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Genetic analysis of early and medium duration pigeonpea [*Cajanus cajan* (L) Millsp.] crosses involving wilt resistant donor in F_1 and F_2 generations

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Abstract

The experiments consisting 55 crosses of pigeonpea made in half-diallel design along with 11 parents in F_1 and F_2 generations were conducted on vertisol under rain-fed condition. Genetic analysis revealed that both additive and non-additive genetic components of variance governed the expression of seed yield, pods per plant, pod clusters per plant and plant height, latter being predominant in both the generations. Stem girth and number of primary branches per plant were predominantly under the control of additive genetic components with significant role of non-additive genetic component. Whereas 100 seed weight was predominantly under the control of additive genetic components. Medium maturing parents, a wilt resistant donor, *viz.*, ICPL 87119 and JKM-7 were identified as good general combiner for seed yield and most of the contributing traits in both F_1 and F_2 generations except ICPL 87119 in F_2 generation for grain yield. Pant 142 was identified as good general combiner for earliness and grain yield in both the generations. These genotypes can be used in future breeding programme to exploit additive component of genetic variation to develop high yielding wilt resistant variety in medium maturing group. Cross combination showing significant specific combining ability effects possessed different maturity group parents with either one or both good general combing parents. Pant 142 × ICPL 87119, GAUT 8630 × ICPL 87119, Pant 142 × KM 84 and GAUT 9002 × ICPL 87119 recorded to be better cross combinations for yield and one or more attributing traits.

Key words: Pigeonpea, diallel cross, wilt resistant donors, genetic variances

Introduction

Pigeonpea [*Cajanus cajan* (L) Millsp.] is an often cross-pollinated important grain legume crop mainly grown under rain-fed conditions in India. Therefore, pigeonpea can be improved genetically following breeding methods suitable for both allogamous as well as autogamous crops. Selection of parent genotypes together with information on nature and magnitude of gene action controlling grain yield and its attributing characters is prerequisite while improving the plant type. An attempt has been made to study nature and magnitude of genetic variation in F_1 and F_2 generations of hybrids and their parents of different maturity groups of pigeonpea.

Materials and methods

Eleven diverse pigeonpea parents and their 55 crosses in half-diallel design were evaluated in F_1 and F_2 generations. Parents consisted indeterminate genotypes of different maturing duration groups i.e., 3 early maturing genotypes (Pant 142, KE 1 and Pusa 942) and 8 medium maturing genotypes, obtained form south, central and north-eastern zones of India. Among medium maturing genotypes, there were 2 high yielding wilt resistant donors (ICPL 87119 and JKM-7) and 6 high yielding medium maturing new genotypes developed at different pigeonpea centres (GAUT 9002, GAU.T 8630, JJAL 16, PBNA 67-1 and KM 84). These varieties were crossed in half-diallel fashion. Experiments on F_1 generation in kharif 1997 and F_2 generation in Kharif 1998 were conducted along with parents in randomised block design with two replications during rainy season on Vertisol with pH 8.5 at Zonal Agricultural Research station, Khargone, Madhya Pradesh. Each pot consisted 2 rows of 4 m length spaced at 60 × 20 cm for the parents and F_1s and four row plots of F_2s. Five plants in F_1 and parents and 20 plants in F_2 generation were selected at random in each plot for recording observations on grain yield and other attributes. Combining ability analysis was worked out in F_1 and F_2 generations according to Method 2 and Model 1 proposed by Griffing [1]. The predictability ratio ($2\sigma^2g/2\sigma^2g + \sigma^2s$) was calculated as suggested by Baker [2].

Results and discussion

Combining ability analysis presented in Table 1 revealed that general as well as specific combing ability variances were significant for yield and its attributing characters in both F_1 and F_2 generations except for grain yield and days to maturity in F_2 generation and 100 seed

Table 1. Analysis of variance for combining ability for yield and its attributes in F_1 and F_2 generations of pigeonpea

