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IDENTIFICATION GENETIC VARIABILITY AND CORRELATION STUDIES OF POD BORER TOLERANT CHARACTERS AND GRAIN YIELD IN PIGEONPEA [*CAJANUS CAJAN* (L.) MILLSP]

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ABSTRACT

Pigeonpea (*Cajanus cajan* (L.) millsp) is often heavily damaged by insect pests and trichomes provide a potential insect resistance mechanism. There glandular (Type A. B. and E) and two non-glandular (Type C and D) trichomes were identified with light microscopy because of their small size and rarity, type E trichomes were not considered in this study. Inter specific derivatives of *Cajanus scarabaeoides* had the most densely pubescent pod followed by *C. albicans, C. trinervus* and *C. lancelotus*. The high heritability estimates couples with high expected genetic advance were observed for trichome type A. B. C. and D. The correlation studies revealed trichome type C, D had positive correlation with grain yield and negative correlation with percent pod damage. As earlier study reported that resistance to *Heliothis dramigera* larvae is due to high density of non-glandular trichomes (type C and D). The mixed pod colour, no streaks on standard petals, reddish brown seed coat colour and spreading growth habit imparted tolerance to pod borer. Besides these characters, number of pods plant^{-1}, number of secondary branches had significantly positive correlation with grain yield. Hence these characters should also be taken into consideration for developing insect pest resistant high yielding pigeonpea genotype.

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INTRODUCTION

Pigeonpea [*Cajanus cajan* (L.) Millsp.], (2n = 2x = 22) is one of the most important legume crops of tropical and subtropical environments. It is the second most important pulses crop after chickpea in India and fifth rank in the world. It is major producer and consumer of pigeonpea in the world and presently occupies an area of about 4.6 million hectares with an annual total production of 3.4 million tonnes and mean productivity of 780 kg/hectare. The area under pigeonpea in India is around 3.88 million hectare with a production of approximately 3.29 million tonnes. (Anonymous, 2015). As 'dal', pigeonpea is an important constituent of the Indian meal. It contains 20-21% protein (Sodavadiya *et al.,* 2009).

The per capita availability of protein in the country is 28 g/day, while WHO recommended it should be 80 g/day, consequently most serious problem of the malnutrition existing among the poor people, where most of the people have vegetarian diet and avoid the animal protein (Prasad *et al.,* 2013). It is needs fulfill its demand through pulses protein. The most devasting pest of pigeonpea is the pod borer *Heliothis armigera* which causes worldwide yield losses of more than US $ 310 million annually. The types of trichomes and their orientation, density and length have been correlated with reduced insect damage in several crops (Peter *et al.,* 1995). They could therefore provide a potential resistance mechanism against *Heliothis armigera* and other pests of pigeonpea with increase the production of pigeonpea, which could be done opting suitable, breeding methods. Further, the yield is complete character which depends upon many determining characters. Hence the information on the correlation between yield and its component character is pre-requisite for crop improvement. Thus the present study was undertaken to identify and characterize trichome density and its interrelationship with yield and yield contributing characters in inter specific derivatives of pigeonpea.

MATERIALS AND METHODS

The experiment was conducted at experimental farm of the Department of Agricultural Botany, VNMKV, Parbhani. The experimental was conducted at forty Interspecific derivatives (ISD) of pigeonpea along with five national checks derive from ICRISAT, Patancheru, Hydrabad and one local check. The field trial comprising of forty ISD, five national released checks and one local check of pigeonpea was undertaken in randomized block design with two replications. Observations were recorded on twenty randomly selected plants in different genotypes in each replication with twenty three characters. Count the number of trichomes in field selected at random and expresses the trichomes per microscopic field (Sharma and Nwanze, 1997). Five morphologically distinct types of trichomes (Type A-E) (Plate 6A and 6B) were identified from pods of *Cajanus spp.* by light/ compound microscope. The data were subjected to following statistical analysis. Analysis of variance was performed to test the significance of differences between the genotypes for all the characters. Heritability (Broad sense) was done by the methods of Hanson *et al.* (1956). The correlation coefficients were calculated according to Johnson *et al.* (1955).

