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Morphological and Biochemical Basis of Resistance in Indian Bean, *Lablab purpureus* var. *typicus* (L.) Sweet Varieties against Pod Borers

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ABSTRACT

Background: Indian bean, *Lablab purpureus* var. *typicus* (L.) Sweet (family: Fabaceae) is an important vegetable crop in India and other countries. The main reasons of variability in the pattern of resistance shown by different genotypes were explained by Painter (1951). Antibiosis is an adverse impact of the host plant on the biology of the insect pests and their progeny due to the biochemical and biophysical factors present in it.

Methods: The experiment was laid out in a simple randomized block design (RBD) with seven treatments, each replicated thrice. The plot size was 1.8 × 1.8 m^2 keeping row to row and plant to plant distance of 45 cm each. The Indian bean varieties, Arka Jay, Konkan Bhushan, Diana, Bauni, Pari, JK Special and Ganganagar local were sown on 25th July in *Kharif,* 2019 (July-November). Horticulture Farm of S.K.N. College of Agriculture, Jobner (Rajasthan). The recommended package of practices was followed to raise the crop. Various morphological parameters, *viz*., pod length, pod width, pod shell thickness, pod weight and number of seeds per pod were noted. The biochemical parameters, *viz*., moisture content, phenol content, total sugars, total protein and fibre content were analyzed.

Result: The results obtained were subjected to correlation and regression analysis to draw the impact of these parameters on pod damage. Morphological parameters like pod length, pod shell thickness showed positive correlation (r = 0.77) with pod damage. Biochemical parameters like moisture content in pods, total sugars, reducing and non-reducing and protein content showed a positive correlation (r = 0.84, 0.86, 0.82, 0.89 and 0.79) with pod damage. Phenol content and fibre content in pods had a negative correlation (r = -0.93 and -0.89) with pod damage.

Key words: Biochemical, Correlation, Indian bean, Morphological, Regression.

INTRODUCTION

Indian bean, *Lablab purpureus* var. *typicus* (L.) Sweet (family: Fabaceae) is an important vegetable crop in India and other countries. It is also called as Indian butter bean, lablab bean, dolichos bean, Egyptian bean, Australian bean, bonavist bean, waby bean (English) and *Sem phali* (local dialect). It is a perennial herbaceous plant, primarily grown for green pods, while dry seeds are used in vegetable and culinary preparations. The leaves are eaten as leafy vegetable and the flowers and seeds are also eaten as food. The fruit (pod) is wide and elongated pod which has seeds inside it. It is one of the major sources of proteins, minerals and dietary fibre. The green pods have a high nutritive value, comprising of protein 3.8 g, carbohydrate 6.7 g, vitamin-A 312 IU, mineral 0.9 g, fat 0.7 g and oxalic acid 1 mg per 100 g (Bose *et al,* 1993). In the present study, the biophysical/ morphological traits of the pods, *viz*., pod length, pod width, pod weight *etc*. and biochemical characters, *viz*., moisture content, sugars, total phenols and fibre content were studied to find out the cause of resistance attributed in the varieties of Indian bean. The biophysical traits can be used as phenotypic markers to identify Indian bean varieties with resistance to spotted pod borer, *M. vitrata* and gram pod borer, *Helicoverpa armigera*. The main reasons of variability in the pattern of resistance shown by different genotypes were explained by Painter (1951). He pointed out three phase mechanism of resistance, *viz*., non-preference (antixenosis), antibiosis and tolerance. Host plant traits are responsible for non-preference of the insects for shelter, oviposition, feeding *etc*. Antibiosis is an adverse impact of the host plant on the biology (survival, development and reproduction) of the insect pests and their progeny due to the biochemical and biophysical factors present in it.

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MATERIALS AND METHODS

The present investigations were conducted at Horticulture Farm of S.K.N. College of Agriculture, Jobner (Rajasthan) on Indian bean crop under field conditions during *Kharif*, 2019 (July-November). Geographical location of Jobner pertains to 26°06′ North latitude, 75°28′ East longitude and an elevation of 427 metres above mean sea level (MSL).

a) Experimental layout

The experiment was laid out in a simple randomized block design (RBD) with seven treatments, each replicated thrice. The plot size was 1.8 × 1.8 m^2 keeping row to row and plant to plant distance of 45 cm each. The Indian bean varieties, Arka Jay, Konkan Bhushan, Diana, Bauni, Pari, JK Special and Ganganagar local were sown on 25th July in *Kharif,* 2019. The recommended package of practices was followed to raise the crop.

b) Observations

i) The pods of individual variety were harvested at each picking from respective plots. From the total pods harvested, the infested pods were separated and counted. This data was used to calculate the pod infestation per cent/ pod damage.

