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To study the biochemical and morphological characters conferring resistance against pod borer complex

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Abstract
An investigation was undertaken to study the biochemical and morphological characteristics associated with resistance against pod borers in pigeonpea genotypes. The research was carried out at the Research cum Instructional farm of Indira Gandhi Krishi Vishwavidyalaya (IGKV), Raipur, during the *Kharif* and *Rabi* seasons of 2022-23 and 2023-24, respectively. Additionally, laboratory studies were conducted at the Biochemical Laboratory, Department of Entomology, IGKV, Raipur. The results of the investigation revealed significant correlations between biochemical characteristics of pigeonpea pods and the extent of damage caused by pod borers. Total phenol content in the pods of medium-duration pigeonpea genotypes showed a strong and negative relationship (r = -0.797) with the percentage of pod damage caused by pod borers. This indicates that higher levels of total phenols in the pods are associated with lower levels of pod damage, suggesting a potential role of phenolic compounds in conferring resistance against pod borers. On the other hand, protein content, total soluble sugar content, and reducing sugar content in the pods of medium-duration pigeonpea genotypes exhibited significant positive associations (protein content: r = 0.927, total soluble sugar: r = 0.957, reducing sugar: r = 0.914) with the percentage of pod damage caused by pod borers. and in case of morphological characters Pod wall thickness of medium-duration pigeonpea genotypes showed a strong and negative relationship (r = -0.873) with the percentage pod damage caused by pod borers. This indicates that higher pod wall thickness is associated with lower levels of pod damage, suggesting a potential role of resistance against pod borers. On the other hand, plant height, pod breadth and days to maturity have non-significant and positively correlated which do not favor the percent damage by pod borers and Pod length, no. of seed per pods of medium-duration pigeonpea genotypes have negatively non-significant relationship which favors the damage done by pod borers.

Keywords: Biochemical, morphological, resistance, phenol, sugar, pod borer

Introduction
Pigeonpea (*Cajanus cajan* (L) Millspaugh) holds a significant position among grain legume crops, particularly in the tropical and subtropical regions of Asia and Africa. In India, it stands as the second most important pulse crop following chickpea and is commonly referred to as Arhar, red gram, or tur. India notably emerges as the largest producer of pigeonpea globally, contributing to over 93% of the total production. The cultivation of pigeonpea spans across approximately 4.46 million hectares of land in India. The production output reaches around 4.18 million tons annually, indicating the substantial contribution of this crop to the agricultural sector. Despite its widespread cultivation, the productivity levels of pigeonpea have shown variability, with an average productivity of about 937 kg/ha during the 2017-18 period.

The pod borer complex, consisting of *Helicoverpa armigera*, *Exilastis atomosa*, and *Maruca vitrata*, has been identified as a significant threat to pigeonpea crops. These pests primarily target the reproductive parts of the plant, leading to substantial reductions in grain yield, with losses ranging from 30 to 100 percent. Among the members of the complex, *H. armigera* alone is responsible for up to 50 percent of the total crop loss in pigeonpea. The damage inflicted by these pests not only affects the quantity but also the quality of the yield, posing a considerable challenge to pigeonpea production and farmer livelihoods.

Infestations by the pod borer complex can lead to economic losses and jeopardize food security, particularly in regions where pigeonpea serves as a staple crop. (Thakare, 2001 and Dodia *et al*., 2009) [22, 3].

The indiscriminate use of insecticides in the field has led to several negative consequences, including the development of resistance among pest populations, resurgence of pests, and secondary outbreaks of minor pests. To address these challenges and ensure sustainable production, it is essential to adopt alternative pest management strategies. (Halder *et al*., 2006) [5]. Host plant resistance involves the use of tolerant cultivars or hybrids that possess inherent resistance to pest attacks. In the context of pigeonpea cultivation, the resistance or susceptibility to the pod borer complex is associated with specific biochemical traits present in the plant. These traits include nitrogen content, protein levels, total soluble sugar concentration, phenol content, and reducing sugar levels.

