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VARIETAL SCREENING OF INDIAN BEAN 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 screen 12 different varieties of Indian Bean to assess the resistance against spotted pod borer, *Maruca vitrata* F. In case of varietal screening during year 2022-23, highest number of larval population (4.46 larvae/plant) and pod damage (50.3%) was observed in 125-36. Least larval population was observed in Guj.Wal-1 (1.85 larvae/plant), while, NIB-202 (26.59%) exhibited lowest pod damage. Also, during year 2023-24, the highest number of larvae (5.22 larvae/plant) and pod damage (50.01%) was observed in 125-36. Significantly least number of larvae (1.44 larvae/plant) and pod damage (24.28%) observed in Guj.Wal-1. According to the pooled data, highest number of larvae (4.84 larvae/plant) and pod damage (50.16%) was recorded in 125-36. Lowest significant larval population was recorded in Guj. Wal-1 with 1.65 larvae/plant, while lowest pod damage was displayed by NIB-202 (27.16%). During year 2022-23, significantly highest yield was recorded in NIB-195 that was 25.66 q/ha. Lowest yield was obtained in NIB-9 with 9.85q/ha. While, in the year 2023-24, NIB-195 (30.48 q/ha) gave significantly highest yield. Lowest pod yield was obtained from GNIB-22 (13.05 q/ha). According to the pooled data, NIB-195 (28.07 q/ha) was significantly highest yielding variety. Least yield was gained from NIB-9 (10.13 q/ha). In categorization no variety was found to be highly resistance. NIB-202 and Guj.Wal-1 was evaluated as resistant according to larval population. Based on pod damage NIB-107 was also evaluated as resistance. NIB-316 and 125-36 was found to be highly susceptible.

Key words : Indian bean, Resistance, Spotted pod borer, Varietal screening.

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; Keval *et al.*, 2017; Lateef *et al.*, 1985). 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). Since, 2019-20 to 2021-22, the production increases from 230.25 lakh t. to 273.02 lakh t. (Anonymous, 2023).

Among the pod borers infesting Indian bean, the spotted pod borer, *Maruca vitrata* is one of the serious pest not only in Indian bean but also other pulses. The destructiveness at critical stages of growth viz., flowering and seed production constitutes a significant constraint to the productivity of grain legumes (Taylor, 1967; Raheja, 1974). *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:

Method of recording observations

The genotypes under test were left unsprayed throughout the crop period and all recommended agronomical practices were adhered to for raising the crop. Five plants from the net plot of each genotype/variety were randomly selected and tagged to record observations. The entire plot remained free from any insecticide application. 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.

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

To record observations on pod damage caused by pod borer, both total pods and damaged pods were counted at each picking from each plot. Following the calculation of the percentage of pod damage inflicted by the pod borer, the genotypes were categorized into different resistance and susceptibility groups. Picking of green pods were carried out as and when pods were ready for harvest. Picking wise yield of Indian bean pods were recorded from each plot. Yield was recorded in kg per plot, was later converted to quintal per ha (q/ha). The observed data was subjected to arcsine transformation and appropriate statistical tools were used for further assessment.

Categories of genotypes

The genotype was classified and grouped in five categories based on per cent pod damage observed. For this purpose, the mean and standard deviation (SD) of the percentage of pod damage were calculated. Classification of genotypes was determined based on the mean ± SD, following the method outlined by Rudranaik *et al.* (2009) and Mallikarjuna (2009) as mentioned in Table 1.

Table 1 : Categories of resistance.

Class	Per cent pod damaged
Highly Resistant	$\bar{X}_i < \bar{X} - 2(\text{SD})$
Resistant	$\bar{X} - 2(\text{SD}) < \bar{X}_i < \bar{X} - \text{SD}$
Moderately resistant	$\bar{X} - \text{SD} < \bar{X}_i < \bar{X}$
Susceptible	$\bar{X} < \bar{X}_i < \bar{X} + \text{SD}$
Highly Susceptible	$\bar{X} + \text{SD} < \bar{X}_i < \bar{X} + 2(\text{SD})$ and above

Notes: $\bar{X}$ = Mean value of all varieties; $\bar{X}_i$ = Mean value of individual varieties; SD = Standard Deviation

Results and Discussion

Number of larvae per plant

As per the presented data in Table 2, of the year 2022-23, among the twelve varieties, the highest larval population was recorded in variety 125-36 (4.46 larvae/plant), which was statistically similar to the pest population in genotype NIB-9 (4.09 larvae/plant). Following these, GNIB-22 (3.6 larvae/plant) and GNIB-21 (3.55 larvae/plant) showed similar larval populations. Next in line were NIB-101 and NIB-9, both exhibiting comparable larval counts of 3.12 and 2.88 larvae/plant, respectively.