ii) The observations on pod borers, *viz.*, spotted pod borer and gram pod borer were recorded at weekly interval from appearance till last picking of pods. The data on pod yield of Indian bean was also recorded plot-wise and converted into quintal per hectare. Borer damaged pods was recorded at each picking. The morphological and biochemical parameters of each variety were recorded.

iii) The morphological and biochemical parameters were attained by following standard procedures as prescribed by earlier workers. These parameters were correlated with the pod damage by borers and also the regression equation was obtained.

c) Statistical analysis

i) The total number of pods and the infested pods on observational plants were counted. The pod infestation per cent (pod damage) was calculated using the following formula:

$$\text{Pod infestation (\%)} = \frac{\text{No. of damaged pods}}{\text{Total number of pods}} \times 100$$

ii) As the data obtained on per cent pod damage from experimental field includes the damage by both borers together, the mean pod damage was cumulatively considered for categorization of Indian bean varieties. The standard deviation of mean pod damage was calculated and used to categorize varieties as least, moderately and highly susceptible This categorization was done as indicated in Table 1 and on the basis of formula given below:

$$\overline{X} \pm \sigma$$

Where,

$\overline{X}$ = Mean pod damage by borers.

σ = Standard deviation.

iii) The data obtained regarding the morphological and biochemical parameters was subjected to simple correlation and regression analysis and the impact of these parameters on pod damage was obtained. The following formula was used for calculating correlation coefficient (Panse and Sukhatme, 1967).

$$r = \frac{N \sum xy - (\sum x)(\sum y)}{\sqrt{N\sum x^2 - (\sum x)^2 \,.\, N \sum y^2 - (\sum y)^2}}$$

Where,

r = Simple correlation coefficient.

x = Independent variables, *i.e.*, morphological and biochemical parameters.

y = Dependent variables, *i.e.,* pod damage.

N = Number of observations.

Table 1: Categories of susceptibility of Indian bean varieties.

Criteria for categorization	Category
Below $\overline{X} - \sigma$	Highly resistant
$\overline{X}$ - s to $\overline{X} + \sigma$	Moderately resistant
Above $\overline{X} + \sigma$	Least resistant

RESULTS AND DISCUSSION

The pod borers recorded in the crop season *Kharif* 2019 were spotted pod borer, *Maruca vitrata* (Geyer) and gram pod borer, *Helicoverpa armigera* (Hubner). The total number of pods and the infested pods on observational plants were counted.

Pod damage due to pod borers, *M. vitrata* and *H. armigera*

As presented in the Table 2 and depicted in Fig 1 the mean per cent pod damage by spotted pod borer and gram pod borer varied from 27.08 to 54.19 per cent. The minimum pod damage was noticed in variety Pari (27.08%) followed by Konkan Bhushan (31.12%) and both were at par. The pod damage was maximum in variety Ganganagar local (54.19%) followed by JK-Special (48.39%) and were at par. The mean per cent pod damage of varieties Arka Jay, Bauni and Diana were 37.07, 40.03 and 43.50 respectively. The ascending order of pod damage by these borers was found to be: Pari, Konkan Bhushan, Arka Jay, Bauni, Diana, JK-Special, Ganganagar local.

Categorization of varieties into categories of resistance

The data presented in Table 3 shows the categorization of varieties based on mean per cent pod damage by pod borers. The formula ($X \pm \sigma$) was used for categorization. The mean (X) for the data was 40.20 and standard deviation (σ) calculated was 9.47. As per the mentioned categorization the varieties having per cent pod damage below 30.73 were designated as highly resistant (Pari), above 49.67 per cent as least resistant (Ganganagar local) and those with pod damage between 30.73 and 49.67 per cent are considered moderately resistant (Konkan Bhushan, Arka Jay, Bauni, Diana, JK-Special).

Morphological parameters of Indian bean varieties

Various pod characters, *viz.,* pod colour, pod wall thickness, pod length, pod width, number of pods per plant, number of infested pods per plant, yield and pod infestation percentage were recorded to know the morphological basis of resistance in seven varieties of Indian bean. Similar nature of work was earlier done by Blaney and Simmonds (1990), Nanda *et al*. (1996), Chandrayudu *et al*. (2006), Kamakshi and Srinivasan (2008) and Divya *et al*. (2020). The data of the above characters is presented in Table 4. The pod characters have been correlated with per cent pod damage and the data are presented in Table 5. The pods of seven varieties have been depicted in Plate 1.

Pod colour

Pods of seven varieties were visually examined to note the colour. The colours of the pods varied from light green to dark green. Pods of varieties Pari and Diana were light green in colour. In varieties Arka Jay, Konkan Bhushan, JK-special, Ganganagar local the pods were green in colour. The pods of Bauni were dark green in colour.

