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ESTIMATION OF COMBINING ABILITY OF PARENTS AND HYBRIDS THROUGH HALF-DIALLEL ANALYSIS FOR YIELD AND QUALITY TRAITS IN PIGEONPEA (*CAJANAS CAJAN* L. MILL.)

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ABSTRACT

Eight diverse cultivars of pigeonpea were crossed in all possible combinations (Half diallel design) excluding reciprocals in *Kharif* 2022-23. The resulting F_1's, and eight parents were grown in a randomized block design replicated thrice at the farm attached to the agriculture research station, Agriculture university, Kota during *Kharif* 2023-24. The higher magnitude of sca variance over gca variance for all the traits which indicated preponderance of non-additive gene action. The parents ICPL-20338, ICPL-20340, ICPL-87, Pusa-992 and PA-16 were good general combiners for seed yield and its two or more component traits. Specific combining ability effects revealed that ICPL-20340 x AL-882 and ICPL-20338 x AL-882 were the best cross combinations expressed significant SCA effects for seed yield per plant and its attributing traits. The crosses, which showed high SCA effect could be used for the hybrid development.
***Keywords* :** GCA, SCA, Non-additive gene action, Half diallel design

Introduction

Pigeonpea [*Cajanus cajan* (L.) Millsp.] is one of the most important pulse crops of India and ranks second to chickpea in area and production. It is grown under wide range of cropping systems in tropics and sub-tropics regions. It is commonly known as red gram, arhar, tur, tuver *etc.* Besides India, it is commercially cultivated in Myanmar, Kenya, Malawi, Uganda and few countries of Central America and West Indies. It is the cultivated food crop of the *cajaninae* sub-tribe of the leguminous tribe phaseolae. The sub-tribe *cajaninae* is well distinguished by the presence of vesicular glands on the leaves, calyx and pods (Vanden Maesen, 1990). It belongs to the family Fabaceae and sub-family papilonaceae having 2n = 2x = 22 diploid chromosome number.

The choice of right type of parents for hybridization programme is crucial step for the breeder. The use of parents of superior genetically worth ensures much better success. Information on combining ability of genotype in hybridization provides guidelines to the plant breeder in selecting the right parents and desirable cross combinations to be used in formation of systematic breeding programme and at the same time provides means of understanding the nature of gene action involved in the inheritance of various traits.

Materials and Method

The present investigation was carried out at ARS, Kota, Agriculture University, Kota (Raj.). Eight early genotypes (ICPL-20338, ICPL-20340, ICPL-87, Pusa-991, Pusa-992, PA-16, PA-291 and AL-882) were crossed (during *Kharif* 2022-23) in diallel fashion (excluding reciprocals) to obtain twenty-eight F_1 hybrids. The seeds of twenty-eight F_1 crosses and eight parents were collected separately. The experiment consists the 37 treatments comprising 8 parents, 28 F_1's was laid out in randomized block design with three replications during *Kharif* 2023-24. Combining ability estimates of parents and crosses were estimated according to the Method-2, Model-1 of Griffing (1956).

Five randomly selected competitive plants from each genotype were used in recording observations on the characters including days to 50% flowering, days to maturity, plant height, primary branches per plant, pod per plant, seed per pod, pod length, 100 seed weight, biological yield per plant, grain yield per plant, harvest index, protein content and carbohydrate content.

Results and Discussion

The analysis of variance for combining ability (Table-1) revealed that mean squares due to GCA and SCA were highly significant for all the traits (except plant height in GCA). The variance due to SCA was higher than the variance due to GCA for all the traits including seed yield per plant showed the predominance of dominance gene action for these traits. Where σ^2gca/ σ^2sca ratio being less than unity indicating that the non-additive gene action was more important in the expression of all characters in each environment. Similar results were reported by Acharya *et al.* (2009), Pandey *et al*. (2014) and Mhasal *et al.* (2015)