Materials and Methods

Biochemical characters conferring resistance against pod borer complex

Methodology

Biochemical parameters *viz.*, total nitrogen and total protein contents, total phenols, total soluble sugars and reducing sugar were estimated on three randomly selected samples in 15 genotypes and data were correlated with the damage of pod borers. The procedures adopted for the estimation of biochemical parameters are described as under:

Total nitrogen content

Nitrogen in plant sample was determined by employing KELPLUS Digestion and Distillation systems by Subbiah and Asija (1956) [18]. This procedure essentially involved:

1) Alteration of organic N compound to NH4-N form during digestion
2) Evaluation of NH4-N in the plant digest during distillation.

Reagents

a) Conc. Sulfuric acid (H_2SO_4)
b) Catalyst salt mixture: A mixture of K_2SO and $CuSO_4$ salts in 10:1 ratio
c) 2.5% sodium hydroxide solution: 25 g of sodium hydroxide pellets were dissolved in distilled water and the volume made up to 1 lit.
d) 0.02N H_2SO_4: 0.1N H_2SO_4 solution was prepared by adding 2.8 ml of concentrated H_2SO_4 in to 1 lit of distilled water. Afterwards, 0.02N H_2SO_4 solution was prepared by diluting a suitable volume five times with distilled water. Obtained solution was then standardized against 0.02 N NaOH solution.
e) 4% Boric acid solution: Firstly 40 g of pure boric acid powder was dissolved in warm distilled water by stirring and 20 ml of mixed indicator was added into the boric acid solution. The pH of solution was adjusted to 4.5 with dil. HCl or NaOH and then the volume was made up to 1 lit.
f) Mixed indicator: Both of the indicators; 0.066 g of methyl red and 0.099 g of bromocresol green were dissolved in 100 ml of 95% ethyl alcohol.

Digestion of plant samples by using KELPLUS

After weighing of 0.1 g of plant sample into 100 ml capacity micro digestion test tube, 2 ml conc. H_2SO_4 solution was added by using 2 ml tilt measure/acid dispense and kept it overnight. Next, 1 g of catalyst/ salt mixture was added to the plant sample mixture and the test tube then transferred to the KELPLUS digestion unit. The test tubes initially heated with 200 °C, which gradually increased and set the temperature to 450 °C. The digestion unit was then putted off until half hours after attaining 450 °C. At last, the test tubes were removed from the digestion chamber and kept them on stand for cooling to room temperature.

Distillation of digested sample by using KELPLUS

The distilled water tank of the KELPLUS until was filled first up to the given water level. Alkali, Boric acid and KMnO4 solutions were loaded to the system through silicon holes provided at the back of the equipment. 25 ml Boric acid was taken with indicator in a 250 ml conical flask and placed at the receiver end. Next, the sample was diluted with distilled water (dilution 10 ml to 20 ml) and the sample tube was loaded to the sample side. System was pre-updated for the addition to add sodium hydroxide (NaOH 40%) for 25 ml. After completion of all above process, the system was processed to start. Timing of distillation was fixed and set as 9 min. During the process, liquid ammonia collected in boric acid and the color of boric acid was changed to green as the color of indicator. After completion of the process, the conical flask was removed from the receiver end and the distilled sample was titrated with 0.02 N H_2SO_4 till the blue color changed to pinkish color.

Calculation

The nitrogen content in plant sample was calculated as follows:

Weight of sample= 0.1 g

Normality of H_2SO_4 = 0.02

$$N\% = \frac{TV \times 0.00028 \times 100}{0.1}$$

Titration value (TV) = Sample titration value – Blank titration value

Total protein content

Total protein content was estimated by "Nitrogen-Protein (N: P) conversion factor". Firstly, total nitrogen content of each genotype was analyzed by KELPLUS unit by Subbiah and Asija (1956) [18] and then the total nitrogen content was multiplied with Nitrogen-Protein (N: P) conversion factor '6.25'.