Pod shell thickness (mm)

The pod wall thickness of different varieties of Indian bean varied from 1.02 to 1.89 mm. The pod shell thickness was maximum in variety Ganganagar local and least in variety Pari. Wall thickness of Bauni, Konkan Bhushan, Diana, JK-Special and Arka Jay are 1.18, 1.22, 1.26, 1.28 and 1.41 mm respectively. The pod shell thickness showed significant positive correlation with pod damage (r= 0.766). The regression equation obtained was:

$$Y= 5.412+26.29X$$

Where,
Y= Per cent pod damage.
X= Pod shell thickness).

Table 2: Pod damage in Indian bean, *Lablab purpureus* var. *typicus* (L.) Sweet varieties due to spotted pod borer, *Maruca vitrata* (Geyer) and gram pod borer, *Helicoverpa armigera* (Hubner).

Varieties	Mean per cent pod damage
Arka Jay	37.07 (37.39)
Bauni	40.03 (39.18)
Konkan Bhushan	31.12 (33.85)
JK-Special	48.39 (44.04)
Pari	27.08 (31.32)
Ganganagar local	54.19 (47.40)
Diana	43.50 (41.21)
S.Em.±	1.82
CD (p=0.05)	5.67

Figures in the parentheses are angular values.

It indicated that 58.7 per cent variation in pod damage is attributable to pod shell thickness. Similar results were reported by Chandrayudu *et al*. (2006) and Divya *et al*. (2020).

Pod length (cm)

The pod length of different varieties of Indian bean ranged from 5.29 to 8.68 cm. Pods of variety Bauni were the longest and those of variety Pari are shortest. The pod lengths of varieties Arka Jay, Konkan Bhushan, Diana, JK-Special and Ganganagar local are 7.01, 7.18, 7.41, 8.16, 8.27 cm respectively. Pod lengths showed significant positive correlation with pod damage (r=0.766). The regression equation obtained was:

$$Y=-7.686+6.445X$$

Where,
Y= Per cent pod damage.
X= Pod length.

It indicated that 58.8 per cent variation in pod damage is attributable to pod length. The present findings corroborate to those of Nanda *et al*. (1996); Halder *et al*. (2006) and Divya *et al*. (2020).

Pod width (cm)

Width of pods in different varieties of Indian bean ranged from 0.84 to 2.04 cm. Pod width was more in variety Bauni and less in variety Ganganagar local. Width of pods in varieties Arka Jay, Konkan Bhushan, JK-Special, Pari and Diana are 1.00, 1.04, 1.17, 1.58, 1.60 cm respectively. Width of pods showed negative non-significant correlation (r= -0.288) with pod damage. The regression equation obtained was:

$$Y=48.65-6.381X$$

Where
Y= Per cent pod damage.
X= Pod width.

It indicated that only 8 per cent variation in pod damage is attributable to pod width. Kamakshi and Srinivasan (2008) also found that there was a non-significant correlation between pod width and pod damage.

Pod weight (g)

The pod weights of seven varieties ranged from 4.72- 8.80g. Individual pod weight was high in variety, Bauni and least in Konkan Bhushan. Pod weights of varieties Pari, Ganganagar local, Diana, Arka Jay and JK-Special were 4.96, 5.21, 5.70, 6.04 and 6.20 respectively. Weights of pods showed positive non-significant correlation (r= 0.182) with pod damage. The regression equation obtained was:

$$Y= 32.681+1.263X$$

Where,
Y= Per cent pod damage.
X= Pod weight.

Table 3: Categorization of varieties based on resistance.

Categories of resistance	Corresponding values	Varieties
Highly resistant	Below 30.73	Pari
Moderately resistant	Between 30.73 and 49.67	Konkan Bhushan, Arka Jay, Bauni, Diana, JK-Special
Least resistant	Above 49.67	Ganganagar local

It indicated that only 3.3 per cent variation in pod damage is attributable to pod weight.

Total number of pods per plant

The total number of pods per plant ranged from 18.40 to 32.60. Highest number of pods per plant were found in variety Konkan Bhushan and least number of pods per plant were seen in variety Bauni. Total number of pods per plant in varieties Diana, JK-Special, Pari, Arka Jay and Ganganagar local were 20.70, 22.70, 24.20, 25.80 and 29.30 respectively.

Total number of pods per plant showed non-significant correlation with pod damage. The regression equation obtained was:

$$Y = 45.831 - 0.227X$$

Where
Y= Per cent pod damage.
X= Total number of pods.

It showed that only 1 per cent variation in pod damage is attributable to total number of pods per plant.

