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Screening of Short Duration Pigeonpea [*Cajanus cajan* (L.) Millsp.] Genotypes against Major Insect Pests

Snehel Chakravarty[1]*, Tanusa Bera[2], Meena Agnihotri[2] and Jaba Jagdish[3]

[1]Department of Entomology and Agricultural Zoology, Institute of Agricultural Sciences,
Banaras Hindu University, Varanasi-221005, Uttar Pradesh, India.
[2]Department of Entomology, G. B. Pant University of Agriculture and Technology,
Pantnagar-263145, Uttarakhand, India.
[3]International Crops Research Institute for the Semi-Arid Tropics,
Patancheru-502324, Telangana, India.
*Corresponding author E-mail: snehelbhu@gmail.com

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Ten promising short duration genotypes of pigeonpea were screened under field conditions for two years (2013-15) to identify sources of resistance against pod borers. On the basis of per cent pod damage and Pest Susceptibility Rating (PSR) index, genotypes PUSA-2012-1, PA 409, PA 406, AL1747 were found to be least susceptible (PSR= 4 to 5) while two genotypes, AL 1790 and AL 1770 were ascertained highly susceptible against pod borers having damage rating of 8 over the susceptible check cultivar (Manak). Phenol and flavonoid content present in the pod wall of all the test genotypes/cultivars were also estimated. Highest phenol and flavonoid content was recorded from PUSA-2012-1 while the lowest content was obtained from the genotype AL 1790. Correlation studies made with these biochemical constituents revealed a significant and negative association of pod damage (%) with phenol (r = -0.896) and flavonoid (r = -0.872**) content in pod walls. Thus the genotypes having higher content of phenols and flavonoids in their pod walls offered resistance against pod borer complex.**

Keywords: Pigeonpea, Screening, Resistance, Pod borers, Biochemical traits.

Pigeonpea, *Cajanus cajan* (L.), is an important legume crop grown in the tropics and subtropics, mostly in Asia, Africa, Latin America and the Caribbean region occupying 6.5 per cent of the world's total pulse area and contributing 5.7 per cent to the total pulse production. In Asia, pigeonpea is grown on 4.1 million ha and India alone accounts for 86 per cent of Asia's total pigeonpea area and contributes 82 per cent to the total production and is the single largest producer of pigeonpea in the world (ICRISAT, 2012). Though, India is largest producer of pigeonpea, contributing more than 90 per cent of the world's production, the productivity has always been a concern. The low productivity of pigeonpea in the country may be attributed to many reasons, among which damage by insect pests is of paramount importance (Mishra *et al*., 2012).

Nearly 300 species of insect pests are known to infest pigeonpea crop at various growth stages in India (Lal and Singh, 1998) but the maximum yield loss is caused by pod borer complex. Amongst many insect pests, the pod borers, *Maruca vitrata* (Geyer), *Exelastis atomosa* (Wals.), *Lampides boeticus* (L.), *Helicoverpa armigera* (Hübner) and *Melanagromyza obtusa* (Malloch), on the pigeonpea are of major importance (Srilaxmi and Paul, 2010; Sharma, 2016).

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* To whom all correspondence should be addressed.
E-mail: snehelbhu@gmail.com

Considerable loss in grain yield is inflicted on account of their association with fruiting bodies. Pod borers have been estimated to cause 60 to 90 per cent loss in the grain yield of pigeonpea under favourable conditions and the damage of seeds by pod fly generally ranges between 14.3 to 46.6 per cent (Priyadarshini *et al*., 2013).

Many synthetic pesticides have been recommended against these insect pests but they are not considered as long term solution. The continuous and indiscriminate use of large quantities of chemical insecticides, besides creating health hazards to human and animal life, development of resistance and destruction of natural enemies as well as environmental pollution has also resulted in the pigeonpea crop failure in different parts of the country (Armes *et al*., 1996). Farmers, use chemical pesticides indiscriminately, which leads to increased cost of plant protection and ultimately resulting in lower profitability. Hence, chemical measures are often termed as necessary evil in present pigeonpea pest management scenario (Wadaskar *et al*., 2013).

