RESEARCH PAPER International Journal of Agricultural Sciences, January to June, 2010, Vol. 6 Issue 1 : 135-137

Concept of general and specific combining ability in relation to diallel crossing system

SNEHAL P. PATEL[1], P.S. BHARODIA AND D.K. KAKADE[1]*
Junagadh Agricultural University, JUNAGADH (GUJARAT) INDIA

ABSTRACT

Combining ability was studied in 7x7 diallel set (excluding reciprocals) of cowpea for pod yield and its nine component characters. Both GCA and SCA variances were highly significant. The higher magnitude of GCA variance compared to SCA variance indicated preponderance of additive gene effects for the inheritance of all the characters studied. Parents JCPL 2000-10 and GC-4 were identified as good general combiners for pod yield per plant as well as for pod length and leaf area. Majority of their crosses had also manifested significant and desirable SCA effects, coupled with high *per se* performance for pod yield per plant. Out of 21 crosses, 11 hybrids displayed significant and desirable SCA effects for pod yield per plant. Of these, three hybrids *viz.*, GC-3 x GC-4, JCPL 2000-10 x JCPL 2000-2 and JCPL 2000-10 x GC-4 had exhibited high positive SCA effects in addition to high *per se* performance for the trait. An analysis of crosses revealed majority of the superior crosses were involved high x low and in few cases high x high or low x low general combiners.

Key words : Cowpea, Diallel cross, Combining ability

INTRODUCTION

Cowpea (*Vigna unguiculata* (L.) Walp.) is one of the important pulse crop which is used extensively in Indian diet. It is grown during rainy and summer seasons as a vegetable crop in most part of India and also for grain and fodder purposes. Green tender pods form an excellent nutritious vegetable and have got a potential to solve the protein problem of human diet. Cowpea is a highly self pollinated crop and the possibility of exploiting hybrid vigour depends on the direction and magnitude of heterosis and type of gene action involved. The breeding method for improvement of crop depends primarily on the nature of gene action involved in the expression of quantitative traits of economic importance. Combining ability leads to identification of parents with GCA effects and in locating cross combinations showing high SCA effects, this helps in choosing the parents to be included in hybridization or population breeding programme. The present investigation had been undertaken on cowpea to know the type of gene action governing yield and other quantitative traits and to identify the parents and crosses which could be exploited for future breeding programme.

MATERIALS AND METHODS

Seven genotypes *viz.*, JCPL 2000-7, JCPL 2000-10, GC-2, JCPL 2000-2, GC-3, GC-4 and Pusakomal were selected on the basis of their diverse geographical origin and conspicuously different morphological characteristics including the yielding ability. These were crossed in all possible combinations excluding reciprocals. A set of 28 entries comprising of seven parents and their 21 hybrids were sown in a Randomized Block Design with three replications at College farm of Agriculture College, Junagadh Agricultural University, Junagadh, Gujarat, India during *Kharif* 2001. Each entry was sown in single row of 3.0 m length having 60 x 30 cm crop geometry. A single row non-experimental row was grown all around the experimental area to neutralize the border effects. All the recommended cultural practices were adopted to raise good crop of cowpea. Data were recorded on five random, competitive plants for each entry, in each replication and the average values were computed. Observations on days to 50 per cent flowering and days to first picking were, however, noted on plot basis. Observations for number of seeds per pod, pod length (cm), number of primary branches per plant, plant height (cm) and leaf area (cm^2) were recorded at last picking. Data on number of pods per plant and green tender pod yield per plant (g) were obtained for each picking and was summed over picking to get total. The average values were computed for both traits. For protein content (%), the nitrogen was estimated in per cent on oven dry basis by using modified '*Kjeldal* method' as described by Jackson (1973). The per cent crude protein was calculated by multiplying per cent nitrogen by 6.25. The general combining ability (GCA) and specific combining ability (SCA) variances and effects were worked out according to Method 2, Model 1 of Griffing (1956).