The general combining ability effects (Table 2) of the parents indicated that five parents' *viz.*, ICPL-20338, ICPL-20340, ICPL-87, Pusa-992 and PA-16 were the good general combiners for seed yield per plant. Among these parent, ICPL-20338 also found to be good general combiners for primary branches per plant, pods per plant, seed per pod, pod length, biological yield per plant and carbohydrate content, while ICPL-20340 was found good general combiner for days to 50% flowering, pods per plant, seeds per pod, 100 seed weight and protein content. Among this parent, ICPL-87 was found good general combiner for days to maturity, pods per plant, pod length, biological yield per plant, harvest index and carbohydrate content. Therefore, these parents had the ability to produce higher yield by imparting desirable genes in the progeny on crossing with diverse lines. Similar results were reported by Chauhan and Tikka (2003) and Acharya *et al.* (2009)

The best specific combinations with respect to seed yield per plant were ICPL-87 x PA-16 (11.92), ICPL-87 x PA-291 (9.18), ICPL-20338 x ICPL-20340 (8.87), Pusa-992 x PA-16 (7.79), ICPL-20340 x AL-882 (7.44) and ICPL-20338 x AL-882 (7.28). Specific combining ability effects revealed that ICPL-20340 x AL-882 and ICPL-20338 x AL-882 were the best cross combinations expressed significant SCA effects for seed yield per plant involving good x good and good x good parental interaction, respectively, also noted significant SCA effects for pods per plant, seed per pod, pod length, 100-seed weight, biological yield per plant and protein content. Therefore, these three cross combinations may be utilized for heterosis breeding as well as for isolating the promising segregates in advanced generations as these crosses are under the control of additive gene effects which are fixable. These hybrids, ICPL-20338 × ICPL-87 and ICPL-20340 × PA-291 were the best cross combinations expressed negative significant SCA effects for days to 50% flowering and days to maturity. Similar results were also reported by Kumar *et al.*, (2001), Chauhan and Tikka (2003), and Rama *et al.* (2010).

Table 1 : Analysis of variance for combining ability for yield and its contributing traits

Characters	Source of variance					
	GCA (7)	SCA (28)	Error (70)	σ^2gca	σ^2sca	σ^2gca/σ^2sca
Days to 50% flowering	17.96**	13.15**	0.84	1.71	12.31	0.13
Days to maturity	10.24**	12.69**	1.73	0.85	10.96	0.07
Plant height	25.19	80.18**	31.73	-0.65	48.46	-0.03
Primary branches per plant	0.84**	3.03**	0.16	0.07	2.87	0.02
No. of pods per plant	2486.40**	1092.97**	35.00	245.14	1057.97	0.23
No. of seed per pod	0.25**	0.18**	0.05	0.02	0.14	0.15
Pod length	0.58**	0.20**	0.05	0.05	0.15	0.36
100- seed weight	0.58**	0.74**	0.08	0.05	0.66	0.07
Biological yield per plant	694.03**	362.29**	21.31	67.27	340.98	0.19
Seed yield per plant	60.89**	50.58**	4.04	5.69	46.54	0.12
Harvest index	29.23**	27.27**	3.29	2.59	23.99	0.10
Protein content	0.75*	1.24**	0.26	0.05	0.99	0.05
Carbohydrate content	10.47**	27.93**	0.26	1.02	27.67	0.03

*, ** significant at 5 per cent and 1 per cent levels of probability, respectively