It has long been recognized that host plant resistance holds a great promise for exploitation in integrated pest management programmes because the use of resistant varieties provide crop protection that is biologically, ecologically, economically and socially acceptable. Resistant varieties have their greatest value in crops of low values per hectare or in situations when yield vary greatly due to uncertainties of weather or other intermittent hazard. Thus, pulses are ideally suited for exploiting the resistance phenomenon to control insect pests ideally and economically (Sachan, 1992). Since pigeonpea growers have to spend much on input like pesticides, therefore also it is considered viable to search the available germplasms for sources of resistance to these insect pests for use in breeding insect resistant cultivars. Thus, keeping these views in mind, the present study was conducted to identify resistant sources so as to evolve short duration cultivars less susceptible to pod borer complex in pigeonpea.

MATERIALS AND METHODS

Field trial was conducted for screening of ten promising short duration pigeonpea genotypes (AL 1495, AL 1735, AL 1747, AL 1770, AL 1790, PA 409, PUSA-2012-1, PA 406, AL 201, PAU 881) along with two checks, Manak and UPAS 120 against lepidopteran pod borers and pod fly at Norman E. Borlaug Crop Research Centre, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar, Uttarakhand, India during *kharif* seasons of 2013-14 and 2014-15. The experimental material (seeds of different genotypes) was procured from Indian Institute of Pulses Research, Kanpur, Uttar Pradesh. Each genotype was sown in three rows of 4m length with row to row spacing of 60 cm and plant to plant spacing of 45 cm in a randomized block design replicated thrice. The crop was raised following all the recommended agronomic practices except plant protection measures.

The observations on larval population of different species of pod borers were recorded by randomly selecting twenty five pigeonpea inflorescences from each plot at ten days interval starting from flowering to maturity stage of the crop. Pod damage at maturity of the crop was recorded from total pods of five plants selected at random in each plot. Sample pods were critically examined for the damage of major pod borers, as described by Yadav and Dahiya (2004). The susceptibility of different genotypes to insect pests was calculated on the basis of per cent pod damage using the formula suggested by Lateef and Reed (1980).

The insect pest resistance/susceptibility rating was done on 1-9 scale as given by Lateef and Sachan (1990).

$$\frac{\text{Percent PD in check cultivar} - \text{Percent PD in test cultivar}}{\text{Percent PD in check cultivar}} \times 100$$

Where, PD = Pod damage

The sampling of pods for biochemical estimation of total phenols and flavonoids was done at 115 days after sowing of the crop when the damage due to different species of pod borers was at peak level. The method described by Singleton *et al*. 1999 was employed for estimating total phenol content in the pod walls of different pigeonpea genotypes while the flavonoid content was estimated as per the method developed by Quettier *et al*. 2000. The total per cent pod damage due to pod borer complex was also correlated with the biochemical constituents in each genotype in order to identify their influence on relative

Table 1. Larval density of lepidopteran pod borers and per cent webbing in different short duration pigeonpea genotypes during *kharif*, 2013-2015 (Pooled mean)