Total protein content = Total nitrogen × 6.25

Total phenols

The total phenols present in pods of twenty-seven pigeonpea genotypes were estimated as per the method developed by Sadasivam and Manickam (1996) [20]. From each sample 0.5 g material was weighed and was added with ten times volume of 80% ethanol and the homogenate was centrifuged at 10,000 rpm for 20 minutes. The supernatant was collected and residue was re-extracted with five times the volume of 80% ethanol, then centrifuged and the supernatants were pooled and evaporated to dryness. The residue was then dissolved in 5 ml distilled water and different aliquots ranging from 0.2 to 2.0 ml were pipetted out in to the test tubes and the volume in each tube was made up to 3 ml by adding distilled water. To this extract 0.5 ml of Folin -

Ciocalteau reagent was added and after 3 minutes. 2 ml of 20% sodium carbonate solution was added to each tube. The material was mixed thoroughly and tubes were placed in boiling water exactly for one minute. The tubes were then cooled and the absorbance was measured at 650 nm against a reagent blank in spectrophotometer. The standard curve was prepared by plotting the Catechol concentrations on X-axis and absorbance values on Y- axis.

Reagents

Ethanol 80% was prepared by adding 80 ml of absolute alcohol in a beaker and made up to 100 ml by using distilled water. (b) Sodium carbonate 20% was prepared by adding 20 g Sodium carbonate in 100 ml of distilled water.

Preparation of Working Standards

The working standards were prepared by dissolving 100 mg catechol was dissolved in 100 ml of distilled water and diluted to 10 times from the working standards, different concentrations ranging from 0.1 to 1.0 ml were prepared. A blank containing all the reagents except plant extract should be used to adjust the absorbance to zero.

Calculation

From the standard curve, concentrations of total phenols in terms of mg phenols / 100 gm plant material were estimated and converted to per cent.

Total soluble sugar (TSS)

The concentrations of total soluble sugar (TSS) were determined with the help of hand refractometer by Srivastava and Kumar (1994) [17]. The device was firstly calibrated by using distilled water, where the TSS reading was displayed as zero. Five plant samples that were randomly selected from each genotype were digested in the mortar and pestle. A double layer of muslin fabric was used to filter the final plant extract. A small amount of the plant extract (2-3 drops) was kept on the optical disc/prism region of refractometer and cover plate was secured. After covering the disc region, the TSS measurements were taken by looking through the lens of hand refractometer. The readings of total soluble sugar were determined and expressed in degree brix (° Brix).

Reducing sugar

For the estimation of reducing sugar, the dinitro alicyclic acid method (Miller, G. L., 1972) [10] was used. Pipette a 3 ml aliquot of the extract into test tubes. Add 3 ml of DNS reagent to each tube. Then heat the mixture for 5 minutes in a boiling water bath. When the color has developed, add 1 ml of 40 per cent warm Rochelle salt to the tubes while the contents are still warm. Cool the tubes under a running tap. Measure the absorbance of the solution at 575 nm. Calculate the amount of reduced sugar using a standard prepared from glucose.

Reagents

- Dinitro salicylic (DNS) reagent: 1 g of dinitro salicylic acid, 200 mg of crystalline phenol, and 50 mg of sodium sulphate dissolved in 100 ml of a 1% solution of NaOH.
- Rochelle Salt (Sodium Potassium Tartrate)— 40% solution

Morphological characters conferring resistance against pod borer complex

Methodology

Study of morphological characters both quantitative and qualitative traits, a set of twenty-seven pigeonpea genotypes for qualitative traits and 15 categorized genotypes based on PRR for quantitative traits were selected and tested. The morphological parameters such as plant height, pod wall thickness, pod length and breadth, days of maturity, flower color, number of seed/pods were recorded in order to study their relationship with resistance or susceptibility to the pod borers. These parameters were observed by following methods:

Observations recorded

1. **Plant height (cm):** The height of plant was measured in centimetre. The height was taken from base to tip of the plant at the time of maturity stage and establish correlation with percent pod damage. (Rana *et al.*, 2017) [13].
2. **Pod wall thickness (mm):** Hand-cut cross sections of thirty different pigeonpea germplasm pods were taken, and the thickness of the outer peel portion of four sections of five pods from each entry was determined using digital Vernier Callipers. The thickness was measured in millimetre and establish correlation with percent pod damage. (Machanwar *et al.*, 2019) [8].
3. **Pod length (cm) and breadth (mm):** Graph paper was used to measure the length and width of the pods of each genotype. For each genotype, three replications were maintained, with five pods in each replicate. It was measured in centimetre and establishes correlation with the percent pod damage. (Machanwar *et al.*, 2019) [8].
4. **Pod form:** The pattern of growth of the genotypes tested, whether flat or cylindrical, were measured and a correlation with the percent pod damage was identified. (Machanwar *et. al*., 2019) [8].
5. **Days of maturity:** Days of maturity was observed in terms of day from the sowing to 50% pod cracking in each line and establish correlation with percent pod damage. (Rana *et al*., 2017) [13].
6. **Flower Color:** Color of flowers *i.e.*, yellow and yellow with red lines of tested genotypes from various groups were recorded by visual observations at the time of blooming period and establish correlation with percent pod damage. (Rana *et al.*, 2017) [13].
7. **Number of seed/ pods:** The number of seed per pod was recorded by counting the seed per pod and correlated with percent pod damage. (Machanwar *et al.*, 2019) [8].

Statistical analysis

The data obtained from all the Biochemical and morphological characters has been subjected to the following statistical analyses.

Mean: It was calculated by using following formula

$$\text{Mean} = \Sigma x/n$$

Where,

Σx = Sum of all the observation

n = Number of observations

Test of significance of correlation coefficient

The test of significance of correlation coefficient, t-test value n-2 degree of freedom was calculated on the following formula:

$$t = \frac{r \times \sqrt{n-2}}{\sqrt{1-r^2}}$$

The coefficient of correlation

$$r = \frac{Cov(X,Y)}{\sigma x \times \sigma y} = \frac{\frac{1}{N}\sum(X-\overline{X})(Y-\overline{Y})}{\sqrt{\frac{1}{N}\sum(X-\overline{X})^2}\sqrt{\frac{1}{N}\sum(Y-\overline{Y})^2}}$$

Where,
X = Mean of first factor
Y= Mean of second factor
n = Total no. of observations
r = Correlation coefficient

Results and Discussion

Biochemical characters conferring resistance against pod borer complex

To investigate the biochemical basis of resistance in pigeonpea genotypes against pod borers, various biochemical parameters were analyzed. These parameters included: Total nitrogen content, Total protein content, Total phenol content, Total soluble sugar content, Reducing sugar content. These biochemical parameters were selected based on their potential roles in plant defense mechanisms and their previous associations with resistance against insect pests. The analysis involved estimating the levels of each biochemical parameter in the pigeonpea genotypes and correlating these levels with the percentage of pod damage caused by pod borers.

A. Protein content (%)

As per the data the protein content ranged from 16.25 to 31.26 percent in the pod of 15 selected pigeonpea genotypes. The presences of considerable differences in the protein per cent among all the genotypes of pigeonpea were tested for the resistance to pod borers. The maximum protein per cent was recorded in highly susceptible genotype PT002 (RAJESHWARI) (31.26%). Whereas the least protein per cent was recorded in CG Arhar-2 (16.25%).

Correlation analysis of protein per cent and total per cent pod damage caused by pod borers conferred positively highly significant with r value 0.927**). This indicates that with increase protein percent, there will be increase in infestation level too.

The present findings are in coordination with Parre *et al.*, (2018) [12] who reported that the protein content showed positive correlation with percent of pod borer damage (0.8035) indicating that genotypes with more protein content are more susceptible to *Helicoverpa* infestation.

B. Total Phenols (mg/g)

The phenol content was showed significant variation among different genotypes. The total phenol content of different genotypes varied from 2.70 - 4.43 mg/g, as presented in Table 4.7 in the pod of pigeonpea genotypes. The highest phenol content was measured in CG Arhar-2 (4.43 mg/g), whereas lowest phenolic content was observed in PT002 (RAJESHWARI) (2.70 mg/g).

Correlation studies between phenolic content and pod damage by pod borers showed highly significant negative association with r value (-0.797**) which clearly shows that high phenol content exhibit critical role in offering resistance to pod borers in field condition.