Table 2 : Estimates GCA effects for different traits in pigeonpea

Parents	**DFF**	**DM**	**PH**	**PBPP**	**NPPP**	**NSPP**	**PL**	**100-SW**	**BYPP**	**GYPP**	**HI**	**PC**	**CC**
ICPL-20338	**-0.80****	0.23	1.26	**0.55****	**7.25****	**0.24****	**0.34****	-0.29**	**11.70****	**1.66****	-1.01	-0.05	**0.95****
ICPL-20340	**-0.66***	0.41	0.30	-0.41**	**16.62****	**0.10***	-0.21**	**0.27****	0.34	**1.55***	1.00	**0.57****	-0.87**
ICPL-87	-0.53	**-1.32****	-2.81	-0.01	**13.10****	0.01	**0.19****	0.06	**6.31****	**3.06****	**1.34***	0.10	**1.13****
Pusa-991	**-1.90****	**-1.52****	-1.82	-0.13	-14.40**	-0.06	0.07	-0.22*	-12.8**	-0.72	**2.52****	-0.12	-0.36*
Pusa-992	0.26	0.54	-0.03	**0.25***	**25.00****	-0.02	-0.06	0.17	**8.51****	**1.50****	-1.25*	-0.05	-1.24**
PA-16	**-0.65***	-0.22	1.37	-0.08	**3.49***	0.12	**0.18***	-0.31**	**4.00****	**2.17****	0.67	0.11	-0.36*
PA-291	2.46**	1.56**	0.04	-0.11	-18.9**	-0.24**	-0.39**	**0.21***	-7.21**	-4.24**	-2.61**	-0.28	-0.68**
AL-882	1.20**	0.31	**1.67***	-0.06	-5.85**	-0.15*	-0.12	0.11	1.80	**2.12****	1.56**	-0.26	**1.44****
SE	0.27	0.38	1.66	0.12	1.75	0.06	0.06	0.08	1.36	0.59	0.53	0.15	0.15
gi-gj	0.41	0.58	2.51	0.18	2.64	0.10	0.10	0.13	2.06	0.89	0.81	0.22	0.22

*, ** significant at 5 per cent and 1 per cent levels of probability, respectively

DFF	-Days to 50% flowering	**100-SW**	-100 Seed weight
DM	-Days to maturity	**BYPP**	-Biological yield per plant
PH	-Plant height	**SYPP**	-Seed yield per plant
PBPP	-Primary branches per plant	**HI**	-Harvest index
NPPP	-Number of pods per plant	**PC**	-Protein content
NSPP	-Number of seeds per pod	**CC**	-Carbohydrate content
PL	-Pod length		

