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Combining Ability in CMS/GMS Based Pigeonpea *(Cajanus cajan (L.)* Millsp.,) Hybrids

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Twenty seven hybrids were developed utilizing three lines (two CMS and one GMS) and nine testers and their hybrids were evaluated for ten characters in order to understand the gene action in pigeonpea. The combining ability analysis revealed that variances due to dominance was higher than variances due to additive for all characters indicating the preponderance of non additive gene action governing these traits. Among the lines, MS CO5 and among the testers, CORG 9060, PA 128, CORG 7 and ICPL 83027 were the best general combiners for seed yield. Most of the crosses showing significant *sca* effects involved one good and one poor or even negative general combiners. The crosses MS CO 5 x CORG 9060, MS CO 5 x PA 128, MS CO5 x CORG 7 , MS CO5 x ICPL 83027 and CORG 990047 A x APK 1 would be suitable for exploiting heterosis for increased pod in pigeonpea.

Key words: Pigeonpea, lines, testers, high yield, combining ability, gene action.

Pigeonpea is one of the major grain legume crops of the tropics and sub tropics. Endowed with several unique characteristics, it finds an important place in the farming systems adopted by small holders farmers in a larger number of developing countries. Seed protein content in pigeonpea (approximately 21%) compares well with that of other important grain legumes. In hybrid breeding programme, success depends upon the choice of parents and a clear knowledge about gene action governing specific trait. Combining ability is one of the most effective tool for deciding the appropriate parents for hybridization. General combining ability is attributed to additive gene effects and additive x additive epistasis and is theoretically fixable. On the other hand, specific combining ability attributable to non additive gene action may be due to dominance or epistasis or both and is non fixable. The presence of non additive genetic variance is the primary justification for initiating the hybrid programme (Cockerham,1961). Identification of genic and cytoplasmic genic male sterility and the presence of considerable degree of natural out crossing in pigeonpea have made it possible to exploit hybrid vigour through the economic production of heterotic hybrids. The present study was thus carried out to estimate the combining ability of pigeonpea genotypes for yield and component traits.

Materials and Methods

The present investigation was performed with three lines of which two CMS lines *viz.,* CORG 990052A, CORG 990047A and one GMS line MS CO5 and nine testers *viz.,* VBN 1, ICPL 87, CORG 9060, ICPL 84031, AL 601, PA 128, CORG 7, ICPL 83027 and APK 1 were crossed in a L x T mating design. The experiment was conducted at Agricultural College and Research Institute, Madurai during 2006-07. Twenty seven F_1s along with standard check VBN 1 were grown in a RBD with three replications. Each genotype was sown in a single row of 4.5 meter length with a spacing of 60 x 30 cm. Recommended agronomical practices were adopted for optimum crop growth and full phenotypic expression of genetic potential. Ten plants were selected at random from each genotype for the purpose of recording observations on days to 50% flowering, days to maturity, plant height (cm), number of branches/plant, number of pods/plant, number of seeds/pod, hundred grain weight (g), seed protein content (%), harvest index (%) and single plant yield (g). Combining ability estimates of parents and crosses were estimated for L x T method described by Kempthorne (1957).

Results and Discussion

The combining ability analysis (Table 1) revealed that differences due to hybrids, lines and testers were significant for all the characters. Difference due to line x tester interaction was also significant for all the characters. For all the characters, SCA variance was higher than GCA variance. High dominance genetic variance than additive genetic variance was noticed for all the ten characters indicating the preponderance of non additive gene action governing these traits. Similar results for non additive gene action governing the characters *viz.,* days to initial flowering, days to maturity, plant height, number of primary branches/plant, harvest index and single plant yield were reported by Reddy Sekhar *et al.* (2004) and Pandey (2004).

