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COMBINING ABILITY ANALYSIS OVER CROPPING SYSTEMS FOR GRAIN YIELD AND RELATED CHARACTERS IN PIGEONPEA

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ABSTRACT

Combining ability analysis for grain yield and its components in diallel crosses involving seven diverse pigeonpea cultivars over three cropping systems, viz., sole crop, intercrop with sorghum and intercrop with pearl millet revealed the predominance of additive gene effects for these characters. Pooled analysis showed that gca and sca variances interacted significantly with the cropping systems for all the characters. The cropping system was found in altering the ranking of the parents for gca effects and also for general performance. Parents BDN 2, ICP 6997, PBNA 54 and Daithna Local were the best general combiners for all the characters except days to maturity. Prabhat showed consistence desirable gca effects for days to maturity. The hybrids ICP 6997 x PBNA 54 and ICP 6997 x BDN 2 showed significant sca effects for grain yield and high per se performance under all three cropping systems.

Key words: Combining ability, cropping systems, pigeonpea.

Pigeonpea (*Cajanus cajan* (L.) Millsp.) is rarely grown as a sole crop. However, in pigeonpea breeding programmes, selections and evaluation are made under sole crop conditions on the assumption that the varieties that do well under sole cropping will also give superior performance under intercropping. The breeding programme may thus be handicapped in cases where this assumption does not hold true. The combining ability studies in a single environment (sole crop) may not be applicable to other cropping systems. Such studies, particularly in pigeonpea, are not available. Therefore, the present investigation was undertaken to get information on the nature of combining ability operative in the inheritance of different economic traits and role of cropping systems on the combining ability.

MATERIALS AND METHODS

Seven diverse strains of pigeonpea (ICP 6997, 4785-2-V_2, PL 8796, Daithna Local, PBNA 54, Prabhat and BDN 2) were mated in a diallel fashion excluding reciprocals. These seven parents and their 21 F_1 were grown in R.B.D. with two replications during rainy season of 1985 at the Experimental Farm of the Botany Department, Marathwada Agricultural University, Parbhani under three cropping systems, viz., i) sole crop, ii) intercrop between paired rows (30-60 cm) of sorghum hybrid CSH 9, and iii) intercrop between paired rows (30-60 cm) of pearl millet hybrid BJ 104. The row length for all cropping systems was 3 meters. The spacing for pigeonpea was 75 x 30 cm in sole crop and 90 x 25 cm under intercropping. A basal dose of 20 kg N + 50 kg P_2O_5/ha to sole crop, 80 kg N + 40 kg P_2O_5/ha to the intercrop with sorghum and 60 kg N + 30 kg P_2O_5/ha to the intercrop with pearl millet was applied. The observations were recorded on five quantitative traits on five random plants in each genotype and replication.

The combining ability analysis for each cropping system was carried out following Model 1, Method 2 of Griffing [1]. Pooled analysis over cropping systems for combining ability and their interactions with cropping systems for Model 1 and Method 2 was conducted as described by Singh [2].

RESULTS AND DISCUSSION

The ranking of the pigeonpea genotypes under sole and intercropping remained the same but grain yield decreased in intercropping. Similarly, the plant height and number of pods per plant decreased under intercropping in parents as well as in hybrids. But the cropping systems greatly influenced maturity of the pigeonpea genotypes, i.e. it was more delayed when intercropped with sorghum. However, no such depressed performance was noticed in harvest index due to different cropping systems. Hybrids showed higher harvest index in intercrop as compared to the sole crop. The probable reason would be production of less biomass in intercrop and better partitioning of dry matter. The preliminary studies indicated that in the intercropping system, yield of pigeonpea cultivars depends not only on their genetic yield potential but also on the ability to compete with the millet. The findings of Nerkar [3] indicated that early generation breeding lines of pigeonpea differ in their companionship ability when intercropped with sorghum. The observations of Singh et al. [4] for plant height and number of pods, Natarajan and Willey [5] for harvest index, and Deshpande [6] for days to flowering, plant height and harvest index were similar to the present findings.