Table 2 : Number of larvae of *M. vitrata* per plant observed in different Indian bean genotypes.

Treatment	Genotypes	Year-I	Year-II	Pooled
T ₁	NIB-9	1.13 (2.88)	1.15 (3.01)	1.14 (2.94)
T ₂	NIB-101	1.16 (3.12)	1.2 (3.38)	1.18 (3.25)
T ₃	NIB-107	1.04 (2.29)	1.0 (2.07)	1.02 (2.18)
T ₄	NIB-195	1.1 (2.7)	1.11 (2.73)	1.1 (2.72)
T ₅	NIB-202	1.02 (2.17)	0.97 (1.84)	0.99 (2.01)
T ₆	NIB-316	1.29 (4.09)	1.39 (4.92)	1.34 (4.51)
T ₇	NIB-370	1.05 (2.38)	1.06 (2.41)	1.0 (2.4)
T ₈	GNIB-21	1.22 (3.55)	1.32 (4.28)	1.27 (3.91)
T ₉	125-36	1.34 (4.46)	1.43 (5.22)	1.38 (4.84)
T ₁₀	Guj.Wal-1	0.97 (1.85)	0.9 (1.44)	0.93 (1.65)
T ₁₁	Guj.Wal-2	1.08 (2.58)	1.1 (2.71)	1.09 (2.65)
T ₁₂	GNIB-22	1.23 (3.6)	1.29 (4.04)	1.26 (3.82)
S.Em. $\pm$ (T)		0.02	0.02	0.01
CD at 5% (T)		0.04	0.06	0.04
S.Em. $\pm$ (Y X T)		-	-	0.02
CD at 5% (Y X T)		-	-	0.05
CV%		2.31	3.01	2.69

Note: Figures in the parentheses are re-transformed values and those outside are arc-sin transformed values.

Moreover, NIB-9 shared a similar larval count with NIB-195 (2.7 larvae/plant) and Guj.Wal-2 (2.58 larvae/plant). Subsequently, NIB-370 (2.38 larvae/plant) showed a larval population similar to Guj.Wal-2 and was on par with NIB-107 and NIB-202, with counts of 2.29 and 2.17 larvae/plant, respectively. Notably, the lowest larval population was observed in Guj.Wal-1 (1.85 larvae/plant), which was statistically comparable to NIB-202. The sequence of varieties from the highest to the lowest larval population is as follows:

125-36 > NIB-316 > GNIB-22 > GNIB-21 > NIB-101 > NIB-9 > NIB-195 > Guj.Wal-2 > NIB-370 > NIB-107 > NIB-202 > Guj.Wal-1.

During the second season *i.e.*, year 2023-24, the highest number of larvae per plant was observed in 125-36 (5.22 larvae/plant), followed by NIB-316 (4.92 larvae/plant), which were which were significantly higher compared to other varieties. After these, GNIB-21 (4.28 larvae/plant) and GNIB-22 (4.04 larvae/plant) showed significantly higher results. They were followed by NIB-101 (3.38 larvae/plant) and NIB-9 (3.01 larvae/plant) which were at par with each other. NIB-9 was also at par with NIB-195 (2.73 larvae/plant) and Guj.Wal-2 (2.71 larvae/plant), followed by NIB-370 (2.41 larvae/plant) and NIB-107 (2.07 larvae/plant) which was at par with Guj.Wal-2. NIB-107 was at par with NIB-202 (1.84 larvae/plant). Significantly least number of larvae *i.e.*,

1.44 larvae/plant observed in Guj.Wal-1. The sequences of varieties in decreasing number of larvae are as follows.

