International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
IJCS 2019; 7(2): 747-753

Received: 21-01-2019
Accepted: 25-02-2019

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Screening of pigeonpea elite germplasms for resistance to pod borers

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Abstract
As regards screening studies, the different groups of forty germplasms of pigeonpea were screened for their resistance to pod borers. out of these, four germplasms viz., PT-0555-2-2, PT-01-11-2, PKV TARA and BDN-2001-6 were found to be most promising genotypes against *H. armigera, E. atomosa* and *M. obtusa* by recording the less pod damage in the range of 4.22 – 4.83, 1.55- 2.42 and 2.90- 4.02 per cent as compared to state check Vipula (7.57, 3.23, 5.72 %, respectively). As regards the morphological characters, it was observed that the growth habit and colour of flower and pod did not influence the pod borer infestation. Whereas on the basis of pod size, long podded varieties were more damaging to *H. armigera* and *E. atomosa*. Irrespective of morphological characters, the biochemical content of total phenol was negatively significant correlated with pod damage caused by *E. atomosa* and negatively non-significant correlated with *H. armigera* and *M. obtusa*, whereas, reducing sugar was positively significant correlated with all pod borers. While non-reducing sugar positively significant correlated with *E. atomosa* and positively non-significant with *H. armigera* and *M. obtusa*.

Keywords: Germplasm, promising genotype, morphological character, correlation

Introduction
The availability of pigeonpea genotypes of varying maturity groups provides better opportunity for the borers to breed and multiply continuously for a long period during the season. The management of pod borers on early, mid late and late genotypes of pigeonpea is, therefore, a challenging problem. Likewise several biochemical parameters viz., proteins, phenols, sugars are known to be associated with insect resistance/susceptibility in pigeonpea. However, indiscriminate use of pesticides to control pod borers has lead to series of consequences like, insecticide resistance, pest resurgence, outbreak of secondary pests, harmful residue effect, imbalance in natural ecosystem and higher production costs, which has been a concern in India and elsewhere. It is therefore necessary to develop more environmental friendly approaches with need base use of chemical pesticides. Development of resistant varieties is one such strategy. In order to develop varieties resistance to pod borer it is necessary to have a resistance source. After identification of resistant source the choice of the best donor is the pre-requsite for a successful breeding programme. Hence an experiment was conducted to screen and evaluate the genotypes in resistant breeding.

Materials and Method
The field experiment were conducted on pigeonpea field at Pulses Improvement Project, MPKV, Rahuri during the Kharif 2013 to study the seasonal incidence of pod borers and screening of pigeonpea elite germplasms for resistance to pod borers. Forty different germplasms of pigeonpea with least susceptible group and different growth habits were selected for their reaction to pod borers *viz., H. armigera, E. atomosa* and *M. obtusa* were screened for pests at Pulses Improvement Project, Mahatma Phule Krishi Vidyapeeth, Rahuri (Maharashtra) according to maturity group. The genotypes which had initially exhibited tolerance / moderately tolerance against lepidopteron pod borers and pod fly were grown in a plot of two rows of 4 m length with two replications. The check Vipula was grown for confirmatory test against these pests under pesticide free field conditions for conducive infestation against pod borers. For assessment, of borer damage was recorded on five randomly sampled plants at the time of harvesting by counting the total number of healthy and damaged pods. From this per cent pod damage was calculated and these percentage were further converted into pest susceptibility rating (PSR), Similarly, pest susceptibility rating

(1-9 Scale) for individual genotypes were worked out based on the formula suggested by Abott, (1925).