GENOTYPES	Number of larvae per 25 inflorescences*			Per cent webbing by lepidopteran pod borers per 25 inflorescences**
	M. vitrata	*E. zinckenella*	*P. critica*	
AL 1495	11.69 ^{de}(3.49)	0.83 ^{c}(1.15)	1.94 ^{def}(1.56)	33.00 ^{d} (35.06)
AL 1735	10.89 ^{cd} (3.37)	0.56 ^{abc} (1.03)	1.39 ^{abc} (1.37)	28.56 ^{c} (32.30)
AL 1747	9.14 ^{b}(3.10)	0.42 ^{abc}(0.95)	1.47 ^{bcd} (1.40)	23.89 ^{b} (29.21)
AL 1770	13.78 ^{f} (3.78)	1.22 ^{d} (1.31)	2.75 ^{gh} (1.80)	37.89 ^{ef} (37.99)
AL 1790	14.97 ^{g} (3.93)	1.47 ^{d} (1.40)	3.06 ^{h}(1.88)	43.78 ^{g} (41.42)
PA 406	10.28 ^{c} (3.28)	0.44 ^{abc} (0.97)	1.59 ^{cde} (1.44)	24.95 ^{b} (29.95)
PUSA-2012-1	7.72 ^{a} (2.87)	0.22 ^{a} (0.85)	0.92 ^{a} (1.18)	18.34 ^{a} (25.35)
PA 409	8.29 ^{ab} (2.96)	0.36 ^{ab} (0.93)	1.05 ^{ab} (1.24)	19.78 ^{a} (26.39)
AL 201	12.03 ^{e} (3.54)	0.58 ^{abc} (1.03)	1.86 $^{c\text{-}f}$ (1.53)	35.06 ^{de} (36.30)
PAU 881	13.53 ^{f} (3.74)	1.39 ^{d} (1.37)	2.31 ^{fg} (1.67)	37.22 ^{ef} (37.59)
UPAS 120 (R)	10.75 ^{cd} (3.35)	0.42 ^{abc}(0.95)	1.71 ^{cde} (1.49)	32.00 ^{d} (34.45)
Manak (S)	11.75 ^{de} (3.50)	0.71 ^{bc} (1.09)	2.08 ^{ef}(1.60)	39.00 ^{f} (38.64)
S.Em.±	0.34	0.13	0.17	1.05
CD at 5%	0.99	0.38	0.50	3.09
CV (%)	5.24	31.58	16.07	5.87

*Data presented in parentheses are square root transformed value $\sqrt{N+0.5}$, **Data presented in parentheses are angular transformed value; R = Resistant check, S = Susceptible check;

In a column, means followed by the common letter (s) are not significant in DMRT @ 5% level of significance

Table 2. Per cent pod damage due to lepidopteran pod borers and pod fly in different short duration pigeonpea genotypes during kharif, 2013-2015 (Pooled mean)

GENOTYPES	Pod Damage (%) at harvest due to lepidopteran pod borers			Pod Damage (%) at harvest due to pod fly		
	Pooled mean	PSR**	SC#	Pooled mean	PSR**	SC#
AL 1495	17.30 ^{def} (24.58)	6	MS	13.58 ^{de} (21.62)	7	MS
AL1735	16.81 ^{def} (24.19)	6	MS	11.85 ^{c} (20.13)	6	MS
AL 1747	13.92 ^{abc} (21.89)	5	LS	9.96 ^{b} (18.38)	5	LS
AL 1770	20.46 ^{g} (26.87)	8	HS	14.93 ^{ef} (22.72)	8	HS
AL 1790	21.03 ^{g} (27.29)	8	HS	15.42 ^{f} (23.12)	8	HS
PA 406	14.77 ^{bcd} (22.60)	5	LS	9.33 ^{b}(17.44)	5	LS
PUSA-2012-1	11.82 ^{a} (19.97)	4	LS	6.79 ^{a}(15.10)	4	LS
PA 409	12.62 ^{ab} (20.79)	5	LS	8.63 ^{b} (17.08)	4	LS
AL 201	18.35 ^{efg} (25.36)	7	MS	11.43 ^{c} (19.76)	6	MS
PAU 881	19.66 ^{fg} (26.32)	7	MS	14.07 ^{def} (22.03)	7	MS
UPAS 120 (R)	15.99 ^{cde} (23.56)	-	-	11.74 ^{c} (20.04)	-	-
Manak (S)	16.98 ^{def} (24.33)	-	-	13.29 ^{d}(21.38)	-	-
S.Em.±	0.92	-	-	0.49	-	-
CD at 5%	2.71	-	-	1.46	-	-
CV (%)	9.61	-	-	7.31	-	-

*Data presented in parentheses are angular transformed value; In a column, means followed by the common letter (s) are not significant in DMRT @ 5% level of significance;

R = Resistant check, S = Susceptible check; ** PSR = Pest susceptibility rating, # SC = Susceptibility category (LS = Least susceptible, MS = Moderately susceptible, HS = Highly susceptible),