125-36 > NIB-316 > GNIB-21 > GNIB-22 > NIB-101 > NIB-9 > NIB-195 > Guj.Wal-2 > NIB-370 > NIB-107 > NIB-202 > Guj.Wal-1.

According to the pooled data obtained, among the twelve varieties, highest number of larvae (4.84 larvae/plant) was recorded in 125-36 followed by NIB-316 with 4.51 larvae/plant. Next in line was GNIB-21 (3.91 larvae/plant) and GNIB-22 (3.82 larvae/plant), which were at par with each other. NIB-101 (3.25 larvae/plant) and NIB-9 (2.94 larvae/plant) followed after. While NIB-195 (2.72 larvae/plant) was at par with NIB-9, it was also at par with Guj.Wal-2 (2.65 larvae/plant) and NIB-370 (2.40 larvae/plant). NIB-370 was also at par with NIB-107 (2.18 larvae/plant), but NIB-107 was also at par with NIB-202 (2.01 larvae/plant). Lowest significant larval population was recorded in Guj.Wal-1 with 1.65 larvae/plant. The sequential arrangements of genotypes are as follows:

125-36 > NIB-316 > GNIB-21 > GNIB-22 >

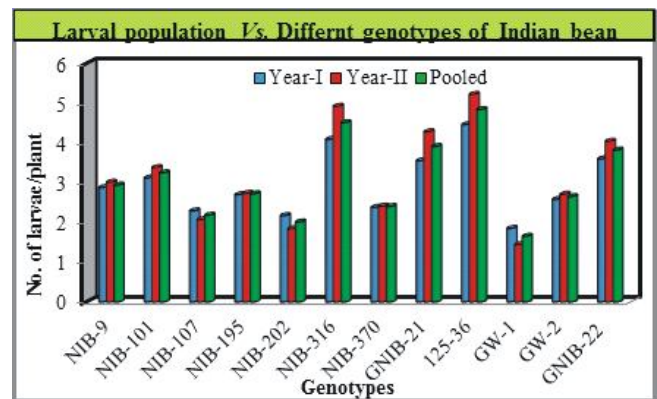


Fig. 1 : Larval population in different genotypes of Indian bean.

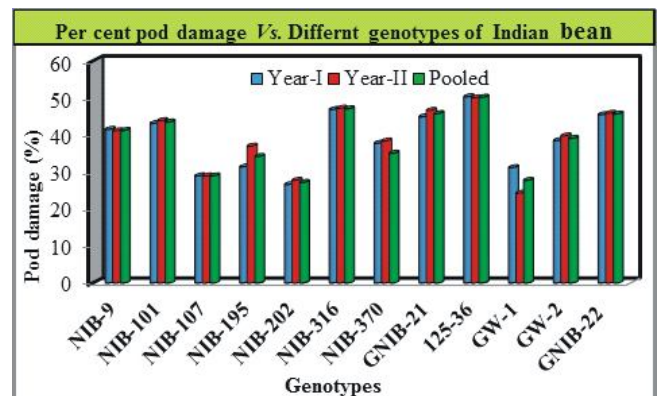


Fig. 2 : Per cent pod damage of different genotypes of Indian bean.

Table 3 : Per cent pod damage by *M. vitrata* observed in different Indian bean genotypes in year 2022-23 and 2023-2024 and pooled.