Method of recording pod damage

The observations on the pod damage were recorded on five randomly selected plants from each entry and from each replication at the time of harvest. For this, the damaged (bored) and total numbers of pods were counted and the per cent pod damage was determined by using the following formula (Hossain *et al*., 2008a) [5].

$$\text{Per cent Pod damage (\%)} = \frac{\text{Number of damaged pods}}{\text{Total number of pods}} \times 100$$

In order to ascertain the pod damage caused by pod borers viz., gram pod borer, *Helicoverpa armigera* (Hubner) and plume moth, *Exelastis atomosa* (Walshingham) and the pod fly, *Melanagromyza obtusa* (Malloch) were inspected on the basis of infestation pattern specified by Bindra and Jokhmola (1967) [2] adopted and which was as follows for each pod borer.

Gram pod borer, *H. armigera*

The pod shells with relatively large and round holes indicate the boring by Helicoverpa caterpillar. Attacked pods with holes are devoid of excreta. Most of the times grains are found completely devoured by the larva.

Tur plume moth, *E. atomosa*

Holes made by the larva of plume moth are small or medium size as compared to those made by Helicoverpa larva, the pods showing holes opposite to seeds and without grains or partially eaten grains with blackish excreta were accounted for tur plume moth damage.

Tur pod fly, *M. obtusa*

For separating the pods damaged by pod fly, the pods were examined externally as well as internally by dissecting them. The damaged pods were brownish in colour with pin holes externally from which adult emerged. The grains damaged by maggot carried a mine below the testa and an ablong notch eaten into the grains. Many times puparium was found lying in the notch or in the pod.

After the data converted into per cent damaged pods (PD), the pest susceptibility rating (PSR) for pods was worked out as per the formula given below (Gangwar *et al*., 2009).

$$\text{Pest Susceptibility (\%)} = \frac{\text{\% P.D. in check cultivar} - \text{\% P.D. in test cultivar}}{\text{\% P. D. in check cultivar}} \times 100$$

Based on the above formula the performance of each genotypes on 1-9 scale was assessed with following scale.

Table 1: Pest susceptibility rating (PSR) on 1-9 scale

Pest Susceptibility (%)	Susceptibility Rating	Category
100	1	Highly Resistant (HR)
75 to 99.9	2	Highly Resistant (HR)
50 to 74.9	3	Least Susceptible (LS)
25 to 49.9	4	Least Susceptible (LS)
10to 24.9	5	Least Susceptible (LS)
-10 to 9.9	6	Moderately susceptible (MS)
-25 to -9.9	7	Moderately susceptible (MS)
-50 to -24.9	8	Highly susceptible (HS)
-50 to less	9	Highly susceptible (HS)

Observations on plant characters

The observations on morphological plant characters such as pod length and width, pod wall toughness (thick/thin) and pod size were recorded after pod development stage.

Chemical analysis of pods

Collection and preparation of pods for analysis

The green pods (30 days after opening of the flowers) were collected from each genotypes to obtain pod wall for biochemical estimation. The pod walls were dried in a oven at 60°C for 2-3 days. The completely dry samples were then used in the estimation of bio-chemical constituents.

The phenolics content and Non-reducing sugar content was estimated by the method quoted by Thimmaiah (1999) [14] while reducing sugar content was estimated by the method quoted by Nelson-Somogyi's Method.

Standard curve

For preparing the standard curve, D-glucose solution containing 0, 10, 20, 30…..100 µg of D-glucose was taken in a series of test tube in triplicate and the final volume in each test tube was made 1ml with distilled water. The colour was developed as described above and the standard curve was prepared by plotting absorbance against the concentration of D-glucose.

Statistical analysis of the data

The data was obtained on screening of germplasms against pod borers and influence of physico-chemical characters on pod damage and subjected to statistical analysis after suitable transformations for interpretation of the results.

Result and Discussion

Screening of pigeonpea germplasms against pod borers

Forty pigeonpea germplasms representing four maturity groups *viz*., early, medium early, midlate and late having different growth habits were screened under natural infestation for their reaction to pod borers *viz., H. armigera, E. atomosa* and *M. obtusa*. The observations on the pod damage of all germplasms were recorded at the maturity and their screening according to Pest Susceptibility Rating (PSR) given in Table 1.