Table 3. Total percent pod damage due to pod borer complex, yield and overall pest susceptibility rating in different short duration pigeonpea genotypes during *kharif*, 2013-2015 (Pooled mean)

GENOTYPES	Total Pod Damage (%) at harvest			Grain Yield (kg/ha)
	Pooled mean	Pest Susceptibility Rating	Susceptibility category	
AL 1495	30.88 ^{cd} (33.76)	7	Moderately Susceptible	379.72 ^{b}
AL 1735	28.66 ^{c} (32.36)	6	Moderately Susceptible	503.40 ^{c}
AL 1747	23.87 ^{b} (29.25)	5	Least Susceptible	582.54 ^{d}
AL 1770	35.39 ^{e} (36.49)	8	Highly Susceptible	359.53 ^{b}
AL 1790	36.45 ^{e} (37.14)	8	Highly Susceptible	302.26 ^{a}
PA 406	24.10 ^{b} (29.40)	5	Least Susceptible	540.14 ^{cd}
PUSA-2012-1	18.61 ^{a}(25.49)	4	Least Susceptible	775.59 ^{g}
PA 409	21.25 ^{ab} (27.46)	5	Least Susceptible	729.44 ^{fg}
AL 201	29.78 ^{c} (33.07)	6	Moderately Susceptible	412.24 ^{b}
PAU 881	33.73 ^{de} (35.50)	7	Moderately Susceptible	402.78 ^{b}
UPAS 120 (R)	27.73 ^{c} (31.77)	-	-	704.67 ^{f}
Manak (S)	30.27 ^{c} (33.38)	-	-	643.20 ^{e}
S.Em.±	1.06	-	-	18.74
CD at 5%	3.11	-	-	54.96
CV (%)	6.46	-	-	6.15

*Data presented in parentheses are angular transformed value; In a column, means followed by the common letter (s) are not significant in DMRT @ 5% level of significance;
R = Resistant check, S = Susceptible check

Table 4. Biochemical constituents in the pod walls of different short duration pigeonpea genotypes screened against pod borer complex

GENOTYPES	Phenolic compounds	
	Phenols (mg/g)	Flavonoids (mg/g)
AL 1495	0.598 ^{cd}	2.082 ^{a}
AL 1735	0.608 ^{cd}	2.949 ^{e}
AL 1747	0.830 ^{e}	3.810 ^{g}
AL 1770	0.523 ^{b}	2.572 ^{d}
AL 1790	0.461 ^{a}	2.012 ^{a}
PA 406	1.157 ^{f}	3.174 ^{f}
PUSA-2012-1	1.752 ^{h}	5.881 ^{h}
PA 409	1.501 ^{g}	3.851 ^{g}
AL 201	0.551 ^{bc}	2.392 ^{c}
PAU 881	0.508 ^{ab}	2.203 ^{b}
Manak (Check)	0.612 ^{d}	2.893 ^{e}
UPAS 120 (Check)	0.644 ^{d}	3.079 ^{f}
S.Em.±	0.019	0.033
CD at 5%	0.056	0.097
CV (%)	4.01	1.86

resistance or susceptibility of the genotypes against pod borers.

RESULTS AND DISCUSSION

Ten short duration pigeonpea genotypes were screened under unprotected conditions for their resistance or tolerance to pod borer complex along with two checks (Manak and UPAS- 120) during 2013-15. The results obtained from the investigation as well as relevant discussion have been summarized under the following heads:

Estimation of larval population of pod borers on pigeonpea genotypes

The data presented in Table 1 revealed that the overall pooled mean of the larval population of *M. vitrata* on different short duration pigeonpea genotypes varied significantly from 7.72 to 14.97 larvae/ 25 inflorescences. The minimum larval population (7.72 larvae/ 25 inflorescences) was counted from the genotype PUSA-2012-1 and it was closely followed by the genotype PA 409 but the maximum larval population (14.97 larvae/

Table 5. Simple correlation coefficient between chemical constituents of pigeonpea genotypes and total percent pod damage under field conditions