The current findings are in accordance with earlier researchers such as, Rashmi *et al.*, (2020) [14] and Tyagi *et al.*, (2021) [21] who reported that the correlation between the pod damage and phenol content in pods of different genotypes was negative and significant, indicating that increase in phenol content resulted in less pod damage. The present results were in agreement with the findings of Sahoo and Patnaik (2002) [15], Anantharaju and Muthiah (2008) [1], Sharma *et al.*, (2009) [16], Bommesha *et al.*, (2012) [2] and Jagtap *et al.*, (2012) [6] who reported that low protein and sugar content and high phenol content in pod coats and seeds were responsible for the resistance of pigeonpea varieties against pod borers. These results are also in accordance with the findings of Vageesh Pandey *et al.*, (2011) [23] that the genotypes with more phenol content suffered less pod and grain damage by pod fly.

C. Total soluble sugar (°Brix)

As per the data, the presences of considerable differences in the TSS among all the genotypes of pigeonpea were tested for the resistance to pod borers and the total soluble sugar content ranged from 2.20 to 9.27 °Brix in the pod of 15 selected pigeonpea genotypes. The maximum TSS was recorded in highly susceptible genotype PT002 (RAJESHWARI) (9.27°Brix), whereas the least TSS was recorded in least susceptible genotype CG Arhar-2(2.20 °Brix).

The results revealed that the Total soluble sugar (r= 0.957**) showed highly significant and positive correlation with pod damage caused by pod borers, indicating that higher the sugar content higher is the infestation.

The present findings are in coordination with Parre *et al.*, (2018) [12] who reported that the Total sugars (0.804) i.e., reducing and non-reducing sugars showed positive association with the percent of pod borer damage indicating that genotypes having more sugars are highly preferred by *Helicoverpa* species.

D. Reducing sugar (mg/g)

The total reducing sugar content in pod samples of different medium genotypes showed significant variation and varied from 0.82 to 1.46 per cent. The genotype PT002 (RAJESHWARI) had high pod damage (35.33%) and possessed relatively higher reducing sugar content (1.46 mg/g), while the genotype CG Arhar-2 suffered least pod damage (17.50%) by pod borer and possessed significantly lower reducing sugar content (0.82 mg/g).

Correlation analysis of reducing sugar and total per cent pod damage caused by pod borers conferred positively highly significant with r value 0.914**. This indicates that with increase in reducing sugar content, there will be increase in infestation level too.

The present findings are in coordination with Parre *et al.*, (2018) [12] who reported that the Total sugars (0.804) i.e., reducing and non-reducing sugars showed positive association with the percent of pod borer damage indicating that genotypes having more sugars are highly preferred by *Helicoverpa* species. Similar findings were also reported by Siva Kumar *et al.*, (2015) [19] who observed that the

correlation between the reducing sugars and pod damage due to pod fly was positive and significant, which indicated that increase in reducing sugar increased the infestation of pest incidence.

Table 1: Influence of biochemical contents on pod damage by pod borers during *kharif* 2022-23 and 2023-24

S. N.	Germplasm	Total % Damage	Protein Content %	Total Phenol mg/g	Total Soluble Sugar (Brix)	Reducing Sugar (mg/g)
1	CG ARHAR-2(RPS-2008-5)	17.50	16.25	4.43	2.20	0.82
2	ICP-6996	19.00	16.55	4.41	2.25	0.88
3	RPS-2015-40	19.17	17.25	4.04	3.22	0.91
4	ICP-7374	20.17	19.69	3.92	3.26	0.87
5	RPS-2015-41	20.33	18.26	4.16	3.05	1.07
6	RPS-2015-35	24.67	19.56	2.92	3.55	0.95
7	BDN-716	24.83	21.28	3.32	4.25	1.07
8	RP-7	25.83	21.54	2.75	3.71	1.35
9	RPS-2015-2	26.50	22.21	3.22	6.30	1.22
10	RPS-2015-38	26.83	23.48	3.35	5.16	1.39
11	RPS-2015-22	29.83	25.65	3.63	7.87	1.44
12	ICPL-87119 (ASHA)	32.83	22.25	2.90	7.35	1.40
13	RPS-2015-51	33.83	26.12	3.41	8.35	1.44
14	RPS-2014-23	34.00	27.55	2.74	8.10	1.45
15	PT 002(RAJESHWARI)	35.33	31.26	2.70	9.27	1.46
	CD @ 5%	-	0.01	0.02	0.09	0.03