Source of variation	df	Grain yield (g/pl)	100 seed weight (g)	50% flowering (days)	75% maturity (days)	Plant height (cm)	Primary branches per plant	Middle br.length (cm)	Stem girth (cm)	Pods per plant	Pod clusters per plant
					F_1 generation						
gca	10	506.02**	1.809**	182.755**	121.336**	2080.48**	32.934**	269.853**	1.702**	19058.1**	5319.40**
sca	55	218.75**	0.771	61.322**	41.145**	341.11**	19.713**	132.964**	0.676**	5934.17**	1617.09**
Error	65	39.17	0.655	1.821	18.239	59.88	0.747	39.511	0.286	814.86	345.48
Genetic parameters											
σ^2g		44.20	0.16	18.68	12.34	267.60	2.03	21.06	0.16	2019.07	569.59
σ^2s		179.57	0.12	59.50	22.91	281.24	18.97	93.45	0.39	5119.31	1271.60
Predictability ratio		0.49	2.74	0.63	1.08	1.90	0.21	0.45	0.81	0.79	0.90
					F_2 generation						
gca	10	242.15**	0.59	111.28**	30.78	812.73**	8.84**	1130.08**	0.39**	2246.88**	751.40**
sca	55	130.84	0.68	51.89**	21.04	421.36**	2.87**	212.79**	0.22**	1179.87**	462.55**
Error	65	83.10	0.47	24.01	70.21	36.71	0.61	24.01	0.04	13.72	19.32
Genetic parameters											
σ^2g		17.13	0.72	9.14	1.50	60.21	0.92	141.12	0.03	164.16	44.44
σ^2s		47.73	0.20	27.88	–49.17	384.65	2.26	188.78	0.18	1166.15	443.22
Predictability ratio		0.72	–0.13	0.66	–0.06	0.31	0.81	1.50	0.30	0.28	0.20

*,**Significant at 5 and 1 per cent level respectively

weight in both generations for specific combing ability, thereby, indicating significant contribution of both additive as well as non-additive genetic components of variation in the expression of all these traits in both the generations. Similar findings were also reported earlier in different maturity groups of pigeonpea [3, 4, 5, 6, 8, 9 and 10]. Relatively similar significant magnitudes of additive and non-additive variances were recorded for plant height and days to 75 % maturity. Whereas 100 seed weight was predominantly under the control of additive component in F_1 generation. These findings were similar to those reported earlier in pigeonpea [5, 7].

The magnitudes of both general as well as specific combing variances in F_2 generation were significant for all the characters, except 100 seed weight and days to maturity for both variances and grain yield for specific combing variances, thereby, indicating that in F_2 generation also had significant contribution of both additive and non-additive genetic components of variation in the expression for these characters except for grain yield where additive variance was involved in the expression of the trait. Magnitudes of both additive as well as non-additive genetic components were relatively lower in F_2 generation compared to F_1 generation. The predictability ratio was near to unity or above for 100 seed weight, plant height, days to maturity and pod clusters per plant in F_1 generations thereby indicating greater importance of additive genetic components for expression of these traits. Whereas predictability ratio was lower than unity indicating greater importance of non-additive genetic components for grain yield and days to 50 % flowering in F_1 generation. However in F_2 generation, almost all characters showed predictability ratio lower than unity except middle branch length indicating greater importance of non-additive gene effects in controlling these traits.

General combing ability effects presented in Table 2 revealed that parents *viz.*, JKM 7 in both F_1 and F_2 generations, ICPL 87119, GAUT 8630.and KM 84 in F_1 generation identified as significant good general combiners for grain yield, whereas, Pant-142 recorded significant good general combiner in F_2 generation only. JKM 7 also expressed significant good general combiner for plant height, stem girth, pods per plant and pod clusters in both the generations except for plant height in F_2 generation. ICPL 87119 was identified good general combiner for plant height, primary branches per plant, middle branch length, pods per plant and pod clusters per plant. GAUT 9002 showed significant good general combiner for 100 seed weight but poor general combiner for the entire yield attributing characters except primary branches. Pant 142 identified as good general combiner for earliness as *gca* effect were negative and significant for days to 50 % flowering in both the generations and for maturity in F_1 generation. GAUT 8630 showed good general combiner for plant height, middle branch length and stem girth in both the generations. Early maturing parents, PUSA 942, UPAS 120 and PBNA 67-1 were also good general combiners for earliness in F_1 generation but were poor combiners for pods per plant and pod clusters per plant. In majority of cases, good general combiners also showed better *per se* performance thus it suggests that parent may be selected either on the basis of *gca* or *per se* performance or in combination.