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Table 1. Analysis of variance of combining ability for different traits

Source	df	Mean squares									
		Days to 50% flowering	Days to maturity	Plant height (cm)	Number of branches / Plant	Number of pods / plant	Number of seeds / pod	Hundred grain weight(g)	Protein content (%)	Harvest index (%)	Single plant yield(g)
Hybrids	26	52.64**	61.64**	586.3**	3.32**	1635.3**	0.99**	6.82**	10.52**	278.5**	1082.0**
Lines	2	260.9**	553.4**	2339.8**	2.05**	1030.7**	6.66**	20.81**	18.01**	287.1**	6015.4**
Testers	8	29.19**	17.84**	368.0**	5.10**	1046.7**	0.63**	3.82**	19.31**	174.3**	944.1**
Line x Testers	16	38.32**	22.07**	476.2**	2.58**	2005.2**	0.47**	6.57**	5.19**	329.6**	534.3**
GCA		0.29	0.81	2.27	0.01	-7.63	0.01	0.005	0.11	-1.05	11.30
SCA		35.31	62.65	344.6	1.02	484.0	0.81	3.44	4.28	92.10	787.4
A (F=0)		0.59	1.63	4.54	0.03	-15.26	0.02	0.01	0.22	-2.10	22.60
D (F=0)		35.31	62.65	344.6	1.02	484.0	0.81	3.44	4.28	92.10	787.40
Error	76	0.01	0.01	0.12	0.0004	0.236	0.0001	0.001	0.0009	0.03	0.12

** - Significant at 1% level * - Significant at 5% level

Character wise estimation of *gca* effects of lines and testers are presented in Table 2. The GMS line MS CO5 recorded significant *gca* effects for days to maturity, plant height, number of pods per plant, number of seeds per pod, protein content, harvest index and single plant yield. The CMS line CORG 990047A showed significantly negative *gca* effects for days to 50 per cent flowering and days to maturity and significantly positive *gca* effects for number of branches per plant, hundred grain weight and harvest index. The testers PA 128 and CORG 7 had favourable and significant *gca* effects for plant height, number of branches per plant, number of pods per plant, hundred grain weight, protein content, harvest index and single plant yield. Tester ICPL 83027 was good combiner for days to maturity, plant height, number of branches per plant, number of pods per plant, number of seeds per pod and single plant yield. Tester CORG 9060 was good combiner for number of pods per plant, hundred grain weight and single plant yield. The parents having high *gca* effects could be useful for producing transgressive segregatns since the *gca* effects are mainly due to additive gene effects and is easily fixable (Sprague

Table 2. General combining ability effects of parents

Source	Mean squares									
	Days to 50% flowering	Days to maturity	Plant height (cm)	Number of branches / Plant	Number of pods / plant	Number of seeds / pod	Hundred grain weight(g)	Protein content (%)	Harvest index (%)	Single plant yield(g)
LINES										
CORG 990052 A	-2.57**	4.88**	2.45**	0.01**	-5.14**	0.04**	0.85**	0.61**	-3.41**	-10.07**
CORG 990047 A	-0.87**	-0.84**	-10.29**	0.26*	-1.70**	-0.51**	0.03**	-0.92**	0.32**	-7.07**
MS CO 5	3.45**	-4.04**	7.83**	-0.28**	6.85**	0.47**	- 0.89**	0.31**	3.08**	17.14**
SE	0.02	0.02	0.06	0.004	0.09	0.002	0.006	0.005	0.03	0.06
TESTERS										
VBN 1	0.15**	1.28**	-7.77**	-0.40**	-3.14**	0.01**	0.13**	-2.29**	4.85**	-7.29**
ICPL 87	-0.93**	0.88**	-6.93**	-0.99**	-22.48**	-0.19**	1.02**	-2.11**	-3.59**	-12.29**
CORG 9060	2.23**	1.26**	-3.83**	-0.13**	2.85**	-0.44**	0.08**	- 0.18	-4.41**	5.03**
ICPL 84031	-2.23**	-0.41**	2.22**	0.37**	-2.81**	-0.03**	-1.39**	0.43**	0.49**	-9.29**
AL 601	-2.53**	0.36**	4.17**	-0.56**	3.85**	-0.04**	0.13**	0.55**	-0.70**	-8.62**
PA 128	-2.20**	0.60**	3.65**	0.43**	13.51**	-0.16**	0.15**	1.41**	3.55*	6.37**
CORG 7	0.62**	-0.14**	0.72**	0.71**	11.18**	0.35**	0.37**	0.55**	7.46**	18.37**
ICPL 83027	1.24**	-0.57**	12.17**	1.29**	4.51**	0.38**	-0.07**	-0.47**	-4.40**	8.37**
APK 1	2.41**	-3.28**	-4.40**	-0.73**	-7.48**	0.13**	-0.44**	2.09**	-3.24**	-0.62**
SE	0.04	0.03	0.11	0.007	0.16	0.003	0.01	0.009	0.06	0.11