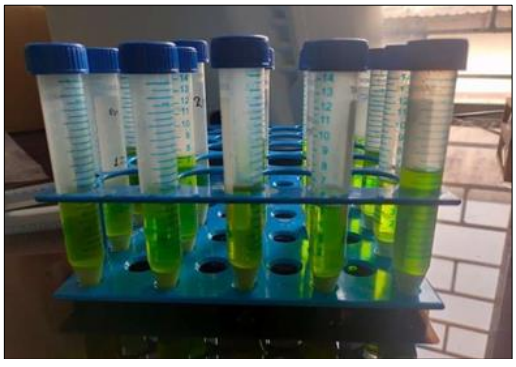
Table 2: correlation coefficient between biochemical content of pigeonpea and total % pod damage

S.N.	Biochemical characters	Correlation coefficient
1	Protein content %	0.927**
2	Total phenol mg/g	-0.797**
3	Total soluble sugar (brix)	0.957**
4	Reducing sugar (mg/g)	0.914**

Pod sample with ethanol

Crushing of pod sample

Centrifugation



Centrifuged samples

Evaporation of ethanol Aliquots

Fig 1: Preparation of Aliquot (plant extract)

Fig 2: Analysis of Total soluble sugar (TSS) by hand refractometer

Morphological characters conferring resistance against pod borer complex

Study of quantitative and qualitative morphological characters, a set of twenty-seven pigeonpea genotypes were selected and tested. The quantitative morphological parameters such as plant height, pod wall thickness, pod length and breadth, days of maturity, number of seeds/pods, and qualitative morphological parameters such as flower color and pod form were recorded in order to study their relationship with resistance or susceptibility to the pod borers and correlated with per cent pod damage due to pod borers (Tur pod borer, Spotted pod borer, and Tur pod fly).

Quantitative morphological characters

Plant height (cm)

The pooled data revealed that, Study of plant height varied from 161.93 cm (ICP-6996) to 175.90 cm (PT002). Among the all genotypes, there was no significant role of plant height for conferring resistance or susceptibility to pod borers as the correlation of plant height with pod borers *viz*., *Helicoverpa armigera, Maruca vitrata* and *Melanagromyza obtusa* infestation was found non-significant and positive correlation.

The current findings are in confirmation with Rana *et al.*, (2017) [13] who found that there is no significant effect of plant height with pod borers.

Pod wall thickness (mm)

The data revealed that the presences of considerable differences in the pod wall thickness among all the genotypes of pigeonpea were tested for the resistance to pod borers. On the basis of data recorded on pod wall thickness was varied from 0.38 mm (PT002) to 0.56 mm (CG Arhar-2).

Correlation of percent pod damage caused by pod borers with pod wall thickness

The results, revealed that the correlation value of pod wall thickness (r= -0.873 showed highly significant but negative correlation with percent pod damage caused by pod borers. These findings justify that increase in pod wall thickness is not favorable for the pod borers and the pod infestation decreased with increase in pod wall thickness. Thus, the pod wall thickness played an important role in tested pigeonpea genotypes against pod borers infestation and making the plant resistance.

The current findings are in confirmation with Rana *et al.*, (2017) [13] who found that the correlation studies showed highly significant negative correlation between pod wall thickness and per cent pod damage by pod borer complex with a correlation value (r) of - 0.96**. Pandey *et al.*, (2011) [11] who reported five tolerant and six resistant genotypes on the basis of pod wall thickness. Similarly, Moudgal *et al.*, (2008) [9] also found negative association between pod wall thickness and pod fly infestation in pigeonpea. Jat *et al.*, (2018) [7] also reported that pod borers infestation was negatively associated with the pod wall thickness.

