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Genetic Architecture of Yield and its Components in Cowpea (*Vigna unguiculata* (L.) Walp)

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ABSTRACT

A nine parent partial diallel analysis was done in F_1 and F_2 generation of cowpea (*Vigna unguiculata* (L.) Walp). The combining ability studies revealed that both additive as well as non-additive gene effects were involved in the inheritance for all the characters with pre-dominant role of non-additive gene action. The parent GC-940 was good general combiner for grain yield, plant height, branches per plant and pods per plant, the parent GC-3 was good combiner for grain yield, pods per plant, pod length and seeds per pod and Pusa Phalguni and RC-8 for early flowering, maturity and plant height. The crosses V 240 x GC-9017, Pusa Phalguni x RC-8 and V 269 x GC 9017 were found to be good combiners for the yield and its components. These parents and crosses can be exploited to develop high yielding elite lines of cowpea. Biparental mating followed by recurrent selection in segregating generations is suggested for the improvement of these characters.

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INTRODUCTION

A knowledge of combining ability provides information on the performance of genotypes in hybrid combinations and also on the nature and magnitude of gene actions involved in controlling such metric traits, which would be helpful in planning the suitable breeding programme for improving the crop. Diallel analysis provides such information. The present study was therefore carried out to study genetic architecture and combining ability of parental material for formulating an efficient breeding methodology in cowpea.

MATERIALS AND METHODS

Nine diverse cultivars of cowpea viz., Pusa Phalguni (PP), GC 2, GC 3, V 240, V 269, RC 8, GC 9017, GC 9024 and GC 9040 were crossed in all possible combinations excluding reciprocals. F_2 progenies were produced by selfing F_1 hybrids. The experimental material consisting of 36 each of F_1 and F_2 progenies alongwith nine parents were sown during kharif 1991-92 in a randomized block design with three replications. Each plot consisted of a single row for each parent and F_1 and five rows of each F_2 keeping row length of 1.5 m a spacing of 45 x 15 cm. Data were recorded from 5 (parents and F_1) and 10 (F_2) randomly selected plants. Observations were recorded on days to flowering, days to maturity, plant height (cm), branches per plant, pods per plant, pod length (cm), seeds per pod, 100 seed weight (g) and grain yield per plant (g).

TABLE 1

Analysis of variance for combining ability.

			Day to flowering	*Dys to maturity*	*Plant height*	*Branches per plant*	*Pods per plant*	*Pod length*	*Seeds per pod*	*100 seed weight*	*Yield per plant*
GCA	F_1	8	13.35**	24.80**	146.05**	18.25**	94.34**	6.92**	3.05**	12.87**	63.97**
	F_2	8	12.46**	22.11**	167.21**	16.88**	119.03**	5.44**	4.15**	12.77**	83.48**
SCA	F_1	36	3.19**	3.35**	33.02**	12.97**	36.73**	1.06**	1.69**	1.40**	30.06**
	F_2	36	2.31**	2.49**	20.29**	11.80**	31.72**	0.86**	1.10**	0.66**	24.72**
Error	F_1	88	0.20	0.25	0.58	0.19	0.74	0.12	0.07	0.04	0.90
	F_2	88	0.24	0.21	0.51	0.20	0.65	0.10	0.07	0.04	0.91
σ^2GCA	F_1	—	0.92	1.95	10.28	0.48	5.24	0.53	0.12	1.04	3.08
	F_2	—	0.92	1.78	13.36	0.46	7.94	0.42	0.28	1.10	5.34
σ^2SCA	F_1	—	2.99	3.10	32.44	12.78	35.99	0.94	1.62	1.36	29.16
	F_2	—	2.07	2.28	19.78	11.60	31.07	0.76	1.03	0.62	23.81
Predictabilty ratio	F_1	—	0.38	0.56	0.39	0.07	0.23	0.53	0.12	0.60	0.17
	F_2	—	0.24	0.61	0.57	0.07	0.34	0.53	0.35	0.78	0.31

** Significant at 1 per cent level.

Plot means were used for statistical analysis. Combining ability analysis was performed according to the method 2 and model 1 of Griffing (1956). General predictability ratio was estimated after Baker (1978).