Biochemical characters	Total per cent pod damage
Phenol content in seeds (mg/g)	-0.896**
Flavonoid content in seeds (mg/g)	-0.872**

** Correlation is significant at 0.01 level (Two-tailed)

25 inflorescences) was counted from the genotype AL 1790. Similarly, the cumulative mean of per cent webbing by *M. vitrata* larvae, ranged from lowest of 18.34 per cent on PUSA-2012-1, followed by 19.78 per cent on PA 409 and highest of 43.78 per cent on AL 1790. Most of the tested genotypes received higher number of larvae and per cent webbing as compared to checks, UPAS 120 and Manak. Randhawa and Kumar (2013) also screened fifteen genotypes of pigeonpea against *M. vitrata* and on the basis of larval polytatic, genotype AL 1743 was found most promising with mean of 14.33 larvae/ 100 flower buds as compared with 28.00 larvae on AL 1811.

When overall mean of the larval population of *P. critica* was considered together, the minimum larval counts (0.92 larvae/ 25 inflorescences) were observed on PUSA-2012-1 followed by PA 409 (1.05 larvae/ 25 inflorescences), AL 1735 (1.39 larvae/ 25 inflorescences) and the highest number of larvae were observed on AL 1790 (3.06/ 25 inflorescences), while the larval population of *E. zinckenella* ranged from lowest of 0.22 larvae/ 25 inflorescences on PUSA-2012-1, followed by 0.36 larvae/ 25 inflorescences on PA 409 and highest of 1.47 larvae/ 25 inflorescences on AL 1790. Sahoo and Senapati (2000) reported that relative abundance of *P. critica* in UPAS 120 (early duration variety) was 48.72, 13.25 and 9.55 per cent at 50 per cent flowering, pod elongation and grain filling stage, respectively while, Bant and Harpreet (2006) reported that among the different pigeonpea genotypes screened for their resistance against pod borer complex, three genotypes, AL1340, AL1498 and AL1502 maintained their superiority and showed resistant reaction for *P. critica*. These reports partially strengthen the findings of the present study.

Per cent pod damage due to lepidopteran pod borers

Per cent pod damage due to lepidopteran pod borers varied significantly from 11.82% on PUSA-2012-1 to 21.03% on AL 1747 as compared to 16.98% and 15.99% on checks, Manak and UPAS 120 respectively (Table 2). Minimum per cent pod damage was observed in PUSA-2012-1 (11.82%), followed by PA 409 (12.62%), AL 1747 (13.92%), PA 406 (14.77%) while maximum pod damage was observed in AL 1790 (21.03%) which was at par with the genotype AL 1770 (20.46%), followed by PAU 881 (19.66%), AL 201 (18.35%), AL 1495 (17.30%) and AL 1735 (16.81%).

Out of ten pigeonpea genotypes, four genotypes were found least susceptible to lepidopteran pod borer damage as they showed a damage rating of 4-5 on a Pest Susceptibility Rating Scale of 1-9 (Table 2). PUSA-2012-1 received score of 4 while PA 409, AL 1747 and PA 406 got grade 5. AL 1495 and AL 1735 were found to be moderately susceptible and had damage rating of 6 over the check cultivar, Manak. AL 201 and PAU 881 were also moderately susceptible with damage rating of 7. While two genotypes, AL 1790 and AL 1770 was found to be highly susceptible to lepidopteran pod borer damage with damage rating of 8 over the check cultivar, Manak.

These findings are in close agreement with Durairaj and Ganapathy (1997) who reported 14.5 to 30.3 per cent pod damage due to lepidopteran pod borer complex on late maturing entries of pigeonpea. Khan *et al.* (2014) also screened 24 pigeonpea genotypes for their resistance/ tolerance against lepidopteran pod borers and found that pod damage due to these pod borers varied significantly between 5.50 to 12.50 per cent. The genotypes, ICPHaRL 4985-4 (7.00%), ICPL 20062 (7.00%) and ICPL 85063 (5.50%) gave a rating of 4 on pest susceptibility rating scale and were found to be least susceptible against these pod borers. Several other workers have also reported serious lepidopteran borers' damage on determinate, clustering early and medium maturing pigeonpea cultivars (Shanower and Romeis, 1999; Minja *et al.*, 1999) and also on the cultivars maturing beyond January.