Table 2. Estimates of general combining ability effects in F_1 and F_2 generation of pigeonpea for yield and its attributes

Genotypes	Grain yield g/plant		100 seed weight	50% flowering (days)		75% maturity (day)	Plant height (cm)		Primary branches per plant (no./plant)		Middle branch lengh (cm)		Stem girth (cm)		Pods per plant (no.)		Pod clusters per plant	
	F_1	F_2	F_1	F_1	F_2	F_2	F_1	F_2	F_1	F_2	F1	F_2	F_1	F_2	F_1	F_2	F_1	F2
1. GAUT 9002	2.63	−0.87	0.66**	0.71*	0.20	2.63*	−12.85**	−11.15**	1.15**	1.41**	−0.41	−24.54**	0.10	−0.29**	1.24	−6.68*	−1.06	−10.07**
2. Pant 142	−7.83**	6.89**	0.35	−2.52**	−7.19**	−2.91**	−16.85**	−7.57**	−1.75**	0.10	−7.40**	−0.23	−0.81**	0.04	−50.99**	1.23	−28.76**	−3.27*
3. GAUT 8630	8.20**	−4.80*	−0.55*	1.33**	2.35	2.48**	18.61**	15.04**	2.90**	−1.08**	6.68**	12.21**	0.39**	0.15**	4.55	9.98**	2.86	2.09
4. JJAL 16	−2.15	−5.24*	0.34	6.33**	1.12	0.94	5.76**	11.65**	0.49*	1.46**	2.24	6.11**	0.15	0.34**	4.48	26.97**	−2.60	15.57**
5. KE 1	−2.56	−1.47	0.381	−5.13**	−0.88	−1.52	6.61**	1.92	−1.62**	−0.51*	−1.62	5.72*	−0.07	−0.01	50.55**	2.52	8.63	4.26**
6. PBNA 67-1	−5.42**	−0.66	−0.22	1.25**	−1.50	0.78	−12.31**	−2.68	−0.21	0.40	−5.93**	1.69	−0.42**	−0.03	−69.91**	−11.53**	−35.76**	−4.76**
7. UPAS 120	−6.35**	−1.31	−0.31	−4.29**	−0.88	−4.22**	−11.93**	2.15	−1.93**	−0.72**	−2.49	0.36	−0.06	0.07	−18.37*	0.17	−11.60*	−0.35
8. ICPL 87119	11.07**	1.58	−0.15	1.64**	2.66*	2.40*	10.38**	1.27	1.25**	0.17	6.74**	3.87**	0.25	−0.01	35.71**	5.76*	26.71**	5.90"
9. KM 84	3.97*	−1.30	−0.05	3.87**	3.43**	3.40**	9.76**	−4.07*	1.56**	−0.55*	2.47	−3.52*	0.22	−0.18**	33.78**	−18.43**	27.40**	−8.63**
10. JKM 7	3.31*	8.76**	−0.24	1.79**	1.81	1.55	12.07**	0.37	−0.57*	−0.33	1.78	2.02	0.38*	0.10*	34.32**	7.11*	17.01**	5.49"
11. PUSA 942	−4.87	−1.57	−0.19	−4.98**	−1.11	−5.52**	−9.24**	−6.93**	−1.26**	−0.35	−2.07	−3.69**	−0.13	−0.17**	−25.37**	−17.10**	−2.83	−6.22**
SE (gi)	1.66	2.41	0.21	0.36	1.30	1.13	2.05	1.60	0.23	0.21	1.66	1.30	0.14	0.05	7.55	0.98	4.92	1.16

*,** Significant at 5 and 1 per cent level respectively.

