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Combining Ability Analysis of Yield and Yield Components in Pigeonpea [*Cajanus cajan* (L.) Millsp.]

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ABSTRACT

An attempt was made to develop early duriation high yielding hyrids and to study the genetics of various characters in pigeonpea. Three lines and twenty one early duration testers were selected for the study. The characters *viz.,* days to fifty per cent flowering, days to maturity, plant height, branches per plant and pods per plant were controlled by additive gene action, while the traits viz., clusters per plant, seeeds/pod, pod length, 100 seed weight and seed yield per plant were controlled by non-additive gene action. The hybrid combinations viz., ms CO5 x ICPAL 83027, ms CO5 x ICPL 83024, msCO5 X ICPL 87105 and ms CO5 x ICPL 87 were the best performing early duration high yielding hybrids, which can be exploited commercially.

Key words : Gene Action, Hybrids, Pigeonpea

Pigeonpea is one of the major pulse crops grown in India. It occupies an area of 3.47m ha next to chickpea with a productivity of 799 kg/ha. In Tamil Nadu, it is cultivated in an area of 1.40 lakh hectares with a production of 1.20 lakh tonnes. The production remains constant for the last one decade and hybrid breeding is the only way to increase the productivity. Hence, the present investigation was carried out with the objective of developing high yielding early duration hybrids and also to study the gene action of yield components to improve the grain yield.

MATERIAL AND METHODS

The experimental material consisted of three genetic male sterile lines viz., ms CO 5, ms Prabhat DT and ms Prabhat NDT and twenty one early cultures of pigeonpea as testers. The experiment was conducted at Millet Breeding Station, Tamil Nadu Agricultural University, Coimbatore during *kharif* 2004. The three lines (female parents) and 21 testers(male parents) were raised and crossed in a linex tester fashion to get 63 cross combinations. Ten important characters viz., days to fifty per cent flowering, days to maturity, plant height, branches per plant, clusters per plant, pods per plant, seeds per pod, pod length, hundred seed weight and seed yeld per plant were recorded. The combining ability analysis was done as per Kempthorne (1957).

RESULTS AND DISCUSSION

The analysis of variance for combining ability of ten characters (Table1) revealed that estimates of treatment sum of squares were statistically significant for all the characters except for seeds per pod, pod length and hundred seed weight. The total variance was partitioned into variance due to GCA of parents and variance due to SCA of hybrids (Table2). The estimates fo variance due to GCA and SCA showed that days to fifty per cent flowering, days to maturity, plant height, branches per plant and pods per plant were under the influence of additive gene action, in accordance to Patel et al.(1992); Vanniarajan, (1993); Manivel and Rangasamy(1998), while the remaining traits under study showed that they were predominantly controlled by non-additive gene action. Similar resuts were reported by Srinivas *et al.,* (1998), Jayamala (1997), Banu *et al.,* (2006), Baskaran and Muthiah (2007), Phad *et al.,*(2007).

The estimates of *gca* effects (Table 3) suggested that the parents such as ms Prabhat DT.ICPL 88039, ICPL 92007 and ICPL 92010 for days to fifty per cent flowering and maturity; ms CO5, ICPL 87105, ICPL 87 and ICPL 86020 for plant height; ms Prabhat NDT, ICPL 87105, ICPL 92009 and ICPL 92010 for branches per plant; ms CO5 , ICPL 88034, ICPL 92009, ICPL 83027, ICPL 83024 and ICPL 86023 for clusters per plant; ms CO5, ICPL 87, ICPL 84031,ICPL 86005,ICPL 86020, ICPL 87105,ICPL 83027 and ICPL 83024 for pods per plant; ms Prabhat DT, ICPL 86005, ICPL 86023, ICPL 87104 and ICPL 84052 for seeds per pod. msCO5, ICPL 83027, ICPL 86005, ICPL 84052 and ICPL 87104 for pod length; msCO5,ICPL 87105, ICPL 83027, ICPL 83024, ICPL 87 and ICPL 84031 for hundred seed weght; msCO5, ICPL 87105,ICPL 83027, ICPL 86005 and ICPL 86015 for seed yield per plant were the best general combiners for their respective traits.