Per cent pod damage due to pod fly

Per cent pod damage due to *M. obtusa* varied significantly from 6.79 per cent to 15.42 per cent on different pigeonpea genotypes as compared to 13.29 per cent and 11.74 per cent on checks, Manak and UPAS 120 respectively, (Table 2). Minimum per cent pod damage (6.79%) was observed in PUSA-2012-1, followed by PA 409 (8.63%), PA 406 (9.33%), AL 1747 (9.96%), while maximum per cent pod damage was observed in AL 1790 (15.42%), followed by AL 1770 (14.93%), PAU 881 (14.07%), AL 1495 (13.58%), AL 1735 (11.85%) and AL 201 (11.43%).

On contrary, Mishra *et al.* (2012) reported that among the 50 pigeonpea germplasms, a wide range of variation of pod (18.33 to 47.00%) and seed (16.43 to 48.44%) damage by pod fly were recorded with average mean of 30.68 and 31.69%, respectively. On the basis of pooled mean, two lines viz., ICP 2514 (18.33%) and ICP 2454 (19.33%) revealed resistance against the pod damage caused by pod fly, respectively whereas, based on seed damage ICP 2459 (16.43%) and ICP 2155 (18.62%) were categorized as resistant. This may be due to difference in susceptibility of genotypes to pod fly.

Out of ten pigeonpea genotypes, four genotypes *viz.*, PUSA-2012-1, PA 406, PA 409 and AL 1495 were found least susceptible to pod fly damage as they showed a damage rating of 4-5 on a Pest Susceptibility Rating scale of 1-9 (Table 2). PUSA-2012-1, PA 409 received score of 4 and PA 406, AL 1495 got grade 5. AL 1735 and PAU 881 were found to be moderately susceptible and had damage rating of 6 over the check, Manak. AL 1790 and AL 201 were also moderately susceptible with damage rating of 7 while two genotypes, AL 1790 and AL 1770 were found to be highly susceptible to pod fly damage with damage rating of 8 over the check cultivar, Manak.

Total per cent pod damage and overall pest susceptibility rating

The data received on total pod damage due to lepidopterans and pod fly are presented in Table 3. Total pod damage by lepidopteran pod borers and pod fly varied significantly from 18.61% to 36.45% among the genotypes. PUSA-2012-1 recorded lowest pod damage of 18.61% followed by PA 409 (21.25%). AL 1747 recorded highest pod damage of 36.45%, followed by AL 1770 (35.49%), as compared to 30.27% and 27.73% on Manak and UPAS 120, respectively. Rests of the genotypes were having total pod damage ranging between 24.10% to 33.73%. These findings are more or less similar with the results found by Gangwar *et al*. (2009); Anitha *et al.* (2006) and Kooner and Cheema (2006).

Out of ten pigeonpea genotypes, four genotypes (PUSA-2012-1, PA 409, PA 406 and AL 1747) were found least susceptible to pod borer damage as they showed a damage rating of 4-5 on a Pest Susceptibility Rating scale of 1-9 (Table 3). PUSA-2012-1 received score of 4 while PA 409, PA 406 and AL 1495 got grade 5. AL 1735 and AL 201 were found to be moderately susceptible and had damage rating of 6 over the check cultivar, Manak. PAU 881 and AL 1495 were also found moderately susceptible with damage rating of 7 while two genotypes, AL 1790 and AL 1770 was found to be highly susceptible to pod borer complex with damage rating of 8 over the check cultivar, Manak.

Grain yield in pigeonpea genotypes

The data on grain yield per hectare of different genotypes are given in Table 3. There was significant difference in grain yield between genotypes and checks. The highest grain yield was recorded from PUSA-2012-1 (818.78 kg/ha) which was significantly different from other genotypes where as lowest grain yield was recorded from AL 1747 (316.56 kg/ha), as compared to checks, Manak (710.72 kg/ha) and UPAS-120 (735.94 kg/ha). These findings are in conformity with Banu *et al.* (2007) and Borad *et al.* (1991) who also reported higher yield potential in those pigeonpea genotypes which showed lesser incidence of pod borers.