Table 3. Estimates of specific combining ability effects in F_1 and F_2 generations of pigeonpea for yield and its attributes

Promising crosses	Grain yield g/plant		50% flowering (days)		75% maturity (days)	Plant height (cm)		Primary branches per plant (no)		Middle branch length (cm)		Stem girth (cm)		Pods per plant (no.)		Pod clusters per plant (no.)	
	F_1	F_2	F_1	F_2	F_1	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
GAUT 9002 × Pant 142	−10.04	−7.95	12.24**	0.04	9.96*	−1.05	−6.31	−0.21	0.14	7.40	−27.25**	0.39	−0.42*	16.59	13.23*	0.00	21.22**
GAUT 9002 × GAUT 8630	37.92**	6.33	−5.60**	−13.50*	−3.42	−11.51	−26.92**	−1.86*	0.31	−1.67	−39.69**	0.48	0.47*	21.05	9.48*	16.38	5.86
GAUT 9002 × JJAL 16	21.28**	−0.83	5.40**	−0.27	7.12	24.33*	−25.53**	-2.46*	−2.22*	25.77**	−30.59**	1.42*	−0.22	78.13*	−43.51**	1.85	−23.62**
GAUT 9002 × KE 1	21.68**	−11.79	−4.14**	1.73	−5.42	−19.51*	−13.79*	−2.64*	0.74	−2.37	4.80	−0.66	−0.37*	−52.95	0.94	−14.38	−5.31
GAUT 9002 × ICPL 87119	22.56**	6.36	3.09*	−1.81	−1.35	4.72	9.85	1.79*	2.06*	21.27*	9.65*	0.83	0.13	41.90	0.70	62.54*	−9.95*
GAUT 9002 × PUSA 942	−16.81*	3.31	−10.29**	3.96	9.58*	−18.67*	−6.15	−0.70	−0.62	−6.93	21.31**	−0.99	−0.01	42.97	−20.84**	−9.92	−10.52*
Pant 142 × GAUT 8630	−11.82*	14.57	−0.37	−8.12	−2.88	−19.51*	−5.79	−1.96	0.73	−10.69	−3.99	−0.40	−0.17	−38.72	−41.13**	−13.92	−17.74**
Pant 142 × ICPL 87119	22.52*	19.59*	1.32	7.58	6.19	11.72	20.67*	3.69**	−0.22	−9.75	−6.46	0.24	0.10	−25.87	−18.31**	−9.77	−9.85*
GAUT 8630 × JJAL 16	−17.80*	18.09*	−5.22**	−3.42	−5.73	−2.13	−25.21**	−2.81*	−3.03**	23.67*	−5.73	1.33*	−0.67*	69.82*	−44.57**	107.92**	−27.68**
GAUT 8630 × KE 1	−13.89*	−9.67	2.24	3.58	2.73	−17.97*	−5.08	−4.09**	−1.26	−1.47	−6.15	−1.15*	−0.42*	−66.26*	−28.32**	−53.31*	−20.17**
GAUT 8630 × ICPL 87119	27.78**	−0.72	−6.53**	1.04	−4.19	−11.74	6.87	−1.96*	−0.05	−11.33	12.21*	−0.76	0.28	78.59*	6.54	−34.38	−6.41
GAUT 8630 × JKM 7	14.24*	−21.50*	21.32**	2.88	1.65	16.56*	3.77	−3.75**	0.36	−20.07*	−0.14	−0.29	0.17	−105.03*	2.69	−41.69*	4.80
GAUT 8630 × PUSA 942	30.92**	−5.57	2.09	5.81	0.73	52.87**	11.87	18.54**	0.58	−7.02	14.87*	2.81**	0.34	89.67*	−10.00*	123.15**	−2.18
JJAL 16 × ICPL 87119	−21.16*	−4.98	2.47	7.27	2.35	−8.90	26.96**	−0.56	4.11**	−17.39*	5.21	−1.23*	0.75**	−111.3**	52.15**	−35.92*	27.52**
JJAL 16 × KM 84	−16.86*	−8.41	2.24	6.50	1.35	−10.28	1.70	2.14*	1.74*	−12.12	6.89	−1.40*	0.01	−119.4**	21.23**	−56.62*	42.55**
KE 1 × PUSA 942	15.18*	−10.89	0.55	−0.96	4.73	−0.13	−15.51*	−2.93*	0.81	−5.72	14.45*	−0.63	0.50*	−56.33*	32.27**	−35.62*	17.85**
ICPL 87119 × KM 84	−17.28*	7.78	−9.06**	−1.04	−10.12*	−12.90	−57.23**	−5.62**	−1.98*	6.38	−14.37*	0.71	−1.5**	−52.64	−60.55**	4.08	−27.38**
ICPL 87119 × JKM 7	−7.62	5.73	5.01**	0.58	1.73	14.79*	−12.26*	4.51**	−0.79	−1.93	2.50	0.55	0.14	−41.18	−16.79**	19.46	−9.61*
ICPL 87119 × PUSA 942	−14.45*	−12.94	5.78**	3.50	8.81*	11.10	6.84	4.20**	−0.68	-7.08	−11.39*	0.06	−0.49*	−31.49	−9.27*	−18.69	−10.59*
KM 84 × PUSA 942	25.15**	−7.07	0.55	0.73	−10.19*	3.72	12.87*	0.89	1.04	39.19**	7.49	0.58	0.27	190.44**	−3.09	73.62**	−5.06
JKM 7 × PUSA 942	1.31	39.88**	13.63**	0.35	−0.35	−17.59*	−22.26*	−1.99*	−0.87	−2.12	−11.64*	0.43	−0.40*	−81.10*	−27.13**	−16.00	−18.68**
UPAS 120 × PUSA 942	−4.59	19.94*	−2.29	9.04	−1.48	−3.59	4.65	−2.63	2.71*	−4.85	3.91	−0.63	0.33	−16.41	35.72**	−25.38	25.85**
SE (Sij)	6.03	8.79	1.30	4.72	4.12	7.46	5.84	0.83	0.75	6.06	4.72	0.52	0.18	27.52	3.57	17.92	4.24