Table 4: Biophysical parameters of different varieties of Indian bean, *Lablab purpureus var. typicus* (L.) Sweet and pod infestation by pod borers, *Maruca vitrata* (Geyer) and *Helicoverpa armigera* (Hubner).

Name of variety	Pod colour	Pod length (cm)	Pod width (cm)	Pod wt. (g)	Pod shell thickness (mm)	No. of pods/ plant	Infested pods/ plant	Pod infestation (%)	Yield/ plant (g)	Yield (q/ha)
Arka Jay	Green	7.01	1.00	6.04	1.41	25.80	9.56	37.07	100.30	72.86
Bauni	Dark green	8.68	2.04	8.80	1.18	18.40	7.36	40.03	97.36	58.26
Konkan Bhushan	Green	7.18	1.04	4.72	1.22	32.60	10.14	31.12	80.63	51.06
JK-Special	Green	8.16	1.17	6.20	1.28	22.70	10.98	48.39	48.03	47.92
Pari	Light green	5.29	1.58	4.96	1.02	24.20	6.55	27.08	31.83	62.68
Ganganagar Local	Green	8.27	0.84	5.21	1.89	29.30	15.87	54.19	50.16	54.20
Diana	Light green	7.41	1.60	5.70	1.26	20.70	9.00	43.50	54.23	50.71
Correlation coefficient (r) between biophysical parameters and pod infestation (%)	-	0.77*	-0.29	0.18	0.77*	-0.12	0.77*	-	-0.14	-

*Significant at 1 per cent level of significance.
**Significant at 5 per cent level of significance.

Table 5: Relationship of biochemical and biophysical parameters with pod damage inflicted by pod borers, *Maruca vitrata* (Geyer) and *Helicoverpa armigera* (Hubner).

Variable	Correlation coefficient	Regression equation (Y= a + bX)	R^2 value
A. Biophysical characters			
Pod length (X) vs. per cent pod damage (Y)	0.766*	Y= -7.686+6.445X	0.588
Pod width (X) vs. per cent pod damage (Y)	-0.288	Y= 48.65-6.381X	0.083
Pod weight (X) vs. per cent pod damage (Y)	0.182	Y= 32.681+1.263X	0.033
Pod shell thickness (X) vs. per cent pod damage (Y)	0.766*	Y= 5.412+26.29X	0.587
Yield per plant (X) vs. per cent pod damage (Y)	-0.135	Y= 43.379-0.048X	0.018
Mean larval population of spotted pod borer (X) vs. per cent pod damage (Y)	0.801*	Y= 9.435+5.543X	0.643
Mean larval population of gram pod borer (X) vs. per cent pod damage (Y)	0.795*	Y= 11.622+6.892X	0.633
Number of pods per plant (X) vs. per cent pod damage (Y)	-0.117	Y= 45.831-0.227X	0.013
Number of infested pods per plant (X) vs. per cent pod damage (Y)	0.767*	Y= 16.460+2.392X	0.589
B. Biochemical characters			
Moisture content of pods (X) vs. per cent pod damage (Y)	0.836*	Y= -406.85+5.276X	0.700
Total sugars (X) vs. per cent pod damage (Y)	0.855*	Y= -131.37+32.759X	0.732
Reducing (X) vs. per cent pod damage (Y)	0.822*	Y= -103.85+40.857X	0.677
Non reducing sugars (X) vs. per cent pod damage (Y)	0.886**	Y= -192.52+135.97X	0.786
Phenols (X) vs. per cent pod damage (Y)	-0.928**	Y= 97.329-13.407X	0.862
Fibre content (X) vs. per cent pod damage (Y)	-0.885**	Y= 117.99-2.75X	0.784
Total protein (X) vs. per cent pod damage (Y)	0.789*	Y= -21.73+233.08X	0.622

*Significant at 1 per cent level of significance
**Significant at 5 per cent level of significance.

Infested pods per plant

Number of infested pods per plant ranged from 6.55 to 15.87 pods. More number of infested pods were found in variety Ganganagar local and only few infested pods were found in variety Pari. The number of infested pods per plant in varieties Bauni, Diana, Arka Jay, Konkan Bhushan and JK-Special were 7.36, 9.00, 9.56, 10.14 and 10.98, respectively.

Number of infested pods per plant showed significant positive correlation (r= 0.767) with pod damage. The regression equation formed was:

$$Y= 16.460+2.392X$$

Where

Y= Per cent pod damage.

X= Number of infested pods per plant.

It showed that 58.9 per cent variation in pod damage is attributable to number of infested pods per plant.