Pod length(cm) and breadth (mm)

The pooled data revealed that the presences of considerable differences in the pod length and pod breadth among all the genotypes of pigeonpea were showed non-significant difference to pod borers. Based on pooled data pod length was varied from 4.29 cm (PT002) to 5.68 cm (CG Arhar-2) and data recorded on pod breadth was varied from 5.46 mm (CG Arhar-2) to 7.39 mm (PT002).

Both pod length and breadth of tested genotypes did not play any role for offering resistance or susceptibility as the correlation of pod length & breadth with pod borers *viz*., *H. armigera, M. vitrata*, and *M. obtusa* infestation was found to be negatively and positively non-significant, respectively.

Days of maturity

On the basis of data recorded on days to maturity showed non- significant differences among the tested genotype which varied from 157.52 days (CG Arhar-2) to 179.52 days (PT002).

Days of maturity of tested genotypes did not play any role for offering resistance or susceptibility as the correlation of days to maturity with pod borer complex *viz. M. vitrata, H. armigera* and *M. obtusa* infestation was found to be non-significant and positively correlated.

Number of seeds per pod

On the basis of data recorded on number of seeds per pod showed non- significant differences among the tested genotype which varied from 2.43 (PT002) to 3.98 (CG Arhar-2).

The results revealed that the correlation value of number of seed/ pod (r=-0.512 showed non-significant but negative correlation with percent pod damage caused by pod borers. Thus, no. of seeds/ pod of tested genotypes did not play any role for offering resistance or susceptibility.

Qualitative morphological characters

Pod form (Flat or cylindrical)

Pod form of different pigeonpea genotypes was observed to be non-significant difference among the tested genotypes. All the genotypes had cylindrical type of pod form Thus, pod form had no direct effect on pod borers for making the plant resistance or susceptible.

Flower color (Yellow and yellow with red lines)

Flower color of different pigeonpea genotypes was observed by visual observation. They were grouped into two i.e., yellow and yellow with red lines. Out of 27 genotypes, 15 genotypes had yellow color and rest of the 12 genotypes had yellow flowers with red lines. Flower Color had no direct effect on pod borers for making the plant resistance or susceptible.

Table 3: Quantitative morphological traits of medium maturity pigeonpea genotypes from each Pest Resistance Rating (PRR) category against pod borers

Germplasm	Total % Damage	PRR	Plant Height (cm)	Pod Wall Thickness (mm)	Pod Length (cm)	Pod Breadth (mm)	No of Seeds/Pods	Days of Maturity
-	-	1	-	-	-	-	-	-
-	-	2	-	-	-	-	-	-
-	-	3	-	-	-	-	-	-
CG ARHAR-2(RPS-2008-5)	17.50	4	163.10	0.56	5.68	5.46	3.98	157.52
ICP-6996	19.00	4	161.93	0.55	5.26	5.76	2.86	172.85
RPS-2015-40	19.17	4	162.60	0.47	4.86	5.75	3.67	166.18
ICP-7374	20.17	4	170.83	0.52	5.51	7.06	3.65	174.52
RPS-2015-41	20.33	4	173.59	0.49	5.52	6.89	3.56	170.35
RPS-2015-35	24.67	5	173.60	0.46	5.28	6.06	2.64	171.35
BDN-716	24.83	5	171.10	0.48	5.66	5.66	3.16	176.18
RP-7	25.83	5	176.43	0.54	5.56	6.36	3.21	175.85
RPS-2015-2	26.50	5	174.10	0.45	4.76	6.21	3.11	172.18
RPS-2015-38	26.83	5	174.11	0.44	4.61	6.31	2.94	166.35
RPS-2015-22	29.83	6	167.10	0.45	4.80	6.66	2.76	166.35
ICPL-87119 (ASHA)	32.83	6	169.43	0.42	5.48	6.81	3.46	175.18
RPS-2015-51	33.83	6	169.25	0.40	5.18	6.51	3.66	169.52
RPS-2014-23	34.00	6	174.77	0.41	4.77	5.86	2.46	169.52
PT 002 (Rajeshwari)	35.33	6	175.90	0.38	4.29	7.39	2.43	179.52
-	-	7	-	-	-	-	-	-
-	-	8	-	-	-	-	-	-
-	-	9	-	-	-	-	-	-

Table 4: Qualitative morphological traits of medium maturity pigeonpea genotypes from each Pest Resistance Rating (PRR) category against pod borers.