Analysis of variance for combining ability for grain yield and yield components for individual cropping systems are presented in Table 1, and the analysis of variance for combining ability pooled over three cropping systems in Table 2. The gca and sca variances

Table 1. Combining ability analysis (mean squares) for yield and yield components under three cropping systems in pigeonpea

Source	Cropping system	d.f.	Days to maturity	Plant height	Pods per plant	Grain yield	Harvest index
Gca	Sole crop	6	329.7**	2166.3**	12606.7**	875.9**	53.3**
	Intercrop in sorghum		635.5**	771.3**	903.9**	135.2**	22.3**
	Intercrop in pearl millet		401.1**	876.9**	3103.2**	527.4**	23.4**
Sca	Sole crop	21	32.1**	309.1**	2277.1**	217.6**	15.0**
	Intercrop in sorghum		41.6**	207.0**	178.7**	50.4**	40.3**
	Intercrop in pearl millet		94.0**	171.7**	210.5**	70.0**	27.5**
Error	Sole crop	27	1.5	4.1	25.1	2.5	0.7
	Intercrop in sorghum		0.7	4.1	3.8	0.5	1.9
	Intercrop in pearl millet		1.5	4.2	11.9	0.8	0.4
σ^2 gca	Sole crop		33.1	206.4	1147.7	73.1	4.4
	Intercrop in sorghum		66.00	62.7	80.6	9.4	-2.0
	Intercrop in pearl millet		34.1	78.3	321.4	51.1	-0.4
σ^2 sca	Sole crop		30.6	305.0	2252.0	215.1	14.4
	Intercrop in sorghum		40.8	202.9	174.9	50.0	38.4
	Intercrop in pearl millet		92.5	167.5	198.6	66.2	27.0
σ^2 gca/ σ^2 sca	Sole crop		1.1	0.7	0.5	0.3	0.3
	Intercrop in sorghum		1.6	0.3	0.5	5.3	-0.05
	Intercrop in pearl millet		0.4	0.5	1.6	0.8	-0.02

**Significant at P = 0.01.

for yield and yield components were significant under all three cropping systems. The variances due to gca x cropping system and sca x cropping system were unstable for all the characters under study. The gca : sca ratio was less than unity for plant height and harvest index under all the three cropping systems as well as over the cropping systems. These results are similar to those of Jadhav [7] for pigeonpea grown under three environments, viz., rainfed sole crop, rainfed intercrop in sorghum and winter sole crop. The estimates of gca and sca for days to maturity, pods and grain yield per plant, were either greater or less than one in individual cropping systems, it was substantially higher than one for these characters in the combined analysis which specified the role of additive type gene effects. Such differential estimates of gca and sca variances in different environments were also reported by [7]. The results indicate the possibility of improvement of pigeonpea through selection in different cropping systems.

The parents BDN 2, ICP 6997, PBNA 54 and Daithna Local were the best general combiners for grain yield, plant height, and pods per plant under individual and over three

Table 2. Analysis of variance (mean squares) for combining ability for yield and yield component pooled over three cropping systems in pigeonpea

Source	d.f.	Days to maturity	Plant height	Pods per plant	Grain yield	Harvest index
Gca	6	1299.0**	3295.0**	11130.0**	1162.0**	40.6**
Sca	21	119.3**	575.0**	1041.0**	169.7**	33.0**
Cropping systems	2	1931.0**	3922.0**	260600.0**	35160.0**	563.6**
Gca x environment	12	33.8**	260.0**	2741.0**	188.1**	29.7**
Sca x environment	42	24.2**	456.1**	812.5**	82.6**	24.9**
Error	81	1.2	4.1	13.6	1.3	1.0
σ^2 gca		43.3	93.1	302.3	32.8	0.1
σ^2 sca		31.7	171.1	76.3	29.0	2.7
σ^2 gca/σ^2 sca		1.4	0.5	4.0	1.1	0.04

**Significant at P = 0.01.

cropping systems (Table 3). Parents like Prabhat, 4785-2-V_2 and Daithna Local showed good combining ability for maturity. Similarly, the parents Daithna Local, 4785-2-V_2, BDN 2 and Prabhat also showed their best general combining ability for harvest index. These results further indicate that high per se performance was also an indicator of high gca effects. The high gca superimposed on high per se mean for the important yield components in the promising parents will permit better utilization without any loss of productivity. The selection of parents on the basis of gca effects, as suggested in cereal breeding [8, 9], may also hold good for pigeonpea breeding.