Biochemical parameters of Indian bean varieties

Various biochemical characters of pods in seven Indian bean varieties were analysed. Parameters like total sugars, reducing sugars, non-reducing sugars, moisture content, total proteins, total phenol content, fibre content of each variety are presented in Table 6. The data obtained from above analysis is correlated with per cent pod damage and presented in Table 5. Similar work by earlier done by Blaney and Simmonds (1990), Dodia (1992), Nanda *et al*. (1996), Green *et al*. (2003), Sahoo and Patnaik (2003), Dodia *et al*. (2005), Halder *et al*. (2006), Rizwana *et al*. (2007), Anantharaju and Muthiah (2008), Sunitha *et al*. (2008a), Sunitha *et al*. (2008b), Singh and Singh (2014), Barad *et al*. (2016), Divya *et al*. (2019).

Moisture content (%)

Moisture contents of seven Indian bean varieties were in the range of 82.20 to 86.60 per cent. The moisture content

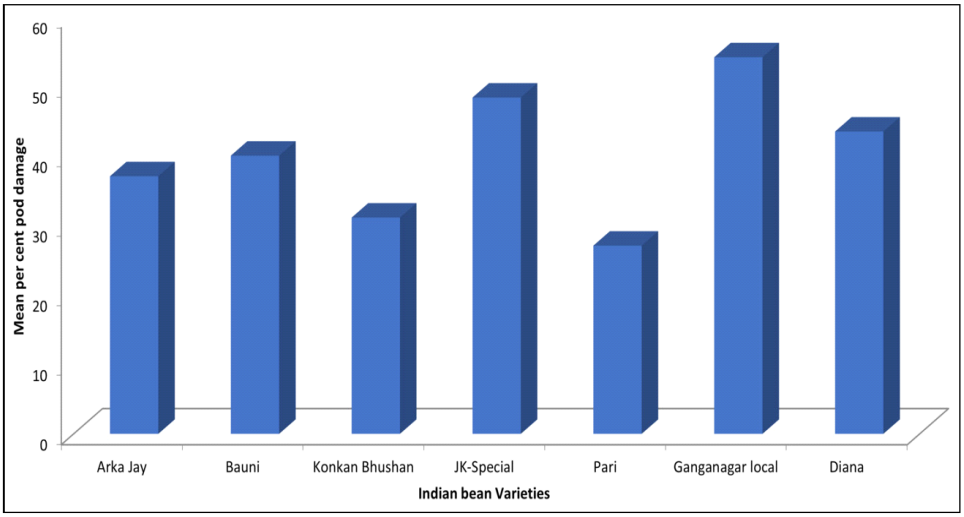


Fig 1: Pod damage in Indian bean, *Lablab purpureus* var. *typicus* (L.) Sweet varieties due to spotted pod borer, *Maruca vitrata* (Geyer) and gram pod borer, *Helicoverpa armigera* (Hubner).

Table 6: Biochemical parameters of different varieties of Indian bean, *Lablab purpureus var. typicus* (L.) Sweet and pod infestation by pod borers, *Maruca vitrata* (Geyer) and *Helicoverpa armigera* (Hubner).

Name of variety	Moisture content (%)	Total Sugars (%)	Reducing sugars (%)	Non- reducing sugars (%)	Total protein (g/100 g)	Total Phenols (mg/g)	Fibre content (%)	Pod infestation (%)
Arka Jay	84.06	5.26	3.56	1.70	0.25	4.13	26.94	37.07
Bauni	84.43	5.07	3.37	1.70	0.25	4.07	27.86	40.03
Konkan Bhushan	82.20	5.02	3.34	1.68	0.23	5.10	30.13	31.12
JK- Special	85.60	5.64	3.83	1.81	0.32	3.70	26.57	48.39
Pari	84.09	4.94	3.32	1.62	0.24	5.27	34.27	27.08
Ganganagar Local	86.60	5.43	3.66	1.77	0.28	3.66	25.12	54.19
Diana	86.12	5.30	3.60	1.70	0.29	3.90	27.01	43.50
Correlation coefficient (r) between biochemical parameters and pod infestation	0.84*	0.86*	0.82*	0.89**	0.79*	-0.93**	-0.89**	-

*Significant at 1 per cent level of significance.

**Significant at 5 per cent level of significance.

was highest in Ganganagar local and lowest in Konkan Bhushan. Moisture contents of varieties Arka Jay, Pari, Bauni, JK-Special and Diana were 84.06, 84.09, 84.43, 85.60 and 86.12 per cent respectively. Divya *et al*. (2019) also reported the same relationship between pod damage and moisture content.

Moisture content of pods showed positive significant correlation (0.836) with pod damage. The regression equation obtained was:

Y= -406.85+5.276X

Where
Y= Per cent pod damage.
X= Moisture content.