H. armigera

The pod borer damage caused by *H. armigera* was in the range of 4.22 to 12.30 per cent. The highest damage recorded in BDN 2010-12 (12.30%) having PSR 9 and also least damage recorded in PKV TARA (4.22%) having PSR 4. The entries *viz*., PKV TARA,PT-01-11-2, BDN-2001-6, PT-257, PT-0555-2-2 and ICPL-98008 recorded 4.22, 4.61,4.83, 5.71, 5.88 and 5.94 per cent pod damage, respectively and were significantly at par with the state check i. e. Vipula (7.57%) and national check i. e. ICPL- 87 (7.98%). As regards the pest susceptibility rating, the entries *viz*., PT-01-11-2, PKV TARA, BDN-2006-1 recorded PSR 4 and only two entries i.e. PT-0555-2-2 and ICPL-98008 recorded PSR 5 which are comes under the least susceptible category when compared with state check i. e. Vipula (PSR 6). Rest of the entries recorded moderately susceptible and highly susceptible to *H. armigera* having PSR 6-7 and 8-9, respectively.

From the present findings, it was noticed that the variety PKV TARA was most promising against *H. armigera,* it was from mid late maturity group with indeterminate growth habit and recorded PSR was 4. The maximum damage of 12.30 per cent was noticed in BDN-2010-12 of mid late and indeterminate variety having PSR 9.

In the present findings data on, the pod infestation caused by *H. armigera* was in the range of 5.94 - 11.86, 4.61 – 11.60, 4.22 – 12.30 and 8.79 per cent in the maturity groups of early, medium early, mid late and late germplasms respectively. According to the present findings pod damage range of mid late and late maturity group showed agreement with Yadav *et al*. (1988) [16] found that *H. armigera* was common on late varieties.

E. atomosa

The pod damage caused by *E. atomosa* was in the range of 1.55 - 8.33 per cent. The highest damage recorded in PT-00-5-7-4-1 (8.33%) having PSR 9 and also the least damage recorded in PT-0555-2-2 (1.55%) having PSR 3.

Out of the forty germplasms, only two entries *viz.*, BDN-2001-6 and PT-0555-2-2 recorded less pod damage 1.66 and 1.55 per cent, respectively and were significantly at par with the state check i. e. Vipula (3.23%) and national check i. e. ICPL (2.46%). As regards the pest susceptibility rating, the entries *viz*., BDN-2001-6 and PT-0555-2-2 recorded PSR 4 and 3, respectively which are comes under the least susceptible category when compared with state check i. e. Vipula (PSR 6). Rest of the entries recorded moderately susceptible (PSR 6-7) and highly susceptible (PSR 8-9) to *E. atomosa*.

From present findings, it was noticed that the variety PT-0555-2-2 was most promising against *E. atomosa* damage, from mid late maturity group with indeterminate growth habit and recorded PSR was 3. And susceptible variety PT-00-5-7-4-1 having medium early and indeterminate with PSR was 9.

The pod infestation caused by *E. atomosa* was in the range of 2.13 – 4.81, 1.66 – 8.33, 1.55 – 7.73 and 4.31 per cent in the maturity groups of early, medium early, midlate and late germplasms respectively.

The present results are accordance with the results of Patel and Patel (1990) [8] that less incidence in early entries. Also with the agreement of Srivastava and Mohapatra (2002) [13] found the extent of pod damage inflicted by *E. atomosa* varied from 1.0 – 6.3 per cent. This results are confirmatory with the present findings.

M. obtusa

The pod damage caused by *M. obtusa* was in the range of 2.90 – 9.42 per cent. The highest damage recorded in BDN-2010-12 (9.42%) having PSR 9. The least damage recoded in PT-0555-2-2 (2.90%) having PSR 4. Several entries *viz.*, PT-0555-2-2, BDN-2010, PT-257, BDN-2001-6, PT-00-17-12-2, PT-2001-5-8-1, and PT-00-1-25-1recorded 2.90, 3.50, 3.50, 3.52, 3.77, 3.78 and 3.89 per cent pod damage, respectively and were significantly at par with the state check i. e. Vipula (5.72%) and national check i. e. ICPL 87 (4.00%).