The scal effects were negative and significant in the cross combinations viz., ms Prabhat DT x ICPL 86020 and ms Prabhat Dt x ICPL 87105 wherein one good and over poor combiner were involved. Either biparental approach or reciprocal recurrent selection procedure may be practiced to obtain early segregants from transgressive variants. The best hybrids namely, ms CO 5 x ICPL 92008, and ms Prabhat NDT x ICPL88034 are poor combiners as their parents. The involvement of dominance gene action in these combinations force the selection in later generations for obtaining desired segregants (Table 4).

With regard to days to maturity, the *sca* effects were negative and significant in the cross combinations viz., ms Prabhat DT X ICPL 87105, ms Prabhat DT x ICPL88001 and ms Prabhat DT x ICPL 8809 whcich had one parent as good combiner and may show transgressive segregants for different maturity groups. Hence, there is a possibility for getting early genotypes if cyclic type or random mating method may be adopted as breeding procedure. The remaining best combinations were ms CO5 x ICPL 92008, ms Prabhat NDT x ICPL 87 and ms Prabhat NDT x ICPL 88934 which had poor combiners as their parents. Selection has to be postponed to later generations for obtaining early variants.

For plant height, the hybrids, msCO5 x ICPL 92007, ms CO5 x ICPL 83024, ms Prabhat DT x ICPL 86020 and ms Prabhat DT x ICPL 87105 showed negative and significant *sca* effects where in one parent was good combiner. Since, the line ms Prabhat DT is determinate, its combination produced somewhat above average yield. These hybrid combinations could be exploited for developing short stature segregants for intercropping systems. The hybrids ms Prabhat NDT x ICPL 87104, ms Prabhat NDTx ICPL 88001, ms Prabhat NDT x ICPL 88009, ms Prabhat NDT x ICPL 92008 and ms Prabhat NDT x CORG 9060 also showed significant and negative *sca* effects, which involve poor combiners as parents. From the future generations of the above combinations, there is a chance of obtaining dwarf genotypes. The hybrid ms Prabhat NDT x ICPL84031 showed significant and positive *sca* effects for branches per plant which involved only one good combiner, whereas the hybrid ms CO5 x ICPL 87104 and ms Prabhat DT x ICPL 84052 had poor combiners and showed positive and significant *sca* effects along with high mean performance. Postponement of selection to later generation would ease the task of getting desired types. The hybrid, ms Prabhat NDT x ICPL 92010 had good combiners as parents, which is an exceptional source for exploitation of developing varieties through pedigree system of breeding.

Among the good combiners ms CO5, ICPL 83024 and ICPL 83027 alone exhibited positive and significant *sca* effects for clusters per plant. The fixable additive gene action in this combination could be advantageously utilised for developing varieties with more number of clusters per plant, especially the hybrid ms CO5 x ICPL 83027 established its superiority with high *per se* performance for yield (53.18).

The hybrid ms Prabhat DT x ICPL 87105 showed positive significant *sca* effects for pod number. The involvement of good and poor combiner may throw transgressive segregants. This will provide a chance to select segregants for more number fo pods. The poor combiners also produced hybrids with significant *sca* effects in the combination of ms Prabhat DT x ICPL 86015, ms Prabhat DT x ICPL 88034 and ms Prabhat NDT x CORG 9060. Delayed selection in these combinations would help to realize genotypes with more number of pods.