Table 3 : Estimates SCA effects for different traits in pigeonpea

Crosses	**DFF**	**DM**	**PH**	**PBPP**	**NPPP**	**NSPP**	**PL**	**100-SW**	**BYPP**	**GYPP**	**HI**	**PC**	**CC**
ICPL-20338 × ICPL-20340	9.02**	7.40**	**11.76***	**1.41****	**24.88****	0.26	**0.42****	0.34	**13.15****	**8.87****	-0.70	0.76	-1.44**
ICPL-20338 × ICPL-87	**-4.11****	**-3.52****	7.16	0.56	**37.82****	**0.44***	0.08	-0.15	**10.35***	1.52	-8.3**	**1.78****	**4.50****
ICPL-20338 × Pusa-991	2.92**	-0.65	1.19	0.63	-20.5**	0.31	-0.02	0.21	1.98	-9.23**	-1.36	0.33	**8.17****
ICPL-20338 × Pusa-992	-1.57	-2.39	-3.16	-0.05	1.43	-0.28	0.06	-0.28	-4.72	-3.48	**4.29***	-1.99**	-6.21**
ICPL-20338 × PA-16	**-4.84****	-0.15	-4.78	0.48	-64.7**	0.20	-0.12	**0.66***	-9.40*	3.09	**3.79***	-0.89	-1.05*
ICPL-20338 × PA-291	0.38	-0.95	-9.81	-2.99**	**45.35****	**0.45***	0.36	0.15	**11.45***	**6.35****	2.92	**2.37****	**4.61****
ICPL-20338 × AL-882	1.22	4.43**	8.16	**0.92***	**43.60****	**0.46***	**0.50***	**1.40****	**10.45***	**7.28****	**6.21****	**1.18***	0.34
ICPL-20340 × ICPL-87	-1.57	**-5.34****	9.10	-1.57**	-67.6**	-0.90**	-0.55*	**1.35****	-48.4**	-6.26**	-4.42*	-0.52	-2.02**
ICPL-20340 × Pusa-991	**-1.75****	1.15	-3.82	1.82**	**34.70****	0.29	-0.33	-0.47	**32.03****	2.52	1.76	0.59	2.36**
ICPL-20340 × Pusa-992	-0.71	-2.24	-11.82*	-2.50**	2.19	0.14	-0.69**	-0.90**	**12.01****	**5.17****	-3.90*	-0.09	-2.15**
ICPL-20340 × PA-16	-0.64	0.99	-17.89**	-3.51**	3.52	0.22	0.51*	0.22	-40.8**	-13.8**	-2.68	**0.97***	-0.85
ICPL-20340 × PA-291	**-1.74***	**-3.14***	7.31	0.43	-28.2**	0.01	-0.18	-0.95**	-6.15	-4.81*	1.05	-0.55	-5.51**
ICPL-20340 × AL-882	2.75**	5.40**	**12.42****	-0.31	**36.69****	**0.64****	**0.96****	**1.64****	**22.07****	**7.44****	-8.2**	**1.17***	**10.73****
ICPL-87 × Pusa-991	2.32**	1.89	-3.11	0.26	**30.06****	-0.60**	0.12	0.23	**13.25****	-5.34**	-6.02**	-0.318	0.01
ICPL-87 × Pusa-992	2.15*	2.49*	-2.68	**0.90***	6.78	0.15	-0.054	0.448	-3.07	-7.57 **	**4.17***	0.92	-5.71**
ICPL-87 × PA-16	-0.77	4.39**	**14.30****	**1.41****	**52.03****	0.36	0.21	0.13	**23.61****	**11.92****	2.03	**1.20***	**3.09****
ICPL-87 × PA-291	2.12*	0.92	0.12	-2.36**	-5.13	**0.51***	**0.46***	-0.53	**29.40****	**9.18****	**11.5****	-1.62**	**8.82****
ICPL-87 × AL-882	7.37**	**-7.52****	-11.13*	0.59	-29.9**	-0.58**	-0.75**	0.23	-24.4**	**5.79****	-0.19	-1.10*	**3.46****
Pusa-991 × Pusa-992	2.85**	2.69*	-0.90	**0.90***	**13.05***	-0.20	**0.43***	0.18	-22.1**	-4.57*	0.63	**1.45****	**1.21***
Pusa-991 × PA-16	-0.74	-0.74	-9.74	-1.12**	-20.6**	0.08	-0.24	0.01	0.89	1.29	-5.18**	-0.41	**4.47****
Pusa-991 × PA-291	**-1.84***	-0.54	-5.66	0.32	-25.9**	-0.52*	-0.45*	0.23	-7.17	-6.22**	**4.98****	-0.29	-4.79**
Pusa-991 × AL-882	**-2.01***	0.01	-0.54	-3.32**	**33.77****	0.23	0.10	-0.53	-3.07	**5.51****	**4.31***	-0.54	-3.88**
Pusa-992 × PA-16	**-2.91****	-2.14	6.55	-2.16**	**13.57***	0.11	**0.71****	0.34	8.39	**7.79****	2.68	0.61	**2.79****
Pusa-992 × PA-291	**-2.67****	0.39	9.16	-0.03	9.83	-0.07	0.04	**0.70***	**9.45***	**4.85***	-2.95	-0.69	-3.55**
Pusa-992 × AL-882	-1.17	-0.72	6.11	**1.50****	-10.52	-0.23	-0.14	**0.68***	2.38	-3.23	0.05	0.15	-2.68**
PA-16 × PA-291	5.38**	**-2.70***	-3.81	**1.72****	**19.12****	-0.13	-0.17	**0.78 ****	4.45	0.24	-4.77**	0.50	**6.28****
PA-16 × AL-882	4.22**	-1.15	-7.61	-1.45**	-26.0**	-0.32	-0.10	-2.18**	3.77	-5.26**	-0.70	-0.07	-5.25**
PA-291 × AL-882	5.12**	6.37**	2.67	0.26	**28.52****	0.22	-0.56*	0.50	-2.01	-1.04	0.01	-2.21	**1.93****
SE	0.83	1.19	5.10	0.36	5.36	0.20	0.21	0.26	4.18	1.82	1.64	0.46	0.46
gi-gj	1.23	1.76	7.55	0.54	7.93	0.30	0.31	0.39	6.19	2.69	2.43	0.68	0.68

*, ** significant at 5 per cent and 1 per cent levels of probability, respectively

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