As regards the pest susceptibility rating, the entries *viz*., PT-00-1-25-1, BDN-2010, PT-00-17-12-2, BDN-2006-1,PT-2001-5-8-1, PT-257 and PT-0555-2-2 recorded PSR 4 which are comes under the least susceptible category when compared with state check i.e. Vipula (PSR 6). Rest of the entries recorded moderately susceptible (PSR 6-7) and highly susceptible (PSR 8-9) to *M. obtusa*.

The results of present study was noticed that the most promising variety to the damage of *M. obtusa* was PT-0555-2-2 with mid late and indeterminate growth habit and having PSR was 4. Also the susceptible variety BDN- 2010-12 having mid late, indeterminate growth habit and PSR was 9.

The pod infestation caused by *M. obtusa* was in the range of 3.88 -7.10, 3.50 – 8.45, 2.90 – 9.42 and 5.71 per cent in the maturity groups of early, medium early, mid late and late germplasms, respectively.

The present findings are in accordance with the Sharma *et al*. (2003) [11] who found the damage in the early duration accessions ICPL 87 in the range of 1.90 to 7.35 per cent by pod fly. The medium maturity group showed 2.10 to 9.00 per cent damage in genotypes of *C. cajan*. And in long duration group, they found 2.54 to 8.61 per cent damage in ICPL 87. Also with the agreement of Chavan *et al.* (2009) [3] reported that entries *viz.*, PA-322 and H-2001-37 were promising against pod fly and recorded PSR 4.

Influence of morphological characters on pigeonpea pod borer infestation

The morphological characters in forty pigeonpea germplasms were studied on the basis of visual observations made during the crop growth period. The results of visual grading are presented in Table 4.

Growth habit

Among the forty pigeonpea entries, only ICPL 87 was determinate and rest of all the entries was indeterminate type. The pod damage recorded in determinate and indeterminate type has not shown any perfect influence of growth habit on pod damage. This findings are accordance with the Sanap (1992) [10] who did not found any perfect influence of growth habit on pod damage by pod borers.

The present findings are contradictory with Moudgal *et al*. (2008) [6] suggested that the resistance to pod fly is not linked to the growth type and maturity period of the genotypes.

Pod colour and flower colour

All the tested varieties were of green with brown, pink and red streak colour and yellow, red and violet coloured flowers. These characters did not show any relationship with the infestation of pod borers.

The present findings are contradictory with Tripathi *et al.* (1983) [15] found that small green pods with streaks showed least damage (33%) compared to green and large pods with streaks recorded less (25.1%) damage compared to large green pods (33.8%). Also with the accordance of Sanap

(1992) [10] reported that he did not found any role of flower colour in imparting resistance or susceptibility to pod borers.

Pod size

It was observed that the entries with long pods had more incidence of *H. armigera* and *M. obtusa*. The exceptions were BMR 736 and PT- 00-5-7-4-1 which though had long pods, showed the low incidence of pod fly.

This findings are in accordance with the Sahoo *et al.* (2002) [9] reported that bigger the size of pod. Higher incidence of pod borers except *E. atomosa*.

Influence of chemical constituents on pigeonpea pod borer infestation

The contents of sugars (reducing and non-reducing) and total phenol were estimated in respect of selected ten varieties from their pods which have different growth habits and some are susceptible and promising against pod borers. The data is presented in Table 10. The coefficient of correlation between chemical constituents and pod borers infestation was worked out and presented in Table 5.

Total phenol

The total phenol content varied from 1.20 to 1.98 per cent in selected pigeonpea germplasms. The highest amount of total phenol found in PKV TARA (1.98) while low in BDN -2010-12 (1.20%).