The hybrids in the present study did not show considerable variation for seeds per pod. The hybrids ms CO5 x ICPl 87, msCO5 x ICPL 86023, ms CO5 x ICPL 87105, ms CO5 x ICPL 92010, ms Prabhat DT x ICPL 86015 and ms Prabhat DT x ICPL 87105 recorded positive and significnat *sca* effects and possessed good *per se* performance for yield also. The hybrids, ms CO5 x ICPL 88001, ms CO5 x UPAS 120, ms Prabhat DT x ICPL 92007, ms Prabhat DT x ICPL 83027 and ms Prabhat NDT X ICPL 92010, recorded positive and significnat *sca* effects for pod length. Hundred seed weight is an important yield component. Cultivars vary widely for this trait. Large seeded types are generally poor pod setters (Remanandan, 1990). The hybrids ms CO5 X ICPL 83027, ms CO5 x ICPL 87 and ms CO5 x ICPL 84031 had good combiners as parents for obtaining heavy seeded segregants. The appropriate breeding method is simple pedigree in these combinations.

The high correlation between grain yields especially with number of pods per plant, demonstrated that number of pods per plant is a reliable indicator of yield. In the present investigation the hybrids ms Prabhat DT x ICPL 87105, ms CO5 x ICPl 83027, ms CO5 x ICPl 87 and ms CO5 x ICPL 84031 showed positive and significant *sca* effects for seed yield. The pod number of these hybrids was also high. The parents of these hybrids contained more number of favourable alleles.

Table 1. Analysis of variance for combining ability from line x tester experiment in pigeonpea [*Cajanus cajan* (L.) Millsp.]

		Mean sum of square		
Source of variation	Lines (C)	Tester(T)	L xT	Error
Degrees of freedom	2	20	40	258
Characters				
Days to 50% flowering	30.58**	108.43**	49.22**	1.77
Days to maturity	189.25**	221.21**	158.36**	2.16
Plant height(cm)	4214.66**	4033.46	1224.56**	64.01
Branches/plant	7.71*	11.40**	9.94**	2.12
Clusters/plant	3349.52**	350.79**	947.30**	60.24
Pods/plant	14510.05**	3499.15**	3821.65**	122.23
Seeds/pod	0.33	18.44**	0.16	0.42
Pod length	0.07	50.56**	0.42**	0.17
100 seed weight	0.01	0.58**	0.31**	0.03
Seed yield/plant	733.06**	199.13**	325.84**	2.20

** significant at 1 per cent level * Significant at 5 per cent level

Table 2. Estimates of variance components from line x tester experiment of pigeonpea [*Cajanus cajan* (L.) Millsp.]

		Estimates of variance component			
Characters	σ^2l	σ^2testers	σ^2gca	σ^2sca	σ^2gca/sca
Days to 50% flowering	45.68**	22.66**	16.50**	16.01**	1.03
Days to maturity	65.53**	10.19**	85.50**	38.98**	2.19
Plant height(cm)	51.92**	18.76**	466.74**	289.34**	1.61
Branches/plant	13.32**	36.24**	0.65	1.94**	0.33
Clusters/plant	20.69**	18.65**	71.98**	219.59**	9.32
Pods/plant	23.36**	20.95**	361.15**	920.82**	0.39
Seeds/pod	11.79	39.15**	0.07**	0.00	0.70
Pod length	4.49	36.80**	0.01	0.08	0.11
100 seed weight	1.78	80.36**	0.03**	0.06**	0.50
Seed yield/plant	30.78**	24.06**	498.93**	814.59**	0.61

** significant at 1 per cent level * Significant at 5 per cent level

Table 3. Estimates of general combining ability effects of lines and testers for different characters in pigeonpea [*Cajanus cajan* (L.) Millsp.]