Five best crosses showing high per se performance for the characters under study were assessed. The sca effects, per se performance, and gca status of these crosses are presented in Table 3. Out of 25 crosses, 19 showed desirable mean and significant sca effects for five characters. The seven, eleven and one crosses showing high F_1 per se and desirable sca effects involved the parents of high x high, high x low (or low x high), and low x low combining ability, respectively. This indicates that most of these crosses were involved in additive x additive and additive x dominance type of gene effects. The cross ICP 6997 x PBNA 54 involving both the parents as good combiner for plant height and grain yield can be utilized for developing pure lines. The other crosses, viz., ICP 6997 x BDN 2 for grain yield, Daithna Local x BDN 2 for number of pods and PBNA 54 x BDN 2 for plant height and number of pods were also of similar nature and are most suitable for intermating to develop new genotype accumulating more desirable genes. The cross PL 8796 x BDN 2 involving one

Table 3. Combining ability of the best five crosses of pigeonpea based on pooled per se performance, sca and gca effects of parents in sorghum

Character	Crosses	Per se F_1 performance	Sca effects	Gca status of parents	Performance of parents	
					P_1	P_2
Days to maturity	PL 8796 x Prabhat	126.5	-6.7**	L x H	163.2	125.8
	ICP 6997 x Prabhat	127.7	-6.0**	L x H	158.5	125.8
	Daithna Local x Prabhat	128.7	-0.5	H x H	145.5	125.8
	4785-2-V_2 x Prabhat	130.2	1.0	H x H	144.2	125.8
	PBNA 54 x Prabhat	131.7	-3.9**	L x H	161.0	125.8
Plant height, cm	ICP 6997 x PBNA 54	177.7	4.7**	H x H	164.6	159.1
	ICP 6997 x PL 8796	174.6	16.0**	H x L	164.6	117.6
	PBNA 54 x BDN 2	174.1	4.6**	H x H	159.1	150.1
	PL 8796 x BDN 2	173.9	18.8**	L x H	117.6	150.1
	PL 8796 x PBNA 54	170.6	11.8**	L x H	117.6	159.1
Pods per plant	PBNA 54 x BDN 2	216.5	28.2**	H x H	155.0	160.7
	Daithna Local x BDN 2	201.0	9.7**	H x H	162.9	160.7
	Daithna Local x Prabhat	189.0	36.8**	H x L	162.9	111.9
	Prabhat x BDN 2	182.9	18.3**	L x H	111.9	160.7
	PL 8796 x BDN 2	172.6	20.1**	L x H	103.9	160.7
Grain yield per plant, g	ICP 6997 x PBNA 54	74.9	17.6**	H x H	45.7	47.9
	ICP 6997 x BDN 2	68.6	6.3**	H x H	45.7	54.8
	PL 8796 x BDN 2	66.1	11.4**	L x H	37.1	54.8
	Daithna Local x BDN 2	69.9	0.4	H x H	47.1	54.8
	PBNA 54 x BDN 2	61.8	-0.5	H x H	47.9	54.8
Harvest index, %	Daithna Local x PBNA 54	41.8	3.4**	H x L	38.5	32.1
	4785-2-V_2 x BDN 2	41.8	1.7**	H x H	36.4	38.3
	4785-2-V_2 x Daithna Local	41.6	0.9	H x H	36.4	38.5
	Daithna Local x BDN 2	41.3	0.7	H x H	38.5	38.3
	ICP 6997 x PL 8796	41.2	5.4**	L x L	32.8	31.4

**Significant at P = 0.01.

good and one poor combiner for plant height, pods per plant, and grain yield is expected to produce desirable transgressive segregates in the advance generations.

It is concluded that the crosses showing high per se performance and desirable sca effects necessarily involve either both or at least one parent as a good combiner. Therefore, gca status of the parent may be the index of selection of superior cross combinations, which can be commercially exploited in pigeonpea hybrid programme using the available genetic male sterility sources.

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