The correlation was negative and non-significant in respect of total phenol with infestation of pod borer and pod fly. But in case of plume moth it is highly significant negatively correlated with phenol content in pods.

Reducing sugar

The reducing sugar content is varied from 0.18 per cent in PKV TARA and ICPL- 332 to 1.23 per cent in BDN-2010-12. The reducing sugar is positively significant with the all pod borers infestation.

Non-reducing sugar

The non- reducing sugar varied from 0.29 per cent in PT-01-2010 to 2.66 per cent in BSMR-736. The non-reducing sugar positive but not significant with *H. armigera* and *M. obtusa* whereas with positive and highly significant with *E. atomosa*.

The present findings are in agreement with the Banu *et al.* (2007b) [1] who revealed that concentration of phenols were higher in tolerant cultivar than susceptible cultivars of pigeonpea in seeds.

The present findings of *H. armigera* are in accordance with Sahoo *et al*. (2003) reported the low sugar content and high phenol contents induced resistance in the pigeonpea cultivars against *H. armigera* similarly Sharma *et al.* (2009) [12] revealed that expressions of resistance to *H. armigera* were associated with low amounts of sugars and high amount of polyphenol. Whereas Pandey *et al*. (2011) [7] revealed that less reducing and non-reducing sugars suffered less pod and grain damage by pod fly.

The present findings are partially agree with the Girija *et al*. (2008) [4] who reported high phenol content induce resistance against *H. armigera* and exhibited highly significant negative association with per cent pod damage. The results reported by Moudgal *et al*. (2008) [6] are contradictory with present findings that the correlation coefficients between physic-chemical traits (reducing sugar, non-reducing sugar and total phenol) were found to be negatively associated with pod damage by *M. obtusa*.

Table 2: Screening of pigeonpea germplasms to pod borers infestation

Sr. No.	Germplasm	Per cent pod damage		
		H. armigera	***E. atomosa***	***M. obtusa***
1.	Phule T-00-12	8.67 (17.11)*	3.28 (10.41)*	6.75 (15.04)*
2.	Phule T-01-2010	7.19 (15.55)	2.69 (9.43)	4.70 (12.50)
3.	Phule T-00-5-8-1	7.00 (15.32)	2.70 (9.45)	5.00 (12.85)
4.	Phule T-00-1-25-1	6.50 (14.76)	5.37 (13.35)	3.89 (11.38)
5.	Phule T-00-5-7-4-1	9.55 (17.99)	8.33 (16.54)	6.93 (15.26)
6.	BDN-2010	7.50 (15.87)	4.04 (11.60)	3.50 (10.78)
7.	PT-00-17-12-2	6.11 (14.31)	5.05 (12.98)	3.77 (11.19)
8.	Phule T-00-4-16-2	6.52 (14.79)	4.39 (12.09)	5.11 (13.03)
9.	Phule T-01-11-2	4.61 (12.36)	2.42 (8.95)	4.02 (11.50)
10.	Phule T-00-16-4-2	6.51 (14.78)	5.30 (13.31)	4.02 (11.56)
11.	PKV TARA	4.22 (11.85)	2.15 (8.35)	4.63 (12.42)
12.	ICPL-87119	6.31 (14.54)	4.81 (12.56)	6.18 (14.40)
13.	Phule T-01-24-1-1	8.14 (16.57)	5.46 (13.47)	5.00 (12.83)
14.	Phule T-00-12-1-1	11.60 (19.89)	7.89 (16.32)	5.25 (13.25)
15.	Phule T-04-24-2	10.52 (18.92)	5.16 (13.10)	8.45 (16.89)
16.	Phule T-00-12-6-4	8.80 (17.13)	3.33 (10.51)	4.44 (12.12)
17.	Phule T-04-31	7.22 (15.59)	6.83 (15.16)	5.10 (13.05)
18.	BSMR-736	6.41 (14.67)	6.71 (15.02)	5.02 (12.95)
19.	BSMR-853	8.93 (17.39)	4.61 (12.39)	4.85 (12.72)
20.	Phule T-00-6-2-2	9.76 (18.21)	3.48 (10.76)	4.38 (12.08)
21.	Phule T-04-307	8.40 (16.85)	5.79 (13.93)	6.07 (14.26)
22.	BDN-2010-12	12.30 (20.53)	7.73 (16.12)	9.42 (17.87)
23.	Phule T-04-257	8.79 (17.25)	4.31 (11.99)	5.71 (13.82)
24.	Phule T-0351-1-13	8.87 (17.35)	3.87 (11.34)	5.15 (13.12)
25.	Phule T-417-8-2-2	8.81 (17.27)	2.42 (8.95)	6.42 (14.68)
26.	Phule T-0273	9.93 (18.36)	3.44 (10.66)	4.61 (12.40)
27.	BDN-2001-6	4.83 (12.70)	1.66 (7.39)	3.52 (10.81)