Biochemical constituents of pigeonpea genotypes

Phenol and flavonoid content present in the pod walls of ten pigeonpea genotypes, along with two checks, Manak and UPAS 120 were estimated and the results are presented in Table 4. The estimated phenol content differed significantly among pigeonpea genotypes. Highest phenol content was recorded from PUSA-2012-1 (1.752 mg/g) followed by PA 409 (1.501 mg/g), whereas lowest phenol content was recorded in AL 1790 (0.461 mg/g). In other genotypes it ranged between 0.523 to 1.157 mg/g as compared to checks, Manak (0.612 mg/g) and UPAS 120 (0.644 mg/g). Similarly, there was also significant difference in the flavonoid content of different pigeonpea genotypes. Highest flavonoid content was recorded in PUSA-2012-1 (5.881 mg/g) followed by PA 409 (3.851 mg/g) and

AL 1495 (3.810 mg/g) which were significantly at par with each other, whereas lowest phenol content was recorded in AL 1747 (2.011 mg/g). In other genotypes it ranged between 2.012 to 3.174 mg/g as compared to checks, Manak (2.893 mg/g) and UPAS 120 (3.079 mg/g).

Correlation studies between biochemical parameters of test genotypes and pod damage (%) in the field

Correlation coefficient was worked out between pod damage and biochemical constituents of pigeonpea genotypes along with checks, Manak and UPAS 120 (Table 5). The correlation studies made with chemical constituents revealed a significant correlation with pod damage. Significant and negative correlation was observed between pod damage (%) and phenol content in pod walls (r = -0.896**) and flavonoid content in pod walls (r = -0.872**). Thus it can be concluded that those genotypes which were having higher content of phenols and flavonoids in their pod walls offered resistance against pod borer complex attack in pigeonpea. These results are in accordance with the findings of Pandey *et al*. (2011) who reported that the genotypes with more phenol content suffered less pod and grain damage by pod fly. Similarly, Jadhav *et al*. (2012) also reported that due to presence of high levels of flavonoids such as chlorogenic acid, quercetin and rutin in ICPL 85010, there was less damage due to *H. armigera* larvae.

Moudgal *et al*. (2008) also noticed that total phenols in the pod walls of pod fly resistant pigeonpea genotypes of extra early and early group were significantly more than that in susceptible genotypes. The expression of resistance to *H. armigera* in wild relatives of pigeonpea has been reported to be associated with high amounts of polyphenols (Sharma *et al*., 2009). These findings also get partial support from studies of Sahoo and Patnaik (2003) who observed low sugar (2.91-3.44% in pod coats and 2.86-3.51% in seeds) and high phenol (6.33-8.97 mg/g in pod coats and 7.64-9.49 mg/g in seeds) in resistant cultivars of pigeonpea against pod borer attack. While high sugar (3.66-4.92% in pod coats: 3.64-4.82% in seeds) and low phenol (5.96-6.30 mg/g in pod coats: 5.86-6.60 mg/g in seed) were recorded in susceptible pigeonpea cultivars.

On the basis of the above investigation it may be concluded that host plant resistance plays a very important role in governing the pest infestation level in pigeonpea and screening is an appropriate method to identify resistant genotypes. Among the ten genotypes screened, PUSA-2012-1 was found to be most resistant against insect pest damage and it also gave the highest grain yield and hence can be recommended as a source of resistance to insect pests. The present investigation also clearly suggested that pigeonpea genotypes with more phenols and flavonoids in the pod walls suffered less pod damage by pod borer complex. Therefore, these biochemical pod traits can be used as markers to identify the resistant sources of pigeonpea with different mechanism of resistance against pod borers. These findings can be used very effectively in resistance breeding programmes against pod borer complex in pigeonpea.

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