RESULTS AND DISCUSSION

The result revealed that five morphologically distinct types of trichomes (Type A-E) were identified from pods of *Cajanus spp.* by light / compound microscope (Plate 6A and 6B). Type-A trichome (Plate 6A) has a long tubular heck from which a clear viscous fluid is secreted. It is longer than all other trichomes except type D. The base is enlarged and appears to consist of 6 to 10 cells. The neck is comprised of 4 to 8 cells. Type B is yellowish, un-segmented, globular sac. It contents are only released after the cell wall is ruptured (Plate 6A). The un-segmented non glandular trichomes were separated into short (type - C) and long (type - D) trichomes (Plate 6B). Type D is 4 to 11 times longer than type C. Type E trichomes are short than all other trichomes type. Because of their small size and rarity, type E trichomes were not considered in this study. Similar results were observed by Romies *et al.* (1999).

Trichomes types A and D (Plate 6A and 6B) were found on pods of all pigeonpea genotypes observed. The density of type A, C and D trichomes varied significantly among genotypes. The variation in trichome type was ranged from 0.165 to 11.48 with mean of 3.67. Among 46 genotypes, (Pant A-2 X *C. scarabaeoides*)-20-1 and (Pant A-2 X *C. scarabaeoides*)-S-1 exhibited maximum number of trichomes type A. The variation in trichome type in trichome type B per microscopic field ranged from 0.16 to 14.32 with general mean

Table 1: Parameters of genetic variability for yield and yield contributing characters in ISD of pigeonpea

Sr. no	parameters	Range	General mean	Genotypic variance	Phenotypic variance	GVC (%)	PVC (%)	Heritability (%)	GA (%)	EGA (%)
1.	Days to flowering initiation	78-130	115.19	100.27	109.37	8.69	9.07	91.6	17.14	14.87
2.	Days to 50% flowering	99.5-159.5	37.79	135.91	145.03	8.46	8.73	93.7	16.87	12.24
3.	Days to maturity	135-220.5	189	208.69	231.90	7.64	8.05	89.9	14.93	7.89
4.	Plant height	100-155.70	131.12	157.33	176.68	9.56	10.13	89.0	18.59	14.17
5.	No. of primary branches	5.30-15.10	11.19	2.65	4.35	14.56	18.62	61.1	23.45	209.56
6.	No. of secondary branches	2.30-25.60	12.47	29.89	32.29	43.84	45.57	92.5	86.89	696.7
7.	Height of first primary branch from ground level	9.80-31.00	25.47	9.82	12.75	12.30	14.02	77.0	22.24	87.31
8.	No. of pods plant^{-1}	18.60-285	151.73	2687.03	2882.57	34.16	35.38	93.2	67.94	44.77
9.	No. of seeds pod^{-1}	3.48-5.00	3.91	0.19	0.22	11.14	11.98	86.4	21.34	545.7
10.	Per cent pod damage	2.41-17.13	16.83	7.47	12.01	16.24	20.57	62.27	26.40	156.8
11.	100 seed wt (g)	5.59-12.6	7.63	1.00	1.24	13.15	14.62	80.8	24.36	319.26
12.	Pod length (cm)	4.41-6.35	5.45	0.07	0.18	5.15	7.81	43.5	7.00	128.44
13.	Pod setting (%)	4.93-39.41	25.45	20.45	23.22	17.76	18.92	88.0	34.34	134.49
14.	Pollen sterility (%)	5.43-20.53	18.36	9.57	11.75	16.85	18.67	81.4	31.32	170.58
15.	Trichome-A	0.16-11.48	3.67	7.18	9.09	73.02	82.16	78.9	133.68	3642.5
16.	Trichome-B	0.16-14.33	6.87	9.35	10.13	44.47	46.30	92.2	88.01	1281.07
17.	Trichome-C	71.16-244	169.80	2127.61	2227.76	27.16	27.79	95.5	54.68	32.39
18.	Trichome-D	2.50-29.16	13.46	28.32	30.46	39.54	41.00	92.9	78.54	583.50
19.	Grain yield (g)	5.74-68.47	30.32	101.05	140.49	33.15	39.08	71.9	57.91	190.99

Plate 1: Flowering pattern: (a) Determinate (Prabhat × *C. scarabaeoides*) -3-2 and (b) Indeterminate; (Pant A-2 × *C. scarabaeoides*) - 27-2-2

Plate 2. Growth habit: (a) Erect (Pant A-2 × *C. scarabaeoides*)-11-1, (b) Semi-spreading (Pant A-2 × *C. scarabaeoides*)-3-3-1 and (c) Spreading (BSMR 736)

Plate 3: ICPL 87 showing determinate growth

Table 2: Genotypic correlation of yield with other components in ISD of pigeonpea