28.	Phule T-2001-5-8-1	7.50 (15.89)	2.50 (9.10)	3.78 (11.22)
29.	Phule T-2001-11-2	11.60 (19.91)	2.69 (9.44)	4.38 (12.08)
30.	Phule T-257	5.71 (13.83)	2.37 (8.85)	3.50 (10.73)
31.	Phule T-417-4-2-1-2	8.45 (16.90)	2.87 (9.76)	5.00 (12.87)
32.	Phule T-417-7-1-4	8.15 (16.59)	3.37 (10.57)	4.21 (11.84)
33.	Phule T-0555-2-2	5.88 (14.02)	1.55 (7.14)	2.90 (9.80)
34.	ICPL-332	7.42 (15.81)	2.52 (9.12)	5.13 (13.09)
35.	ICP-13198	11.07 (19.43)	2.21 (8.55)	5.04 (12.98)
36.	ICPL-98008	5.94 (14.04)	2.13 (8.40)	3.88 (11.36)
37.	Phule T-03-142	9.37 (17.82)	3.64 (11.00)	5.74 (13.87)
38.	ICPL-88039	11.86 (20.08)	4.31 (11.96)	7.10 (15.45)
39.	ICPL-87(National check)	7.98 (16.41)	2.46 (8.98)	4.00 (11.48)
40.	Vipula (State check)	7.57 (15.97)	3.23 (10.34)	5.72(13.84)
	S.E. ±	0.67	0.79	0.57
	CD at 5 %	1.92	2.26	1.64

*Figures in parentheses are arcsin tranformed values.

Table 3: Screening of pigeonpea germplasms according to pest susceptibility rating (PSR)