Parents	Days to 50% flowering	Days to maturity	Plant height(cm)	Branches/ plant	Clusters/ plant	Poda/ plant	Seeds/ Plant	Pod length	100 seed weight	Seed yield/ plant
ms CO5	4.05**	11.02**	23.46**	0.32*	7.54**	21.99**	0.43**	1.01**	0.05**	8.19**
ms Prabhat DT	-4.07**	-7.77**	-21.89**	-0.90**	-9.62**	-15.36**	0.68**	-0.47**	0.04**	-5.68**
ms Prabhat NDT	-0.08	-3.25**	-1.57*	0.57**	2.08*	-6.63**	-1.12**	-0.53**	-0.09	-2.51*
SE	0.15	0.16	0.88	0.15	0.90	1.28	0.04	0.03	0.02	1.08
ICPL 87	3.29**	3.42**	14.31**	0.57	-1.26	5.89	1.53**	3.23**	0.57**	1.66
84031	-0.36	-1.65**	-11.97**	-1.06**	-1.15	4.82	-1.55**	1.07**	0.53**	1.95
84-052	4.13**	3.67**	17.93**	-0.21	-5.66**	-7.28	1.86**	2.07**	-0.62**	0.00
86005	0.71*	3.42**	-6.79**	-1.96**	-5.28*	13.53	2.90**	3.90**	-0.36**	7.83**
86015	0.96**	-0.57	7.01**	-0.04	4.34*	5.97	0.38**	-1.84**	-0.11	6.37*
86020	0.46	-0.07	11.19**	-0.31	1.08	-6.39	0.69**	-1.59**	-0.45**	-1.56
86023	3.13**	4.92**	17.71**	-0.33	4.61*	0.87	2.53**	0.07	-0.50**	3.00
87104	1.54**	0.01	-3.51	-0.94*	-5.24*	1.82	1.94**	1.82**	-0.03	1.45
87105	1.63**	3.76**	19.71	1.60**	13.40**	41.83**	-0.63**	1.32**	0.90**	17.18**
88001	-0.03	0.262	-8.93**	-1.40**	-13.74**	-29.40**	0.10	-1.09**	-0.22**	-11.24**
88009	-2.78**	-1.90**	-6.40**	-0.20	-3.23	-2.12	0.36**	-2.01**	-0.66**	0.05
88034	-3.03**	-0.73*	6.91**	1.30**	9.93**	22.87*	0.38*	-0.76**	-0.25**	3.06
88039	-3.45**	-6.07**	-16.22**	-2.30**	-13.25**	-24.08**	-0.71**	-1042**	-0.19**	-4.63**
92007	-3.53**	-0.67**	-14.25**	0.26	-4.84*	-7.99	0.94**	1.40**	-0.07	-2.93
92008	-0.53	2.34**	0.02	1.09**	2.51	-7.31	-0.63**	0.23**	-0.17**	-7.96*
92009	0.04	3.26**	-1.80	1.50**	8.74**	2.33	-1.21**	-2.76**	-0.31**	-1.65
92010	-3.70**	-5.23**	-12.59**	1.28**	-1.33	-17.35*	-2.13**	-0.92**	-0.24**	-5.64*
83027	-2.53**	-2.23**	-4.06*	0.31	6.97**	-1.06	0.03	3.32**	-0.90**	10.66**
83024	-1.45**	-1.73**	-13.83**	0.66	4.61*	45.13**	-0.96**	-3.59**	0.61**	1.67
UPAS 120	3.46**	2.01**	4.36*	0.13	-2.25	-12.04	-1.13**	-0.67	0.32**	-1.30
CORG 9060	2.04**	-0.82*	1.75	0.04	1.41	9.98	-1.96**	-1.76**	0.37**	-3.09
SE	3.96	0.22	2.33	0.41	2.39	3.39	0.12	0.08	0.05	2.86

** Significant at 1% probability level * Significant at 5% probability level

Table 4. Crosses showing desirable sca effects (top five performaers) for different characters in pigeonpea [*Cajanus cajan* (L.) Millsp.]