RESULTS AND DISCUSSION

Variances due to genotypes were highly significant for all the characters. Differences among parents, F_1's and F_2's were also highly significant in respect of all these characters. This indicated the presence of greater diversity among the parents selected for the study. The comparision of parents Vs crossess (F_1 + F_2) was significant for all the characters, except days to maturity. Similarly, differences between F_1 and F_2 population were found significant for all characters except for pod length. Thus, the presence of general heterosis was evident for majority of the characters. Combining ability analysis (Table 1) indicated that the variances due to general and specific combining ability were highly significant for all characters in both the generations. The results indicated that additive as well as non-additive variances were important in the expression of all the characters. Predictability ratio was less than 0.50 in both generations for the traits except for days to maturity, pod length and 100 seed weight. This indicated preponderence of non-additive gene effects for these traits. For the remaining three characters both types of gene effects were equally important. The non-additive gene action has also been reported for days to flowering, days to maturity, pods per plant, pod length and test weight by Patil and Bhapkar (1986), Patil and Shete (1986), Zaveri *et al.* (1983) and Patel (1988) while for plant height, branches per plant, seeds per pod and grain yield by Godhani (1986) and Thiyagarajan *et al.* (1990).

In general sca variences of F_1's were higher than their sca variances for F_2. Similarly the predictability ratio of F_2's were generally higher than respective F_1's ratio. This indicated presence of higher non-additive effect in F_1's than in F_2's. Under such situation methods like diallel selective mating (Jensen, 1970) and biparental mating followed by recurrent selection in segregating generations will be helpful to break the undesirable linkage and to provide better opportunity for selection, recombination and accumulation of desirable genes.

Estimates of gca effects of parents are presented in Table-2. None of the parents exhibited high general combining ability for all the characters. The parent GC 9040 and GC 3 displayed high general combiners for grain yield and one more yield components. The use of these two parents in future breeding programmes would be useful to improve yield in this crop. The parent Pusa Phalguni, GC 2, RC 8 and GC 9024 showed high and negative gca effects for earliness. Thus, these parents may be exploited to develop early varieties of cowpea. High and negative gca effects for plant height were expressed by Pusa Phalguni, RC 8 and GC 9024. Use of these parents would be helpful for developing dwarf variety, Parents V 240 and V 269 were good general cominers for pod length, seed per pod and branches per plant. The use of these parents would be helpful to improve such yield components of high yielding but small poded lines.

Two best specific cross combinations for seed yield and yield component (Table-3) indicated that for days to flowering V 240 x V 269 showed high sca effect in F_1 followed by V 240 x GC 9024. The later hybrid also expressed high sca effects for early maturity. The cross combinations V 269 x GC 9040 exhibited high sca effect in F_2 for days to flowering followed by V 240 x GC 9017. The later hybrid expressed high sca for early maturity in F_1 and plant height in F_1 and F_2. The hybrid GC 2 x GC 3 expressed high sca for days to maturity and seeds per pod in F_2 while second best hybrid for early maturity in

TABLE 2

Estimates of general combining ability effects.

	Day to flowering		*Dys to maturity*		*Plant height*		*Branches per plant*		*Pods per plant*		*Pod length*		*Seeds per pod*		*100-seed weight*		*Yield per plant*	
	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
Pusa Phalguni	-1.07**	-0.88**	-1.19**	-1.36**	-6.60**	-6.01**	-2.03**	-2.00**	-2.07**	-1.22**	-0.54**	-0.41**	-0.35**	-0.49**	-0.88**	-1.25**	-1.22**	00.02
GC2	-0.56**	-0.55**	-0.80**	-0.93**	0.83**	0.41*	-0.52**	-0.42**	-0.81**	-0.19	-0.79**	-0.96**	-0.46**	-0.61**	-0.16**	-1.19**	0.09	-0.40
GC3	1.38**	1.03**	1.33**	1.10**	0.73**	-0.83**	-0.11	0.30*	3.90**	3.51**	0.53**	0.75**	0.59**	0.76**	0.07	0.09	3.81**	3.14**
V240	0.66**	1.82**	1.30**	1.80**	4.73**	6.09**	0.70**	0.30**	-2.30**	-2.33**	0.61**	0.79**	0.44**	0.69**	0.26**	0.75**	-2.41**	-1.02**
V269	1.35**	-1.03**	1.60**	1.95**	4.90**	5.10**	0.51**	0.21	-3.95**	-4.20**	1.42**	0.83**	0.90**	0.83**	0.80**	0.51**	-3.08**	4.12**
RC8	-1.47**	-1.13**	-2.31**	-1.08**	-3.79**	-4.26**	-0.95**	-1.03**	-1.10**	-3.43**	-0.89**	-0.84**	-0.65**	-0.71**	-1.87**	-1.64**	-1.49**	-3.66**
GC9017	0.38	0.15	0.99**	0.34*	-0.17	0.81**	-0.43**	0.65**	0.94**	1.82**	0.26**	0.01	-0.07	-0.29**	1.12**	1.21**	1.23**	1.51**
GC9024	-1.22**	-1.06**	-1.73**	-1.96**	0.19	0.29	0.20	-0.12	0.36	0.16	-0.75**	-0.47**	-0.32**	-0.24**	0.38**	0.45**	-0.30	0.42
GC9040	0.54**	-0.40**	0.81**	0.16	-0.81**	-1.61**	2.65**	2.53**	5.04**	5.88**	0.14	0.29**	-0.08	0.05	1.29**	1.07**	3.72**	4.11**
SE (GG_i)	0.19	0.21	.21	0.20	0.32	0.30	0.19	0.10	0.37	0.34	0.15	0.13	0.12	0.11	0.8	0.08	0.41	0.41