Treatment	Genotypes	1 st Picking	2 nd Picking	Year-I Pooled	1 st Picking	2 nd Picking	Year-II Pooled	Pooled
T1	NIB-9	3.73(41.46)	3.74(41.54)	3.73(41.5)	3.72(41.43)	3.7(40.76)	3.71(41.09)	3.72(41.3)
T2	NIB-101	3.85(44.14)	3.76(42.09)	3.81(43.11)	3.89(45.09)	3.78(42.61)	3.84(43.85)	3.82(43.48)
T3	NIB-107	3.11(28.69)	3.14(29.17)	3.13(28.93)	3.08(28.2)	3.17(29.61)	3.12(28.9)	3.13 (28.92)
T4	NIB-195	3.25(31.56)	3.25(31.19)	3.25(31.38)	3.67(40.06)	3.33(33.81)	3.5(36.94)	3.38 (34.16)
T5	NIB-202	3.04(27.41)	2.95(25.78)	3.00(26.59)	3.16 (29.49)	2.98(25.95)	3.07(27.72)	3.04 (27.16)
T6	NIB-316	4.00(47.78)	3.93(45.95)	3.97(46.87)	4.02 (48.13)	3.94(46.3)	3.98(47.21)	3.97 (47.04)
T7	NIB-370	3.54(37.29)	3.59(38.24)	3.57(37.76)	3.65 (39.79)	3.52(36.92)	3.59(38.35)	3.58 (38.06)
T8	GNIB-21	3.88(45.18)	3.87(44.59)	3.88(44.89)	3.97 (46.93)	3.94(46.3)	3.96(46.61)	3.92 (45.75)
T9	125-36	4.19(52.4)	4.02(48.2)	4.11(50.3)	4.13 (50.84)	4.06(49.18)	4.09(50.01)	4.1(50.16)
T10	Guj.Wal -1	2.87(24.11)	3.53(38.2)	3.2(31.15)	3.01 (26.55)	2.74(22.00)	2.87(24.28)	3.06 (27.72)
T11	Guj.Wal -2	3.58(38.19)	3.61(38.72)	3.6(38.45)	3.72 (41.19)	3.59(38.24)	3.65(39.71)	3.63(39.08)
T12	GNIB-22	3.96(47.1)	3.84(43.85)	3.9(45.47)	3.97 (46.86)	3.88(44.8)	3.92(45.83)	3.91 (45.65)
Mean		38.78	38.96	38.87	40.38	38.04	39.21	39.04
S.Em. $\pm$ (T)		0.16	0.17	0.12	0.16	0.16	0.11	0.09
CD at 5% (T)		0.48	0.49	0.36	0.46	0.47	0.32	0.25
S.Em. $\pm$ (Y X T)		-	-	0.18	-	-	0.16	0.12
CD at 5% (Y X T)		-	-	NS	-	-	NS	NS
CV%		7.93	8.01	8.50	7.43	7.89	7.68	5.94

Note: Figures in the parentheses are re-transformed values and those outside are arc-sin transformed values.

Table 4 : Yield (q/ha) of different Indian bean genotypes.

Treatment	Genotypes	Year-I	Year-II	Pooled
T ₁	NIB-9	9.85	10.42	10.13
T ₂	NIB-101	21.22	22.18	21.70
T ₃	NIB-107	16.98	20.64	18.81
T ₄	NIB-195	25.66	30.48	28.07
T ₅	NIB-202	12.54	16.01	14.27
T ₆	NIB-316	10.42	15.05	12.73
T ₇	NIB-370	21.41	23.34	22.38
T ₈	GNIB-21	13.89	18.52	16.20
T ₉	125-36	10.03	13.50	11.77
T ₁₀	Guj.Wal -1	21.41	23.34	22.38
T ₁₁	Guj.Wal -2	20.25	25.66	22.96
T ₁₂	GNIB-22	10.62	12.54	11.58
S.Em. $\pm$ (T)		1.05	1.11	0.77
CD at 5% (T)		3.07	3.25	2.20
S.Em. $\pm$ (Y X T)		-	-	1.09
CD at 5% (Y X T)		-	-	3.10
CV%		11.21	9.94	10.62

NIB-101 > NIB-9 > NIB-195 > Guj.Wal-2 > NIB-370 > NIB-107 > NIB-202 > Guj.Wal-1.

Per cent pod damage

Based on the results presented in Table 3, data revealed similar trends regarding the percentage of pod