**- Significant at 1% level *- Significant at 5% level and Tatum, (1942) and Jagtap (1986). Hence, for the improvement of yield in pigeonpea, MS CO5 among the line and PA128, CORG 7, ICPL 83027and CORG 9060 among the testers could be involved in the recombination breeding programme. Similar results for significant *gca* effects for protein content, hundred seed weight, number of seeds per pod, number of pods per plant, days to 50 percent flowering, number of pods per plant were reported by Khorgade *et al.* (2000) and significant *gca* effects for number of pods per plant and single plant yield were recorded in pigeonpea by Pandey and Singh (2002). Phad *et al.* (2007) also reported good general combiners in pigeonpea for plant height, primary branches per plant, number of pods per plant, grain yield per plant, hundred seed weight and harvest index in pigeonpea.

Specific combining ability of 27 hybrid combinations were studied (Table 3). Hybrid MS CO

Table 3. Specific combining ability effects of hybrids

Hybrids	Mean squares									
	Days to 50% flowering	Days to maturity	Plant height (cm)	No.of branches / Plant	No.of pods / plant	No.of seeds / pod	Hundred grain weight(g)	Protein content (%)	Harvest index (%)	Single plant yield(g)
CORG 990052 A x VBN 1	1.86**	0.07	4.01**	-0.83**	-18.85**	-0.68**	-0.35**	-1.33**	8.13**	0.07
CORG 990052 A x ICPL 87	0.20**	-1.52**	-5.93**	0.75**	-4.51**	-0.46**	0.25**	-1.21**	-0.08	10.07**
CORG 990052 A x CORG 9060	-0.17*	-1.39**	8.09**	-1.40**	-24.85**	-0.21**	-2.42**	1.78**	0.73**	-7.25**
CORG 990052 A x ICPL 84031	2.29**	0.77**	13.71**	0.18**	30.81**	0.17**	-1.28**	1.26**	10.25**	11.07**
CORG 990052 A x AL 601	1.27**	0.50**	7.76**	1.02**	10.14**	0.08**	1.05**	0.94**	-2.97**	11.40**
CORG 990052 A x PA 128	-2.46**	0.96**	7.27**	-0.07**	14.48**	0.25**	0.43**	0.63**	-9.96**	-7.59**
CORG 990052 A x CORG 7	-1.03**	-0.49**	-1.78**	0.57**	-3.18**	0.18**	2.05**	0.51**	-0.80**	-10.59**
CORG 990052 A x ICPL 83027	-1.36**	-1.06**	1.51**	0.46**	7.48**	0.45**	- 0.12**	-1.65**	0.71**	-0.59**
CORG 990052 A x APK 1	-0.60**	2.15**	-34.65**	-0.69**	-11.51**	0.20**	0.38**	-0.92**	- 5.99**	-6.59**
CORG 990047 A x VBN 1	3.06**	2.50**	-3.54**	0.86**	18.70**	0.38**	0.20**	0.30	-9.77**	7.07**
CORG 990047A x ICPL 87	5.00**	3.80**	0.94**	-0.79**	31.03**	0.35**	2.27**	1.58**	6.17**	-2.92**
CORG 990047 A x CORG 9060	-4.12**	4.15**	-2.48**	0.29**	41.70**	0.35**	0.93**	-1.34**	3.60**	-5.25**
CORG 990047 A x ICPL 84031	0.10	0.50**	-3.54**	-0.45**	-29.62**	0.19*	0.60**	-1.74**	8.75**	9.07**
CORG 990047 A x AL 601	-1.31**	-1.86**	-7.15**	-0.19**	-22.29**	-0.04**	-0.90**	-1.21**	-15.04**	3.40**
CORG 990047 A x PA 128	-2.14**	-2.20**	-4.17**	-0.01	-36.96**	-0.33**	-0.64**	0.08	5.70**	-16.59**
CORG 990047 A x CORG 7	0.13	-1.56**	1.95**	0.52**	-11.62**	0.02**	-2.07**	0.22	1.78**	1.40**
CORG 990047 A x ICPL 83027	2.32**	-1.19**	-3.09**	-1.23**	-8.96**	-0.48**	-0.36**	1.50**	-8.57**	-6.59**
CORG 990047 A x APK 1	-3.04**	-4.14**	21.09**	1.00**	18.03**	-0.47**	-0.03	0.61**	7.37**	10.40**
MS CO5 x VBN 1	-4.93**	-2.58**	-0.46*	- 0.03**	0.14	0.29**	0.14**	1.03**	1.63**	-7.14**
MS CO 5x ICPL 87	-5.20**	-2.28**	4.98**	0.04**	-26.51**	0.11**	-2.53**	-0.37**	-6.08**	-7.14**
MS CO 5 x CORG 9060	4.30**	-2.76**	-5.61**	1.11**	-16.85**	-0.13**	1.48**	-0.43**	-4.33**	12.51**
MS CO5x ICPL 84031	-2.40**	-1.28**	-10.16**	0.26**	-1.18**	-0.37**	0.67**	0.47**	-19.01**	-20.14**
MS CO 5x AL 601	0.04	1.36**	-0.61**	-0.82**	12.14**	-0.03**	-0.14**	0.27**	18.02	-14.81**
MS CO 5 x PA 128	4.61**	1.24**	-3.10**	0.08**	22.48**	0.07**	0.21**	-0.71**	4.26**	24.18**
MS CO5 x CORG 7	0.90**	2.05**	-0.16	-1.10**	14.81**	-0.23**	0.02	-0.73**	-0.97**	9.18**
MS CO5 x ICPL 83027	-0.96**	2.25**	1.58**	0.76**	1.48**	0.02**	0.48**	0.15**	7.86**	7.18**
MS CO5x APK 1	3.65**	1.99**	13.56**	-0.30**	-6.51**	0.27**	-0.35**	0.30**	-1.37**	-3.81**
SE	0.07	0.06	0.20	0.01	0.28	0.006	0.01	0.01	0.11	0.20