Sr. No.	Germplasms	Pest susceptibility (%)			Pest susceptibility rating		
		H. armigera	***E. atomosa***	***M. obtusa***	***H. armigera***	***E. atomosa***	***M. obtusa***
1.	Phule T-00-12	-14.53	-1.54	-18.00	7	6	7
2.	Phule T-01-2010	5.01	16.71	17.83	6	5	5
3.	Phule T-00-5-8-1	7.66	16.40	12.76	6	5	7
4.	Phule T-00-1-25-1	14.26	-66.25	31.99	5	9	4
5.	Phule T-00-5-7-4-1	-26.15	-157.89	-22.02	8	9	7
6.	BDN-2010	1.05	-25.07	38.81	6	8	4
7.	PT-00-17-12-2	19.28	-56.34	34.09	5	9	4
8.	Phule T-00-4-16-2	13.87	-35.91	10.66	5	8	5
9.	Phule T-01-11-2	39.10	25.07	29.72	4	4	4
10.	Phule T-00-16-4-2	14.00	-64.08	29.72	5	9	4
11.	PKV TARA	44.25	33.43	19.05	4	4	5
12.	ICPL-87119	16.64	-49.84	-8.04	5	8	5
13.	Phule T-01-24-1-1	-7.52	-69.04	12.76	6	9	7
14.	Phule T-00-12-1-1	-53.23	-144.27	8.21	9	9	6
15.	Phule T-04-24-2	-38.96	-59.75	-47.72	8	9	8
16.	Phule T-00-12-6-4	-16.24	-3.09	22.37	7	6	4
17.	Phule T-04-31	4.62	-111.45	10.83	6	9	5
18.	BSMR-736	15.32	-107.73	12.23	5	9	5
19.	BSMR-853	-17.96	-42.72	15.20	7	8	5
20.	Phule T-00-6-2-2	-28.92	-77.39	23.42	8	9	5
21.	Phule T-04-307	-10.96	-79.25	-6.11	7	9	6
22.	BDN-2010-12	-62.48	-139.31	-64.68	9	9	9
23.	Phule T-04-257	-16.11	-33.43	0.17	7	8	6
24.	Phule T-0351-1-13	-17.17	-19.81	9.96	7	7	6
25.	Phule T-417-8-2-2	-16.38	25.07	-12.23	7	4	7
26.	Phule T-0273	-31.17	-6.50	19.39	8	6	5
27.	BDN-2001-6	36.19	48.60	38.46	4	4	4
28.	Phule T-2001-5-8-1	1.05	22.60	33.91	6	5	4
29.	Phule T-2001-11-2	-53.23	16.71	23.42	9	5	5
30.	Phule T-257	24.57	26.62	39.16	5	4	4
31.	Phule T-417-4-2-1-2	-11.62	11.14	13.28	7	5	5
32.	Phule T-417-7-1-4	-7.66	-20.43	26.39	6	7	4
33.	Phule T-0555-2-2	22.32	51.70	49.30	5	3	4
34.	ICPL-332	1.98	21.98	10.31	6	5	5
35.	ICP-13198	-46.23	31.57	11.88	8	4	5
36.	ICPL-98008	21.53	34.05	32.16	5	4	4
37.	Phule T-03-142	-23.77	-12.69	-0.34	7	7	6
38.	ICPL-88039	-56.67	-33.43	-24.12	9	8	7
39.	ICPL-87(National check)	-5.41	23.83	30.24	7	5	4
40.	Vipula(State check)	0	0	0	6	6	6