Characters	Days to flowering initiation	Days to 50% flowering	Days to maturity	Plant height	No. of primary branches	No. of secondary branches	Height of I[st] primary branch from GL	No. of pods plant[-1]	No. of seeds pod[-1]	Per cent pod damage	100 seed wt (g)	Pod length (cm)	Pod setting (%)	Pollen sterility (%)	Tric-home-A	Tric-home-B	Trich-ome-C	Tric-home-D	Grain yield (g)
Days to flowering initiation		0.851**	0.834**	0.128	0.059	0.162	0.130	0.170	-0.216	-0.353**	0.045	0.057	-0.196	0.269	0.042	0.267	0.340**	0.277	0.037
Days to 50% flowering			0.894**	0.134	0.036	0.034	0.123	0.042	-0.124	-0.200	0.053	0.070	-0.290	0.226	-0.005	0.190	0.293*	0.292*	-0.106
Days to maturity				0.183	-0.010	0.069	0.114	0.070	0.001	-0.160	0.064	0.250	-0.158	0.205	-0.051	0.241	0.194	0.262	-0.088
Plant height					0.678**	0.507**	0.205	0.682**	-0.025	-0.423**	-0.283	-0.055	-0.034	0.217	-0.090	0.390**	0.418**	0.175	0.649**
No. of primary branches						0.548**	0.006	0.670**	-0.113	-0.565**	-0.468**	-0.461**	-0.198	0.342*	0.012	0.360*	0.509**	0.169	0.567**
No. of secondary branches							-0.111	0.802**	-0.079	-0.314*	-1.25**	-0.301	-0.059	0.205	0.020	0.196	0.286	0.193	0.827**
Height of I[st] primary branch from GL								0.018	0.012	-00.79	0.104	0.278	-0.130	0.167	0.075	0.164	0.180	0.092	0.074
No. of pods plant[-1]									0.013	-0.604**	-0.288**	-0.075	-0.066	0.237	-0.064	0.319**	0.537**	0.104	0.953**
No. of seeds pod[-1]										0.020	-0.027	0.220	0.213	-0.015	-0.021	0.045	-0.082	-0.112	-0.011
Per cent pod damage											0.610**	0.491**	-0.008	-0.146	-0.041	-0.468**	-1.078**	-0.201	-0.392**
100 seed wt (g)												0.734**	0.064	-0.088	0.174	-0.415**	-0.536**	-0.330*	-0.059
Pod length (cm)													-0.110	0.001	0.172	0.001	-0.306*	-0.246	0.001
Pod setting (%)														-0.392**	0.176	-0.298*	-0.114	-0.359*	-0.055
Pollen sterility (%)															-0.003	0.428**	0.182	0.330*	0.208
Trich-ome-A																-0.201	-0.095	-0.109	-0.010
Tric-home-B																	0.456**	0.377**	0.165
Trich-ome-C																		0.207	0.364*
Tric-home-D																			0.03

Table 3: Phenotypic correlation of yield with other components in ISD of pigeonpea

Characters	Days to flowering initiation	Days to 50% flowering	Days to maturity	Plant height	No. of primary branches	No. of secondary branches	Height of I[st] primary branch from GL	No. of pods plant[-1]	No. of seeds pod[-1]	Per cent pod damage	100 seed wt (g)	Pod length (cm)	Pod setting (%)	Pollen sterility (%)	Trich-ome-A	Tric-home-B	Trich-ome-C	Tric-home-D	Grain yield (g)
Days to flowering initiation		0.798**	0.766**	0.111	0.025	0.150	0.092	0.177	-0.181	-0.275	0.042	0.025	-0.158	0.244	0.002	0.227	0.319*	0.260	0.038
Days to 50% flowering			0.859**	0.108	-0.005	0.019	0.116	0.020	-0.130	-0.185	0.029	0.022	-0.270	0.198	-0.003	0.159	0.272	0.273	-0.124
Days to maturity				0.141	-0.058	0.049	0.085	0.054	-0.005	-0.139	0.048	0.150	-0.116	0.167	-0.015	0.228	0.187	0.244	-0.068
Plant height					0.517**	0.459**	0.179	0.608**	-0.036	-0.312*	-0.249	-0.074	-0.048	0.178	-0.060	0.341*	0.386**	0.151	0.491**
No. of primary branches						0.452**	0.038	0.580**	-0.037	-0.368*	-0.346*	-0.164	-0.167	0.244	0.007	0.309*	0.390**	0.158	0.531**
No. of secondary branches							-0.137	0.775**	-0.081	-0.269	-1.102	-0.121	-0.018	0.168	0.020	0.177	0.277	0.183	0.714**
Height of I[st] primary branch from GL							0.005	0.019	-00.59	0.104	0.044	-0.166	0.161	0.168	0.069	0.110	0.136	0.051	
No. of pods plant[-1]									0.035	-0.453**	-0.224	-0.017	-0.047	0.209	-0.068	0.303*	0.508**	0.103	0.882**
No. of seeds pod[-1]										0.016	-0.003	0.133	0.195	-0.039	-0.048	0.058	-0.074	-0.066	-0.073
Per cent pod damage											0.442**	0.066	-0.046	-0.135	-0.029	-0.354*	-0.799**	-0.165	0.311*
100 seed wt (g)												0.422**	0.030	-0.070	0.124	-0.365**	-0.463**	-0.286**	-0.012
Pod length (cm)													-0.011	0.074	0.181	0.009	-0.183	-0.114	0.102
Pod setting (%)														-0.322**	0.158	-0.267	-0.096	-0.304**	-0.004
Pollen sterility (%)															-0.021	0.325*	0.144	0.303**	0.131
Trich-ome-A																-0.179	-0.078	-0.067	-0.020
Tric-home-B																	0.433**	0.344*	0.198
Trich-ome-C																		0.196	0.316*
Tric-home-D																			0.020