S.N.	Germplasm	Total % pod damage	PRR	Pod form	Flower Color
1	RP-1	22.67	4	Cylindrical	Yellow
2	RP-3	22.00	4	Cylindrical	Yellow with red lines
3	RP-7	25.83	5	Cylindrical	Yellow
4	ICP-7374	20.17	4	Cylindrical	Yellow with red lines
5	ICP-6994	21.33	4	Cylindrical	Yellow
6	ICP-6996	19.00	4	Cylindrical	Yellow with red lines
7	BDN-716	24.83	5	Cylindrical	Yellow
8	RPS-2015-1	20.83	4	Cylindrical	Yellow with red lines
9	RPS-2015-2	26.50	5	Cylindrical	Yellow
10	RPS-2015-4	28.83	5	Cylindrical	Yellow with red lines
11	RPS-2015-10	19.67	4	Cylindrical	Yellow
12	RPS-2014-23	34.00	6	Cylindrical	Yellow
13	RPS-2014-26	24.00	4	Cylindrical	Yellow with red lines
14	RPS-2015-21	21.67	4	Cylindrical	Yellow
15	RPS-2015-22	29.83	6	Cylindrical	Yellow with red lines
16	RPS-2015-23	27.00	5	Cylindrical	Yellow
17	RPS-2015-34	21.83	4	Cylindrical	Yellow with red lines
18	RPS-2015-35	24.67	4	Cylindrical	Yellow
19	RPS-2015-36	33.83	6	Cylindrical	Yellow with red lines
20	RPS-2015-38	26.83	5	Cylindrical	Yellow
21	RPS-2015-40	19.17	4	Cylindrical	Yellow with red lines
22	RPS-2015-41	20.33	4	Cylindrical	Yellow
23	RPS-2015-50	35.83	6	Cylindrical	Yellow with red lines
24	RPS-2015-51	33.83	6	Cylindrical	Yellow
25	PT 002(RAJESHWARI)	35.33	6	Cylindrical	Yellow with red lines
26	CG ARHAR-2(RPS-2008-5)	17.50	4	Cylindrical	Yellow
27	ICPL-87119 (ASHA)	32.83	6	Cylindrical	Yellow

Table 5: Correlation of quantitative morphological traits with pigeonpea pod borers of medium duration pigeonpea genotypes

S.N.	Morphological Characters	Correlation coefficient
1	Plant height (cm)	0.510
2	Pod wall thickness (mm)	-0.873*
3	Pod length (cm)	-0.513
4	Pod breadth(mm)	0.437
5	No of seeds /pods	-0.512
6	Days of maturity	0.382

*Significant at 5% (p=0.05) level Table value: (r) = 0.514

Conclusion

The study highlights the significance of plant-herbivore interactions, emphasizing that these interactions are not only influenced by environmental conditions but also by various physico-chemical traits of plants and the physiological status of the herbivores. Specifically, the research demonstrates variations among different plant genotypes regarding several biochemical traits such as total phenol, nitrogen content, protein content, total soluble sugar, and reducing sugar. These variations suggest the potential utility

of genetic resources in enhancing host plant resistance against herbivores. By identifying genotypes that exhibit differences in these biochemical traits, the study suggests that it may be possible to improve host plant resistance through selective breeding or genetic modification. Host plant resistance, in this context, refers to the ability of plants to resist damage from herbivores, either through chemical defenses or other mechanisms. The association of multiple biochemical traits with host plant resistance underscores the complex nature of plant-herbivore interactions and the importance of considering various factors in efforts to enhance plant resistance.

Overall, the findings of this study contribute to our understanding of the mechanisms underlying plant-herbivore interactions and highlight the potential for using genetic resources to develop more resistant crop varieties, thereby reducing the need for chemical pesticides and promoting sustainable agriculture.

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