found in Guj. Wal-1, it was significantly higher than others. The lowest potassium (K) content was 1.80 per cent in 125-36; it was also at par with NIB-318 (1.88%).

The biochemical parameters were further correlated with the per cent pod damage (Table 4). The correlation coefficient ($r=-0.66$) showed that moisture content and pod damage have significant positive correlation. Thus higher the moisture content of pod, higher would be the susceptibility of the variety. Barad *et al.* (2016) assessed moisture content in relation to pod damage in cowpea and found a significant positive correlation ($r=0.63$). This result is in good agreement with the present results. Similar results were recorded by Bharathi *et al.* (2019). The correlation between TSS content and pod damage was $r = 0.52$, it was non-significant positive correlation. The result indicated that higher TSS content was found in varieties with higher pod damage. Thus, higher TSS promotes susceptibility. Somewhat similar results for TSS content were derived by Rashmi *et al.* (2020) and Bharathi *et al.* (2019) with a positive and significant correlation between TSS content and pod damage in Indian bean. Same result was recorded by Kamakshi *et al.* (2008) using resistant and susceptible variety. Sai *et al.* (2018) also suggested a positive correlation in pigeon pea. The correlation coefficient of the association between reducing sugar content and per cent pod damage was $r = 0.60$. Thus, this correlation was considered significant and positive. High reducing sugar was found in variety with higher pod damage. Thus, reducing sugar promotes susceptibility. Analogous results were observed by Kamakshi *et al.* (2008), Parvathy (2011), Sujithra and Srinivasan (2012), Paikra (2018), Bharathi *et al.* (2019), and Rashmi *et al.* (2020). The correlation coefficient ($r=-0.02$) showed that non-reducing sugar and pod damage have non-significant positive correlation. Based on the results obtained, it could be said that non-reducing sugar has negligible impact on the pod damage. There are no researches on Indian bean found to support this result. But, Halder and Srinivasan (2007) in urd bean suggested a positively significant relationship between non-

Table 3 : Correlation coefficient and regression line of morphological characters against per cent pod damage by *M. vitrata*.

S. no.	Parameters	Correlation coefficient (r)	Regression line
1	Trichome length	0.15	$y = 52.205x + 33.52$
2	Trichome density	-0.92**	$y = -0.114x + 74.954$
3	Pod length	0.60*	$y = 7.4221x + 2.2589$
4	Pod width	0.06	$y = 1.6304x + 36.245$
5	Pod wall thickness	-0.65*	$y = -34.381x + 61.832$
6	No. of seeds/pod	0.85**	$y = 14.529x - 10.774$

Note: * Significant at 5% level and **Significant at 1% level; y = pod damage (dependent value); x = parameters (independent value).

Table 4 : Correlation coefficient and regression line of biochemical characters against pod damage by *M. vitrata*.

S. no.	Parameters	Correlation coefficient (r)	Regression line
1	Moisture	0.66*	$y = 1.2179x - 58.044$
2	TSS	0.52	$y = 12.487x + 17.002$
3	Reducing sugar	0.60*	$y = 16.952x + 25.02$
4	Non-reducing sugar	0.02	$y = 0.7061x + 38.209$
5	Total Phenol	-0.87**	$y = -15.031x + 79.718$
6	Protein	0.89**	$y = 4.538x - 87.954$
7	Nitrogen	0.89**	$y = 27.773x - 85.364$
8	Phosphorus	0.27	$y = 14.66x + 27.251$
9	Potassium	-0.68*	$y = -22.63x + 86.454$

Note: * Significant at 5% level and **Significant at 1% level; y = pod damage (dependent value); x = parameters (independent value).

reducing sugar and pod damage. Difference could be due to different crop composition or regional variation. The correlation between phenol content and pod damage was $r = -0.87$, depicting it to be highly significant negative correlation indicating a strong reverse relation between phenol and resistance of plant. This current outcome coincides with many research work such as, Kamakshi *et al.* (2008), Parvathy (2011), Paikra (2018) who found similar results in Indian bean. Also, concurrent result was found in other pulse crops viz., Halder and Srinivasan (2007) in urd bean, Sunitha *et al.* (2008) and Sai *et al.* (2018) in pigeon pea, Barad *et al.* (2016), Mahipal (2016) and Muchhadiya *et al.* (2023) in cowpea. The correlation coefficient of nitrogen and protein with per cent pod damage was $r = 0.89$. Thus, this correlation was highly

significant and positive. The result suggested that higher protein content promotes susceptibility in Indian bean. The correlation between phosphorus content and pod damage was $r = 0.27$, which indicated a non-significant but, positive relation. The association between potassium content and pod damage was $r = -0.68$, which was significantly negative correlation. Higher potassium content could be responsible for lower pod damage. Hence, imparting resistance to the plant against spotted pod borer. According to the observations recorded by Kamakshi *et al.* (2008), Parvathy (2011), Sujithra and Srinivasan (2012), Paikra (2018), Bharathi *et al.* (2019), and Rashmi *et al.* (2020) in Indian bean, the protein content was higher in susceptible varieties while, low protein content was found in resistant varieties which coincides with this result. Barad *et al.* (2016) derived the nitrogen content from cowpea and assessed in relation to pod damage by *M. vitrata* and found a highly significant positive correlation ($r = 0.856$).

Conclusion

The varietal screening of genotypes depicted that, the variety 125-36 showed highest number of larvae/plant and pod damage percentage, while the least was found in Guj. Wal.-1. Further categorizing the varieties and genotypes Guj. Wal.-1, NIB-202 and based on pod damage NIB-107 were found resistant, while NIB-316 and 125-36 were found highly susceptible. But, highest yield was found in NIB-195 while least pod yield was obtained from NIB-9. Accordingly, morphological and biochemical parameters were tested to better understand the basis of resistance, the following results were obtained. Among the morphological parameters, trichome density and pod wall thickness had a significant negative impact on pod damage, thus promoting resistance. In contrast, pod length and number of seeds/pod had a significant positive influence on pod damage, thus higher pod length and more number of seeds per pod corresponds to higher pod damage. The biochemical parameters such as moisture content, reducing sugar, protein content and nitrogen content showed significant positive relationship with pod damage. Hence, it could be stated that higher the content of these biochemical, more susceptible is the crop. On the other hand, total phenol and potassium content negatively significant relationship, thus, can be considered responsible for resistance.

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