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

5 x ICPL 83027 showed favourable *sca* effects for days to 50% flowering, plant height(cm), number of branches/plant, number of pods/plant, number of seeds/pod, hundred grain weight, protein content, harvest index and single plant yield. Hybrid CORG 990047A x APK 1 showed favourable *sca* effects for days to 50% flowering, days to maturity, plant height(cm), number of branches/plant, number of pods/plant, protein content, harvest index and single plant yield. These combinations involved high x high combiners indicating the major role of additive gene action complimenting for the expression of the traits. Some of the cross combinations having parents with high x low and low x high gca effects also produced significant *sca* effects. As was observed in the crosses of CORG 990052 A x APK 1(days to 50% flowering), MS CO5 x VBN 1 and MS CO5 x CORG 9060 (days to maturity), MSCO5 x ICPL 83027 (harvest index). In some of the crosses having high *sca* effects, both the parents were poor general combiners. This indicates the presence of non additive gene effects in these cross combinations. It is observed in the crosses CORG 990052 A x CORG 9060 (days to maturity),CORG 990047A x CORG 9060 (number of seeds/pod), MS CO5 x ICPL 84031 (hundred grain weight),CORG 990047A x ICPL 87 (protein content),CORG 990052 A x ICPL 87 (single plant yield).This was in agreement with the reports of Baskaran and Muthiah (2007).

The studies on combining ability indicated that parents MS CO5, CORG 9060, PA 128, CORG7 and ICPL 83027 could be considered as desirable parents. The present study pointed out that the crosses MS CO5 x ICPL 83027, CORG 990047 A x APK 1, MS CO5 x CORG9060, MS CO5 x PA 128 and MS CO5 x CORG 7 showing high *per se* performance, *sca* effects for grain yield and their significant response to other related traits could be commercially exploited for development of high yielding hybrids in pigeonpea.

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