It showed that 70 per cent variation in pod damage is attributable to moisture content.

Total sugars (%)

Total sugar content in pods of seven varieties ranged between 4.94 to 5.64 per cent. Total sugar content was highest in JK-Special and least in Pari. Sugar content in varieties Konkan Bhushan, Bauni, Arka Jay, Diana and Ganganagar local were 5.02, 5.07, 5.26, 5.30 and 5.43 per cent respectively.

The total sugar content of pods showed positive significant correlation (0.855) with pod damage. The regression equation obtained was:

Y= -131.37+32.759X

Where,
Y= Per cent pod damage.
X= Total sugar content.

It is noticed that 73.2 per cent variation in pod damage is attributable to total sugar content.

Reducing sugars (%)

The content of reducing sugars in pods of seven varieties were in the range of 3.32 to 3.83 per cent. Reducing sugars content was maximum in variety JK-Special and least in Pari. Reducing sugar content in pods of varieties Konkan Bhushan, Bauni, Arka Jay, Diana and Ganganagar local were 3.34, 3.37, 3.56, 3.60 and 3.66 per cent respectively.

Reducing sugar content in pods showed positive significant correlation (0.822) with pod damage. The regression equation obtained was:

Y= -103.85+40.857X

Where
Y= Per cent pod damage.
X= Reducing sugar content in pods.

It is noticed that 67.7 per cent variation in pod damage is attributable to reducing sugar content of pods.

Non-reducing sugars (%)

The non-reducing sugar content of seven Indian bean varieties ranged between 1.62 to 1.81 per cent. Content of non-reducing sugars was maximum in JK-Special and least in Pari. Non reducing sugar content in varieties Konkan Bhushan and Ganganagar local were 1.68 and 1.77 per cent respectively and 1.70 per cent in Arka Jay, Bauni and Diana. Non reducing sugar content in pods showed positive significant correlation (0.886) with pod damage. The regression equation obtained was:

Y= -192.52+135.97X

Where
Y= Per cent pod damage.
X= Non-reducing sugar content in pods.

It is noticed that 78.6 per cent variation in pod damage is attributable to non-reducing sugars. Divya *et al*. (2019) reported that total sugars, reducing sugars and non-reducing sugars content in pods had positive significant correlation with pod damage which supports the present findings.

Total protein (g/100 g)

Protein content of seven Indian bean varieties ranged between 0.23 to 0.32 g/100 g. Protein content was maximum in Variety JK-Special and minimum in Konkan Bhushan. Protein content in pods of varieties Pari, Ganganagar local and Diana were 0.24, 0.28 and 0.29 g/100 g respectively. It was 0.25 g/100g in Arka Jay and Bauni.

Protein content in pods showed positive significant correlation with pod damage. The regression equation obtained was:

Y= -21.73+233.08X

Where
Y= Per cent pod damage.
X= Total protein content in pods.

It showed that 62.2 per cent variation in pod damage is attributable to total protein content of pods. The similar results were reported by Anantharaju and Muthaiah (2008), Singh and Singh (2014), Divya *et al*. (2019).

Total phenols (mg/ g)

Phenol content in seven varieties of Indian bean varied from 3.66 to 5.27 mg/g. Total phenol content was maximum in variety Pari and minimum in variety Ganganagar local. Phenol content in varieties JK-Special, Diana, Bauni, Arka Jay and Konkan Bhushan were 3.70, 3.90, 4.07, 4.13 and 5.10 mg/g respectively.

Total phenol content in pods showed highly negative significant correlation (-0.928) with pod damage. The regression equation obtained was:

Y= 97.329-13.407 X

Where
Y= Per cent pod damage.
X= Total phenol content.

It showed that 86.2 per cent variation in pod damage is attributable to phenol content of pods. The present finding got support from the results obtained by Sahoo and Patnaik (2003), Halder *et al*. (2006), Anantharaju and Muthaiah (2008), Barad *et al*. (2016) and Divya *et al*. (2019).