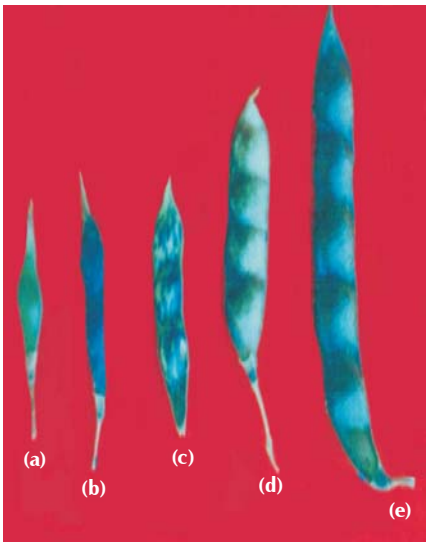

Plate 4. Pod colour: (a) Green (Prabhat × *C. scarabaeoides*)-27-2-1, (b) Dark purple (Pant A-2 × *C. scarabaeoides*)-12-2, (c) Mixed (Pant A-2 × *C. scarabaeoides*)-3-1, (d) Mixed (ICPL 87119) and (e) Purple (ICPL 7035)

Plate 5A: Standard petel colour and pattern of streak: (a) Red and uniform cover (ICP 7035) and (b) Yellow and no streak (Pant A-2 × *C. scarabaeoides*)-29-1

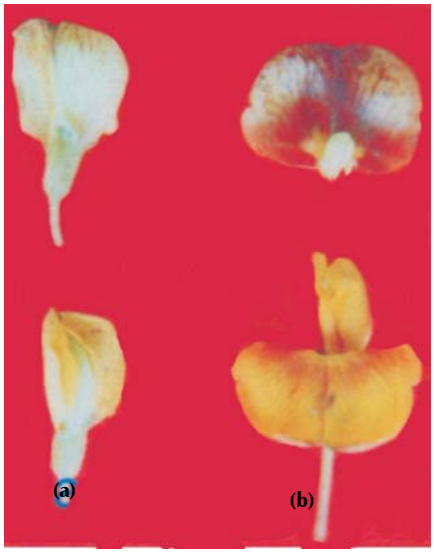

Plate 5B: Standard petal colour and pattern of streak (a) Yellow and sparse streak (Pant A-2 × *C. scarabaeoides*)-3-1 and (b) Yellow and dark red streak (Pant A-2 × *C. scarabaeoides*)-24-1