damage as seen in larval population. Variety 125-36 exhibited the highest pod damage percentage during the 1st picking (52.4%), 2nd picking (48.2%) and pooled data (50.3%). Following closely, NIB-316 displayed percentages of 47.78, 45.95 and 46.87 per cent during the 1st picking, 2nd picking and pooled data, respectively. In the 1st picking, GNIB-22 (47.1%) recorded higher damage after NIB-316, followed by GNIB-21 (45.18%). Succeeding this was NIB-101 (44.14%), NIB-9 (41.46%), NIB-370 (37.29%) and NIB-195 (31.56%). The lowest percentage of pod damage during the 1st picking was observed in Guj.Wal-1 (24.11%), which was statistically similar to NIB-107 (28.69%) and NIB-202 (27.41%). Conversely, during 2nd picking, GNIB-21 (44.59%) surpassed GNIB-22 (43.85%) in damage percentage. Following were NIB-101 (42.09%), NIB-9 (41.54%), Guj.Wal.-2 (38.72%), NIB-370 (38.24%) and Guj.Wal.-1 (38.2%). Whereas, NIB-202 (25.78%) displayed the lowest pod damage, followed by NIB-107 (29.17%) and NIB-195 (31.19%). When considering pooled data for the year 2022-23, from both pickings, GNIB-22 (45.47%) showed higher damage than GNIB-21 (44.98%) after NIB-316. Followed by, NIB-101 (43.11%), NIB-9 (41.5%), Guj.Wal-2 (38.45%) and NIB-370 (37.76%). NIB-202 (26.59%) exhibited the lowest percentage of pod damage, similar to NIB-107 (28.93%),

Guj.Wal-1 (31.15%) and NIB-195 (31.38%). The sequence of varieties based on their total percentage of pod damage, in descending order, is as follows:

125-36 > NIB-316 > GNIB-21 > GNIB-22 > NIB-101 > NIB-9 > Guj.Wal-2 > NIB-370 > NIB-195 > Guj.Wal-1 > NIB-107 > NIB-202.

The data of second year 2023-24, reveals that 125-36 exhibited highest pod damage per cent in 1st picking (50.84%), 2nd picking (49.18%) and pooled (50.01%). During 1st picking, it was followed NIB-316 (48.13%), GNIB-21 (46.93%), GNIB-22 (46.86%), NIB-101 (45.09%), NIB-9 (41.43%), Guj.Wal-2 (41.19%), NIB-195 (40.06%) and NIB-370 (39.79%). Lowest per cent pod damage was seen in Guj.Wal-1 (26.55%), followed by NIB-107 and NIB-202 with 28.2 and 29.49 per cent, respectively. During the 2nd picking, after 125-36, both NIB-316 and GNIB-21 displayed same per cent damage (46.3%), followed by GNIB-22 (44.8%), NIB-101 (42.61%), NIB-9 (40.76%), Guj.Wal-2 (38.24%), NIB-370 (36.92%) and NIB-195 (33.81%). Guj.Wal-1 exhibited least pod damage of 22 per cent, followed by NIB-202 (25.95%) and NIB-107 (29.61%). In pooled data, 125-36 was followed by NIB-316, GNIB-21, GNIB-22, NIB-101, NIB-9, Guj.Wal-2, NIB-370 and NIB-195 with 47.21, 46.61, 45.83, 43.85, 41.09, 39.71, 38.35 and 36.94 per cent. The least pod damage was displayed by Guj.Wal-1 (24.28%), followed by NIB-202 (27.72%) and NIB-107 (28.9%).

125-36 > NIB-316 > GNIB-21 > GNIB-22 > NIB-101 > NIB-9 > Guj.Wal-2 > NIB-370 > NIB-195 > NIB-107 > NIB-202 > Guj. Wal-1.

The pooled data of the year 2022-23 and 2023-24, follows similar trends as the yearly data. 125-36 exhibited highest pod damage of 50.16 per cent, followed by NIB-316 (47.04%), GNIB-21 (45.75%), GNIB-22 (45.65%), NIB-101 (43.48%), NIB-9 (41.3%), Guj.Wal-2 (39.08%), NIB-370 (38.06%) and NIB-195 (34.16%). The lowest pod damage was observed in NIB-202, with a percentage of 27.16 per cent, which was statistically similar to Guj.Wal-1 (27.27%) and NIB-107 (28.92%). The sequential arrangement of genotypes according to their percentage pod damage, in decreasing order, is as follows:

125-36 > NIB-316 > GNIB-21 > GNIB-22 > NIB-101 > NIB-9 > Guj.Wal-2 > NIB-370 > NIB-195 > NIB-107 > Guj.Wal-1 > NIB-202

Yield

The yield of each plot was taken in terms of kilogram per plot which was later converted to quintal per hectare. The yield data is as presented in Table 4 and graphically