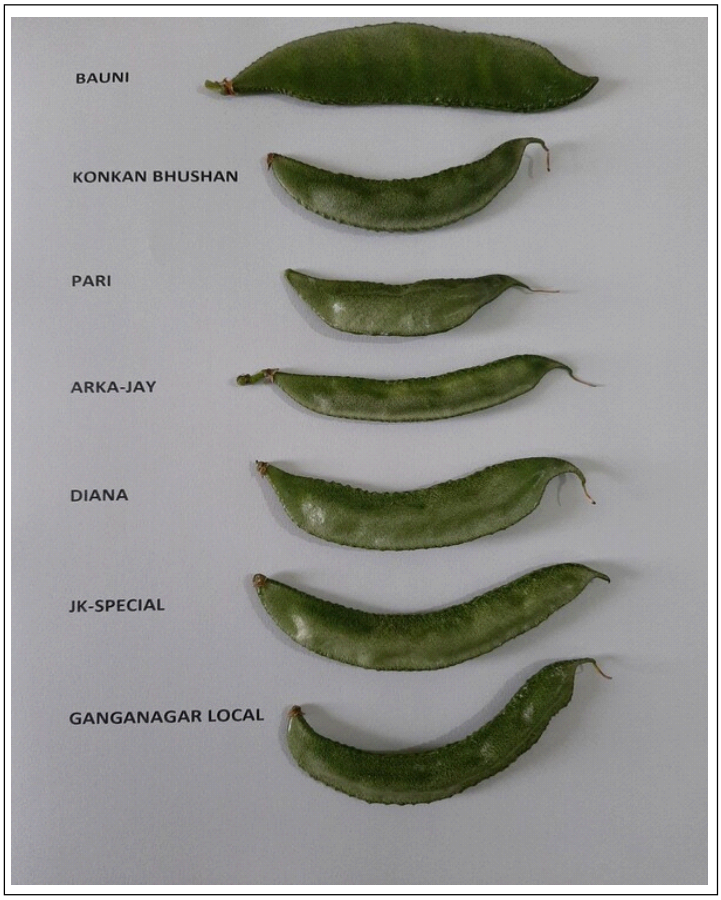


Plate 1: Biophysical characters of Pods of different Indian bean varieties.

Fibre content (%)

The fibre content of pods in varieties of Indian bean were in the range of 25.12 to 34.27 per cent. High fibre content was seen in variety Pari and low fibre content was seen in variety Ganganagar local. Fibre content of pods in varieties JK-Special, Arka Jay, Diana, Bauni and Konkan Bhushan were 26.57, 26.94, 27.01, 27.86 and 30.13 per cent respectively. The fibre content in pods of seven varieties showed highly negative significant correlation (-0.885) with pod damage. The regression equation obtained was:

$$Y= 117.99-2.75\ X$$

Where,
Y= Per cent pod damage.
X= Fibre content in pods.

It showed that 78.4 per cent variation in pod damage is attributable to fibre content of pods. Similar results were reported by Barad *et al*. (2016) in cowpea and Divya *et al*. (2019) in Indian bean.

SUMMARY

Seven Indian bean varieties, *viz*., Arka Jay, Bauni, Konkan Bhushan, JK-Special, Pari, Ganganagar local and Diana were screened for their resistance against pod borers. Out of these, a variety Pari was found to be highly resistant to the pod borers and variety Ganganagar local was least resistant. Other varieties Konkan Bhushan, Arka Jay, Bauni, Diana and JK-Special were reported to be moderately resistant to pod borers. Based on the per cent pod damage. The statistical categorization ($X + \sigma$) was done to know the level of resistance of each variety. The varieties with pod damage < 30.73 (%) were considered as resistant, those with pod damage between 30.73 and 49.67 (%) were moderately resistant and if the pod damage is > 49.67 (%) then it is treated as least resistant. Shorter pods, less pod shell thickness, low sugar content (reducing and non-reducing), low protein content, high phenol and fibre content are attributable to resistance of variety Pari.

Various biophysical and biochemical parameters of pods were analyzed to know their impact on resistance of a variety. Biophysical parameters like pod length, pod shell thickness showed positive correlation (r= 0.77) with pod damage. Biochemical parameters like moisture content in pods, total sugars, reducing and non-reducing and protein content showed a positive correlation (r= 0.84, 0.86, 0.82, 0.89 and 0.79) with pod damage. Phenol content and fibre content in pods had a negative correlation (r= -0.93 and -0.89) with pod damage.

CONCLUSION

Seven Indian bean varieties, *viz*., Arka Jay, Bauni, Konkan Bhushan, JK-Special, Pari, Ganganagar local and Diana were screened for their resistance against pod borers. Out of these, a variety Pari was found to be highly resistant to the pod borers and variety Ganganagar local was least resistant. Other varieties Konkan Bhushan, Arka Jay, Bauni, Diana and JK-Special were reported to be moderately resistant to pod borers. Based on the per cent pod damage. Biophysical parameters like pod length, pod shell thickness showed positive correlation (r= 0.77) with pod damage. Biochemical parameters like moisture content in pods, total sugars, reducing and non-reducing and protein content showed a positive correlation (r= 0.84, 0.86, 0.82, 0.89 and 0.79) with pod damage. Phenol content and fibre content in pods had a negative correlation (r= -0.93 and -0.89) with pod damage.