Days to 50% flowering	Days to maturity	Plant height(cm)	Branches/ plant	Clusters/ plant	Pods/ plant	Seeds/ pod	Pod length	100 seed weight	Seed yield/ plant
L_1 x T_1	L_1 x T_5	L_1 x T_2	L_1 x T_7	L_1 x T_{18}	L_1 x T_1	L_1 x T_1	L_1 x T_1	L_1 x T_{19}	L_1 x T_1
L_1 x T_3	L_1 x T_6	L_1 x T_7	L_2 x T_{12}	L_1 x T_{19}	L_1 x T_2	L_2 x T_{21}	L_1 x T_{20}	L_2 x T_{20}	L_1 x T_2
L_2 x T_2	L_2 x T_2	L_2 x T_{21}	L_2 x T_{21}	L_2 x T_9	L_2 x T_{18}	L_3 x T_{12}	L_2 x T_{21}	L_3 x T_7	L_1 x T_{18}
L_3 x T_1	L_2 x T_6	L_3 x T_{11}	L_3 x T_{17}	L_3 x T_{15}	L_2 x T_{12}	L_3 x T_{16}	L_3 x T_{16}	L_3 x T_{11}	L_3 x T_{13}
L_3 x T_{11}	L_3 x T_1	L_3 x T_{15}	L_3 x T_{18}	L_3 x T_{21}	L_3 x T_{21}	L_3 x T_{20}	L_3 x T_{17}	L_3 x T_{16}	L_3 x T_{19}

L_1 - msCO5, L_2 - ms Prabhat DT, L_3 -ms Prabhat NDT, T_1 - ICPL 87, T_2 - ICPL 84031, T_3-ICPL84052, T_4-ICPL 86005, T_5-ICPL 86015, T_6-ICPL 86020, T_7-ICPL 86023, T_8-ICPL 87104, T_9-ICPL 87105, T_{10}-ICPL 88801, T_{11}-ICPL 88009,T_{12}-ICPL 88034, T_{13}-ICPL 88039, T_{14}-ICPL 92007, T_{15}-ICPL92008, T_{16}-ICPL92009, T_{17}-ICPL 92010, T_{18}-ICPL 83027, T_{19}- ICPL 83024.

Pedigree selection in these combinations would yield high yielding segregants. The superior high yielding hybrid combinations *viz.,* ms CO5 x ICPL 83027, ms CO5 x ICPL 83024, ms CO5 x ICPL 87105 and ms CO5 x ICPL 87 resulted from good combiners could also be used for developing good segregants.

LITERATURE CITED

Banu R M Muthiah A R and Ashok S 2006 Combining ability studies. Crop Research 31(3):396-398

Baskaran K and Muthiah A R 2007. Studies on combining ability in pigeonpea [*Cajanus cajan* (L.) Millsp.] Legume Research 30(1):67-69.

Jayamala P 1997. Heterosis, combining ability and inbreeding depression in pigeonpea [*Cajanus cajan* (L.) Millsp.] M.Sc(Ag.) Thesis. Tamil Nadu Agricultural University, Coimbatore pp.119-135.

Kempthorne O 1957. An Introgduction to Genetic Statistics. John Wiley and Sons Inc., New York. pp.222-240

Manivel P and Rangasamy P 1998. Influence of environment on heterosis and combining ability in pigeonpea. Annals of Agricultural Research 19:133-138

Patel G V, Zaveri P P and Pathak A R 1992. Combining ability analysis of parents and hybrids using genic male sterility in pigeonpea. The Indian Journal of Genetics and Plant Breeding 52:292-296

Phad D D, Madrap I A and Dalvi V A 2007. Studty of combining ability analysis in pigeonpea under different environments for yield contributing characters. Legume Research 30(2):123-127.

Remanandan P 1990. Pigeonpea: Genetic resources. In:*Pigeonpea* (Eds) Y L Nene, Susan D Hall and V K Sheila. CAB International, Walligford, Oxon Ox108DE, UK pp.301-340.

Srinivas T, Jain K C and Reddy M S S 1998. Combining ability studies of sterility mosaic resistant pigeonpea [*Cajanus cajan* (L.) Millsp.] Crop Research **15**:99-103

Vanniarajan C 1993. Heterotic vigour in pigeonpea [*Cajanus cajan* (L.) Millsp.] hybrids over different environments Ph.D. Thesis. Tamil Nadu Agricultural University, Coimbatore pp. 205-210

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