*,** Significant at 5 and 1 per cent level respectively

The magnitude and direction of specific combing ability effects is of vital importance in selecting with higher probability of obtaining desirable transgressive segregates. Specific combing ability effects showed that only 18 crosses recorded significant *sca* effects in F_1 and 4 crosses in F_2 generations for grain yield (Table 3). Out of these, 8 crosses in F_1 and 4 crosses in F_2 generations showed significant positive *sca* effects for grain yield indicating good specific combining crosses for grain yield. Pant 142 × ICPL 87119 showed significant positive *sca* effects in both the generations for grain yield and primary branches per plant, thereby indicating consistent good specific cross combination for both grain yield and primary branches. The consistency in *sca* effect observed over generations might be attributed to both additive and non-additive gene action in positive direction. In F1 generation, 36 crosses and in F_2 generation 4 crosses showed significant sea effects for days to 50 % flowering but only 18 and 4 crosses were good specific combining crosses for early flowering in F_1 and F_2 generation, respectively. Direction of *sca* effect for days to 50 % flowering changes positive to negative and vice versa with changes in generations may be attributed to non-additive gene interaction in different directions in different generations. GAUT 9002 × GAUT 8630 was identified as good specific combining cross for grain yield in F_1 generation, for stem girth and pods per plant in F_2 generation and for earliness in both the generations. KM 84 × PUSA 942 was good specific cross combination for grain yield, middle branch length, pod clusters per plant and early maturity in F_1 generation and for plant height in F_2 generation. GAUT 9002 × KE 1 and JKM 7 × PUSA 942 were identified good specific cross combinations consistent for smaller plant height in both generations and for grain yield former cross in F_1 and latter cross in F_2 generation. GAUT 9002 × ICPL 87119 was identified good specific combiner for primary branches per plant and middle branch length in both the generations and for grain yield in F_1 generation. UPAS 120 × PUSA 942 was the only cross recorded good specific combiner for grain yield, primary branches per plant, pods per pant and pod clusters per pant in F_2 generation. It was observed that crosses showing significant specific combining ability effects possessed different maturity group parents with either one or both good general combing parents for grain yield and good specific combiner for one or more yield attributing traits in both the generations. The present results are in agreement with earlier reports [4, 8 and 10].

In the present material additive and non-additive components of genetic variation showed significant contribution for the expression of grain yield and attributing traits in both F_1 and F_2 generations, thereby, suggested that choice of parents for developing high yielding pigeonpea variety could be based upon *gca* effect, while for exploitation of heterosis, breeding should be based on *sca* effects. Bi-parental inter-mating of selected plants in early segregating generation involving high *sca* effect in positive direction and high *per se* performance for grain yield and component traits would effectively exploit both additive and non-additive genetic variances.

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