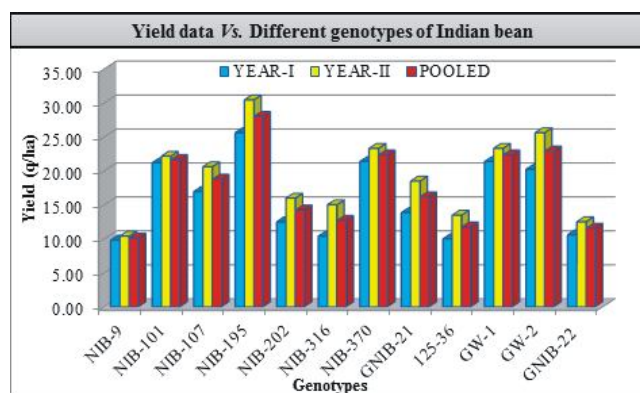


Fig. 3 : Yield data of different genotypes of Indian bean.

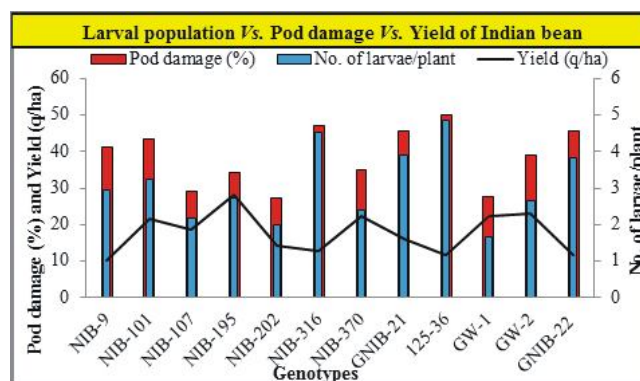


Fig. 4 : Larval population, per cent pod damage and yield of different genotypes of Indian bean.

pictured in Fig. 4. The comparison of yield with the per cent pod damage and larval population is shown in Fig. 4.

During year 2022-23, significantly highest yield was recorded in NIB-195 that was 25.66 q/ha. NIB-370 and Guj.Wal-1 gave same yield of 21.41 q/ha, which was also at par with NIB-101 (21.22 q/ha) and Guj.Wal-2 (20.25 q/ha). This was followed by NIB-107 (16.98 q/ha) and GNIB-21 (13.89 q/ha). Lowest yield was obtained in NIB-9 with 9.85q/ha, but it was found to be at par with 125-36 (10.03 q/ha), NIB-316 (10.42 q/ha), GNIB-22 (10.62 q/ha) and NIB-202 (12.54 q/ha).

While in the year 2023-24, NIB-195 did yielded significantly highest with 30.48 q/ha, after that, the higher yield, was obtained from Guj.Wal-2 (25.67 q/ha). It was followed by NIB-370 and Guj.Wal-1, which recorded same yield i.e., 23.34 q/ha. Next in line was NIB-101 (22.18 q/ha), NIB-307 (20.64 q/ha), NIB-202(16.01 q/ha) and NIB-316 (15.05 q/ha). The least pod yield was obtained from NIB-9 (10.42 q/ha). After that, lower pod yield was obtained from GNIB-22 and 125-36 with 12.54 and 13.05 q/ha, respectively.

According to the pooled data, NIB-195 (28.07 q/ha) was significantly highest yielding variety, followed by Guj.Wal-2 (22.96 q/ha). NIB-370 and Guj.Wal-1 recorded same yield of 22.38 q/ha. It was followed by NIB-101

Table 5 : Categories of different genotypes against *M. vitrata* infesting Indian bean with number of larvae per plant.