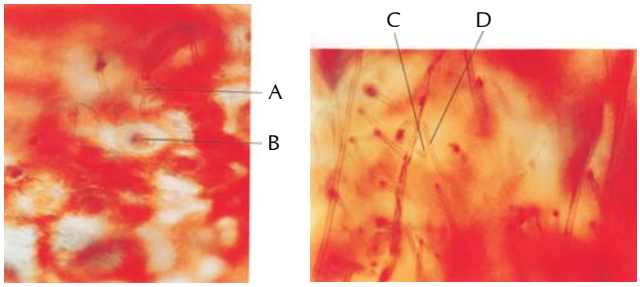

Plate 6A: Trichome type: A, B, C and D

value of 6.88. Inter specific derivatives of *C. scarabaeoides viz.*, (Pant A-2 X *C. scarabaeoides*)-27-2-2 (14.33) (Plate 1). (Pant A-2 X *C. scarabaeoides*)-27-2-1 (12.83) and (Pant A-2 X *C. scarabaeoides*)-16-1 (12.50) recorded highest number of trichome type B as compared to inter specific derivatives of *C. albicans, C. trinervius, C. lancelotus*. The mean number of trichome type C per microscopic field was ranged from 71.16 to 244.50 with a general mean value of 169.80. The highest number of trichome type C per microscopic field was recorded for inter specific derivatives of *C. albicans viz.*, (Pant A-2 X *C. albicans*)-29-1 (244.50) followed by inter specific derivatives of *C. scarabaeoides viz.*, (Pant A-2 X *C. scarabaeoides*)-14-1 (231.16). The mean number of trichome type D per microscopic field was ranged from 2.50 to 29.16 with a general mean value of 13.46. The maximum number of trichome type D were observed in ISD of *C. scarabaeoides viz.*, (Prabhat X *C. scarabaeoides*)-3-1-1 (29.16) followed by (Pant A-2 X *C. scarabaeoides*)-S-1 (25.66). (Prabhat X *C. scarabaeoides*)-3-3-1 (24.19) (Table 2).

In the present study, high genotype and phenotype coefficient of variation were observed for trichome type A (73.02, 82.16), trichome type B (44.47, 46.30), trichome type D (39.54, 41.00) and trichome type C (27.16, 27.29). The difference between genotype and phenotype coefficient of variation had lower magnitude indicating small effect of environment and selection may be effective. Similar results were reported by Romies *et al.* (1999).

Although GCV is indicative of the presence of high degree of genetic variation, the amount of heritable portion can only be determined with the help of heritability estimates and genetic gain. High values of heritability couple with high genetic advance were observed for trichome type C (95.5, 54.68), trichome type D (92.9, 78.54), trichome type B (92.2, 88.01) and trichome type A (78.9, 133.68) indicating the additive gene action and effective for phenotypic selection. While exploitation genetic variability, due weightage should be given to these characters for developing insect pest resistant genotype (Table 1).

The genotypic correlation provides a measure of genotype association among different characters and also helps in identifying the traits in selection programme (Table 2). In the present study positive and highly significant genotypic and phenotypic correlation were observed between grain yield and trichome type C (0.364) (Table 1 and 2). The seed yield also had positive significant correlation with other yield contributing characters *viz.*, number of pods per plant (0.953), number of secondary branches per plant (0.827), plant height (0.649) and number of primary branches per plant (0.567) similar observation recorded by Pande and Singh (2002), Nagy *et al.* (2013) and Saroj *et al.* (2013). However per cent pod damage should negative significant genotypic and phenotypic correlation with grain yield.

Thrichome type B exhibited significant positive correlation at genotypic and phenotypic level with plant height, number of primary branches per plant, number of pods per plant while it had negative significant correlation with per cent pod damage, 100 seed wt. and pod setting (%) (Table 3). Trichome type C

exhibited significant positive correlation with days to flower initiation, days to 50% flowering, plant height, number of primary branches per plant number of pods per plant and trichome type B while it had significant negative correlation with per cent pod damage, 100 seed wt. (gm), pod length. Trichome type D had significant positive correlation with days to 50% flowering and trichome type B. The negative correlation of trichome density and per cent pod damage was reported by Levin (1973) and Pournami *et al*. (2002).

Tripathi and Purohit (1984) observed that the variety with brown colour small sized seeds and green pods with streaks were least affected by pod borer. In the present study, result of qualitative observation revealed that the interspecific derivatives *viz.,* (Pant A-2 X *C. albicans*) - 29-2, ICPZ-332 and (Pant A-2 X *C. scarabaeoides*)-14-1 had mixed pod colour, no streaks or sparse streaks on standard petal (Plate 4, 5A and 5B) reddish brown seed coat colour and spreading growth habit (Plate 1, 2 and 3) having less than 5 per cent pod damage indication of some indication of pod borer tolerance however further bio-chemical confirmation is needs.

In the present study five promising interspecific derivatives *viz.,* ICPL-332, c (Prabhat X *C. scarabaeoides*) -3-2, (Pant A-2 X *C. scarabaeoides*) 27-2-2, ICPC 87119, and (UPAS 120 X *C. trinervius*)-5-1 were recorded highest yield coupled with low per cent pod damage and high number of non glandular trichomes C and D. hence these genotypes should be further evaluated for yield and other characters in future.

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