Table 4: Morphological characters of different pigeonpea germplasms

Sr. No.	Germplasm	Growth Habit	Pod colour	Pod streak colour	Pod length Long/Short	Flower colour
1.	PT-01-2010	Indeterminate	Green	Brown	Long	Yellow
2.	PT-00-5-7-4-1	Indeterminate	Green	Brown	Long	Yellow
3.	PT-00-16-4-2	Indeterminate	Green	Brown	Medium	Yellow
4.	PT-00-1-25-1	Indeterminate	Green	Brown	Medium	Yellow
5.	PKVTARA	Indeterminate	Green	Brown	Short	Yellow
6.	ICPL-87119	Indeterminate	Green	Brown	Short	Yellow
7.	PT-17-12-2	Indeterminate	Green	Brown	Medium	Yellow
8.	PT-00-4-16-2	Indeterminate	Green	Brown	Long	Yellow
9.	PT-00-12-1-1	Indeterminate	Green	Brown	Medium	Yellow
10.	PT-04-24-2	Indeterminate	Green	Brown	Medium	Yellow
11.	PT-00-12-6-4	Indeterminate	Green	Brown	Medium	Yellow
12.	PT-04-31	Indeterminate	Green	Brown	Short	Yellow
13.	BSMR-736	Indeterminate	Green	Brown	Long	Yellow
14.	BSMR-853	Indeterminate	Green	Brown	Long	Yellow
15.	PT-00-6-2-2	Indeterminate	Green	Brown	Long	Yellow
16.	PT-04-307	Indeterminate	Green	Brown	Medium	Yellow
17.	BDN-2010-12	Indeterminate	Brown	Brown	Short	Red
18.	PT-04-257	Indeterminate	Green	Brown	Medium	Yellow
19.	PT-0351-1-13	Indeterminate	Green	Brown	Medium	Yellow
20.	PT-417-8-2-2	Indeterminate	Green	Brown	Medium	Yellow
21.	PT-04-0273	Indeterminate	Pink	Pink	Short	Yellow
22.	BDN-2001-6	Indeterminate	Green	Brown	Short	Yellow
23.	PT-00-12	Indeterminate	Green	Brown	Short	Yellow
24.	PT-2001-5-8-1	Indeterminate	Green	Red	Long	Red
25.	PT-2001-11-2	Indeterminate	Green	Brown	Long	Yellow
26.	PT-417-4-2-1-2	Indeterminate	Green	Brown	Long	Yellow
27.	PT-417-7-1-4	Indeterminate	Green	Brown	Short	Yellow
28.	PT-0555-2-2	Indeterminate	Green	Brown	Long	Violet
29.	ICPL-332	Indeterminate	Green	Brown	Short	Yellow
30.	ICP-13198	Indeterminate	Green	Brown	Short	Yellow
31.	ICPL-98008	Indeterminate	Green	Brown	Short	Yellow
32.	PT-03-142	Indeterminate	Green	Brown	Short	Yellow
33.	ICPL-88039	Indeterminate	Green	Brown	Short	Yellow
34.	PT-00-5-8-1	Indeterminate	Green	Red	Long	Yellow
35.	BDN-2010	Indeterminate	Green	Brown	Short	Yellow
36.	PT-01-11-2	Indeterminate	Green	Brown	Short	Yellow
37.	PT-01-24-1-1	Indeterminate	Green	Brown	Long	Yellow
38.	PT-257	Indeterminate	Green	Brown	Long	Yellow
39.	Vipula	Indeterminate	Green	Brown	Medium	Yellow
40.	ICPL-87	Determinate	Green	Brown	Long	Yellow

Table 5: Total phenol, reducing sugar and non-reducing sugar content in green pods of different pigeonpea germplasms

Sr. No.	Germplasm	Total phenol (%)	Reducing sugar (%)	Non-reducing sugar (%)
1.	BDN-2010	1.45 (6.90)*	0.49 (3.99)*	1.30 (6.53)*
2.	PKV-TARA	1.98 (8.08)	0.18 (2.40)	0.44 (3.80)
3.	BSMR-736	1.32 (6.58)	0.50 (4.05)	2.66 (9.38)
4.	BDN-2010-12	1.20 (6.35)	1.23 (6.35)	3.15 (10.22)
5.	ICPL-87119	1.33 (6.62)	0.60 (4.44)	1.43 (6.86)
6.	PT-01-2010	1.91 (7.93)	0.27 (2.95)	0.29 (3.06)
7.	PT-00-12	1.77 (7.63)	0.75 (4.95)	2.16 (8.44)
8.	BDN-2001-6	1.79 (7.68)	0.39 (3.56)	1.59 (7.23)
9.	ICPL-332	1.84 (7.79)	0.18 (2.39)	0.45 (3.82)
10.	ICPL-87(National check)	1.65 (7.37)	0.55 (4.23)	1.35 (6.66)
	S.E. ±	0.01	0.03	0.03
	CD at 5 %	0.03	0.10	0.10

*Figures in parentheses are arcsin tranformed values.

Table 6: Correlation coefficient (r) between per cent pod damage by pod borers and biochemical parameters

Sr. No.	Biochemical parameters	Correlation coefficient (r)		
		Pod borers		
		H. armigera	*E. atomosa*	*M. obtusa*
1.	Total phenol	-0.504	-0.887**	-0.466
2.	Reducing sugar	0.820**	0.741*	0.801**
3.	Non reducing sugar	0.578	0.790**	0.609

** Significance levels at 0.05 % (0.632), * Significance levels at 0.01% (0.765)

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