Class	Scale	Varieties
Mean ($\bar{X}$) = 3.07; SD = 0.97		
Highly Resistant	$\bar{X}_i < 1.14$	-
Resistant	$1.14 < \bar{X}_i < 2.11$	NIB-202, Guj. Wal-1
Moderately Resistant	$2.11 < \bar{X}_i < 3.07$	NIB-107, NIB-195, NIB-370, NIB-9, Guj. Wal-2
Susceptible	$3.07 < \bar{X}_i < 4.04$	NIB-101, GNIB-21, GNIB-22
Highly Susceptible	$4.04 < \bar{X}_i < 5.01$ or above	NIB-316, 125-36

Notes: $\bar{X}$ = Mean value of all varieties, $\bar{X}_i$ = Mean value of individual varieties, SD = Standard Deviation.

(21.70 q/ha), NIB-307 (18.81 q/ha), GNIB-21 (16.20 q/ha), NIB-202 (14.27 q/ha) and NIB-316 (12.73 q/ha). Least yield was gained from NIB-9 (10.13 q/ha), which was at par with GNIB-22 (11.58 q/ha) and 125-36 (11.77 q/ha). The sequence of varieties from higher to lower yielding variety is as follows:

NIB-195 > Guj. Wal-2 > NIB-370 = Guj. Wal-1 > NIB-101 > NIB-107 > GNIB-21 > NIB-202 > NIB-316 > 125-36 > GNIB-22 > NIB-9

Categories of resistance of different Indian bean genotypes

The different genotypes of Indian bean were also grouped into five categories of resistance viz., highly resistance, resistance, moderately resistance, susceptible, highly susceptible. Genotypes were grouped into above categories-based number of larvae per plant and per cent pod damage by comparing the mean incidence of genotype/varieties ($\bar{X}_i$) with incidence of all genotype/varieties ($\bar{X}$) and standard deviation (SD). The data are presented in Table 5 as well as Table 6 and results are discussed here under.

As mentioned in Table 5 based on the number of larvae per plant, all the varieties were categorized in different category. No variety was highly resistance. NIB-202 and Guj. Wal-1 was evaluated as resistant. Four genotypes and one variety viz., NIB-9, NIB-107, NIB-195, NIB-370 and Guj. Wal-2 grouped in moderately resistance category. Susceptible category contained NIB-101, GNIB-21 and GNIB-22. NIB-316 and 125-36 was found to be highly susceptible.

Table 6 : Categories of different genotypes against *M. vitrata* infesting Indian bean with per cent pod damage.

Class	Scale	Varieties
Mean ($\bar{X}$) = 39.20; SD = 7.9		
Highly Resistant	$\bar{X}_i < 23.39$	-
Resistant	$23.39 < \bar{X}_i < 31.30$	NIB-107, NIB-202, Guj. Wal-1
Moderately Resistant	$31.30 < \bar{X}_i < 39.20$	NIB-195, NIB-370
Susceptible	$39.20 < \bar{X}_i < 47.11$	NIB-9, NIB-101, GNIB-21, GNIB-22, Guj. Wal-2
Highly Susceptible	$47.11 < \bar{X}_i < 55.01$ or above	NIB-316, 125-36

Notes: $\bar{X}$ = Mean value of all varieties, $\bar{X}_i$ = Mean value of individual varieties, SD = Standard Deviation.

Based on pooled data of per cent pod damage, the categorization of varieties was done. The results obtained were that none of the varieties were highly resistance, While NIB-107, NIB-202 and Guj. Wal-1 was found to be resistant. NIB-195 and NIB-370 were classified as moderately resistance. NIB-9, NIB-101, GNIB-21, GNIB-22 and Guj. Wal-2 was found to be susceptible. NIB-316 and 125-36 were grouped in highly susceptible.

Devashrayee Vaidik *et al.* (2021) evaluated the different varieties of Indian bean based on the mean number of larvae/plant. Among them 5 varieties from above viz., Guj. Wal-1, Guj. Wal-2, GNIB-22, GNIB-21 and 125-36 were evaluated. The results found to be were similar to the present investigations. They also found Guj. Wal-1 resistance while 125-36 to be susceptible. Guj. Wal-2 was evaluated as moderately resistance which was also in concurrence with present results. On the other hand, GNIB-21 and GNIB-22 was evaluated as moderately susceptible, while, it was classified as susceptible in the present investigation. As the genotypes screened for their relative resistance against spotted pod borer in Indian bean vary from one location/region to other and hence the findings of present results regarding the performance of different genotypes could not be compared and discussed.

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.

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