* Significant at 5 per cent.

** Significant at 1 per cent.

TABLE 3

Estimates of sca effects of two best crosses each per character (Parenthesis showed sca value).

Characters	*Best two cross*	
	F_1	F_2
Days to flowering	V240 x V269 (-3.59**) V240 x GC9024 (-2.68**)	V269 x GC9040 (-2.73**) V240 x GC9017 (-2.07**)
Days to maturity	V240 x GC9024 (-3.50**) V240 x GC9017 (-3.23**)	GC2 x GC3 (-2.96**) Pusa Phalguni x V240 (-2.23**)
Plant height	V240 x GC90017 (-14.04**) Pusa Phalguni x V269 (-10.20**)	V240 x GC9017 (-12.73**) PP x V269 (-7.94**)
Branches per plant	RC8 x GC9040 (5.69**) GC2 x V269 (5.41**)	RC8 x GC9040 (7.96**) GC2 x V240 (6.90**)
Pods per plant	GC9017 x GC9024 (9.84**) PP x RC8 (8.15**)	V269 x GC9017 (10.80**) RC8 x GC9040 (9.83**)
Pod length	V269 x GC9017 (2.10**) PP x RC8 (1.44**)	GC3 x GC9017 (1.42**) GC3 x V240 (1.38**)
Seeds per pod	V269 x GC9017 (2.23**) GC2 x V269 (2.01**)	PP x GC2 (1.72**) GC2 x GC3 (1.66**)
100-seed weight	V269 x GC9017 (3.69**) V240 x GC9040 (1.97**)	PP x GC2 (1.85**) GC3 x GC9040 (1.35**)
Yield per plant	PP x RC8 (9.45**) GC9017 x GC9024 (8.57**) GC3 x GC9040 (6.43**) GC3 x GC9017 (5.27**) V269 x GC9017 (4.48**)	GC3 x GC9017 (8.38**) GC2 x V240 (8.27**) GC3 x GC9040 (5.67**) V269 x GC9017 (3.12) PP x RC8 (-1.97**)

F_2 was Pusa Phalguni x V 240. For plant height second best hybrid was Pusa Phalguni x V 269 . The cross combination RC 8 x GC 9040 expressed sca effect for branches per plant in both generation and for pods per plant in F_2. The cross GC 2 x V 269 was sesond best combiners for branches per plant and seeds per pod in F_1, whereas GC 2 x V 240 for branches per plant and grain yield in F_2. The cross GC 9017 x GC 9024 was best combiners for pods per plant and yield in F_1, Pusa Phalguni x RC 8 for pods per plant, pod length and yield per plant in F_1. The hybrid V 269 x GC 9017 expressed significantly sca effect for pods per plant in F_2 and for pod length, seeds per pod and test weight in F_1. The cross combination GC 3 x GC 9017 exhibited highest sca effect for pod length and grain yield in F_2 whereas, GC 3 x V 240 for pod length in F_2 only. The cross Pusa Phalguni x GC 2 expressed highest sca effect for seeds per pod and test weight in F_2. The cross combination V 240 x GC 9040 in F_1 and GC 3 x GC 9040 in F_2 exhibited sca effect for test weight.

The specific combining ability effects for grain yield some crosses [Pusa Phalguni x RC 8 and V 269 x GC 9017] were higher in F_1 and low in F_2. They also involved both or atleast one poor combining parent.This suggested the presence of mainly dominance and dominance x dominance or dominance x additive type of gene actions. To exploit prevalling variability of such crosses methods like biparental mating in early segregating generations would be more useful than pedigree method. In crosses like GC 3 x GC 9017 and GC 3 x GC 9040 which showed high sca effect in both the generation for grain yield involved both the good combining parents. It could be due to the presence of additive x additive type of epistasis. Such hybrid can be handled by simple pedigree method to isolate elite and high yielding lines.

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