Conflict of interest

All authors declared that there is no conflict of interest.

REFERENCES

Anantharaju, P. and Muthiah, A.R. (2008). Biochemical components in relation to incidence of pigeon pea spotted pod borer (*Maruca vitrata*) and blister beetle (*Mylabris* spp.). Legume Research. 31: 87-93.

Barad, C.S., Patel, P.S., Rabari, G.N. and Panickar, B. (2016). Biochemical basis of resistance against *Maruca vitrata* in selected genotypes/ varieties of cowpea. Indian Journal of Plant Protection. 44: 59-62.

Blaney, W.M. and Simmonds, M.S.J. (1990). In: Host Selection Behaviour of *H. armigera*. ICRISAT, Hyderabad, pp. 11-18.

Bose, T.K., Som, M.G. and Kabir, J. (1993). Vegetable Crops. Published by Naya Prakash, 206 Bidhan Sarani, Calcutta, pp. 612.

Chandrayudu, E., Srinivasan, S. and Rao, N.V. (2006). Incidence of *Maruca vitrata* in grain legumes in relation to plant characters. Annals of Plant Protection Sciences. 14: 465-466.

Divya Bharathi, V., Viji, C.P., Sujatha, A. (2020). Morphological basis of resistance against *Maruca vitrata* (Geyer) in Indian bean, *Lablab purpureus* var. *typicus* (L) Sweet. Journal of Entomology and Zoology Studies. 8: 1587-1591.

Divya Bharathi, V., Viji, C.P., Sujatha, A., Uma Jyothi, K. and Suneetha Salomi, D.R. (2019). Biochemical basis of resistance in Indian bean against pod borer. Biochemical and Cellular Archives. 19: 401-404.

Dodia, D.A. (1992). Control of Pests of Pigeon pea with Special Reference to Host Plant Resistance. Ph. D. Thesis submitted to Gujarat Agricultural University, Anand.

Dodia, D.A., Shukla, Y.M., Patel, A.G., Prajapati, B.G. and Tikka, S.B.S. (2005). Host plant resistance parameters in pigeon pea (*Cajanus cajan* L.) against *Helicoverpa armigera*, Abstracts IFRLV-1V, New Delhi.

Green, P.W., Stevenson, P.C., Simmonds, M.S.J. and Sharma, H. C. (2003). Phenolic compounds on the pod surface of pigeon pea, *Cajanus cajan* mediate feeding behavior of *Helicoverpa armigera* larvae. Journal of Chemical Ecology. 29: 811-821.

Halder, J., Srinivasan, S. and Muralikrishna, T. (2006). Biochemical basis of resistance to spotted pod borer, *Maruca vitrata* (Geyer) in mungbean. Journal of Entomological Research. 30: 313-316.

Kamakshi, N. and Srinivasan, S. (2008). Influence of certain biophysical factors on incidence of pod borer complex in selected genotypes of field bean. Annals of Plant Protection Sciences. 16: 407-409.

Nanda, U.K., Sasmal, A. and Mohapatra, S.K. (1996). Varietal reaction of pigeon pea to pod borer, *Helicoverpa* (*Heliothis*) *armigera* (Hubner) and modalities of resistance. Current Agricultural Research. 9: 107-111.

Painter, R.H. (1951). Insect resistance in crop plants. The Macmillan Publishers Limited.

Panse, V.G. and Sukhatme, P.V. (1967). Statistical methods for agricultural workers. Indian Council of Agricultural Research. New Delhi.

Rizwana, M., Muthaiah, A.R. and Ashok, S. (2007). Host plant resistance mechanism to pod borer (*Helicoverpa armigera* Hub.) in pigeon pea. Asian Journal of Plant Science and Research. 6: 193-194.

Sahoo, B.K. and Patnaik, H.P. (2003). Effect of biochemicals on the incidence of pigeon pea pod borers. Indian Journal of Entomology. 31: 105-108.

Singh, C. and Singh, N.N. (2014). Evaluation of responses of cowpea genotypes [*Vigna unguiculata* (L.) Walpers] genotypes to infestation of legume pod borer (*Maruca vitrata*). Journal of Food Legumes. 27: 334-39.

Sunitha, V., Lakshmi, K.V. and Rao, G.V.R. (2008a). Screening of pigeon pea genotypes against *Maruca vitrata* (Geyer). Journal of Food Legumes. 21: 193-195.

Sunitha, V., Ranga, G.V., Lakshmi, K.V., Saxena, K.B., Rameshwar Rao, V. and Reddy, Y.V.R. (2008b). Morphological and biochemical factors associated with resistance to *Maruca vitrata* in short duration pigeon pea. International Journal of Tropical Insect Science. 28: 45-52.