*** Author for correspondence**
[1] Directorate of Groundnut Research (ICAR) JUNAGADH (GUJARAT) INDIA

RESULTS AND DISCUSSION

A perusal of the general combining ability effects for parents (Table 1) revealed that none of the parent showed desirable GCA effects simultaneously for all the characters. However, JCPL 2000-10 ranked first in respect to good general combiner for pod yield per plant. They also registered good general combining ability effects for five yield attributing characters *viz.*, days to 50 per cent flowering, days to first picking, pod length, leaf area and number of pods per plant. Similarly, GC-4 depicted significant and positive GCA effects for pod yield per plant. This parent was also appeared to be good general combiner for pod length, leaf area, plant height and protein content. The parent JCPL 2000-2 was found to be good source of genes for increasing number of branches per plant, leaf area, plant height and protein content. Whereas, early parents *viz.*, JCPL 2000-7 and Pusakomal were identified as good general combiners for days to 50 per cent flowering, days to first picking and number of pods per plant. A negative GCA effects for days to 50 per cent flowering and days to first picking is a favorable situation. The parent GC-2 was a good general combiner for number of seeds per pod and number of branches per plant. In contrast to these, parent GC-3 proved to be poor and average combiner for all the characters studied. These good combiner parents may be used in crop breeding programme aimed at improvement of the respective characters.

Among the parents, JCPL 2000-10 and GC-4 were registered to be good general combiners for pod yield per plant as well as for majority of yield contributing characters in which pod length and leaf area were common, indicating the importance of both these characters towards pod yield. Further, the parents, who recorded high mean pod yield per plant *viz.*, GC-4 and JCPL 2000-10 were good general combiners for five and six out of ten characters studied, respectively. A close relationship between the mean performance and GCA effects was also reported by Buhecha (1981), Godhani (1986), Thiyagarajan *et al.* (1993) and Sawant (1995). Hence, these parents could be utilized in crossing programme to generate genetic variability for effective selection to develop high yielding varieties of cowpea.

It is apparent that none of the cross combination was found to be consistently good for all characters. Eleven crosses had exhibited significant desirable SCA effects for pod yield per plant. Among these, only three crosses *viz.*, GC-3 x GC-4, JCPL 2000-10 x JCPL 2000-2 and JCPL 2000-10 x GC-4 had recorded significant and high positive SCA effects, coupled with high *per se* performance for pod yield per plant. The hybrid GC-3 x GC-4 manifested the highest SCA effects for pod yield per plant. This cross had also recorded significant and desirable SCA effects for five component traits *viz.*, number of pods per plant, number of branches per plant, pod length, number of seeds per pod and days to 50 per cent flowering. The cross combination JCPL 2000-10 x JCPL 2000-2 had also depicted significant and desired SCA effects for yield attributing characters *viz.*, number of pods per plant, protein content, plant height, leaf area, days to 50 per cent flowering and days to first picking. JCPL 2000-10 x GC-4 produced the highest mean pod yield per plant. This cross combination portrayed low SCA effects for leaf area and high SCA effects for pod yield per plant, number of branches per plant and plant height. Moreover, it showed average SCA effects for number of pods per plant, pod length, number of seeds per pod and protein content. Thus, the *per se* performance of crosses was found to be related with SCA effects of hybrids for pod yield per plant and its majority of component characters.

Table 1 : Estimates of General Combining Ability effects of parents for pod yield and its component traits in cowpea

Sr. No.	Parent	Pod yield per plant	Days to 50 % flowering	Days to first Picking	Number of seeds per pod	Pod length	Leaf area	Number of branches per plant	Plant height	Number of pods per plant	Protein content
1.	JCPL 2000-7	-2.22	-3.04**	-2.44**	-0.35*	-1.57**	-14.07**	-0.41**	-13.16**	8.28**	0.14
2.	JCPL 2000-10	32.89**	-4.78**	-4.41**	0.21	2.63**	9.14**	-0.98**	-29.42**	3.10**	-0.57*
3.	GC-2	-6.88*	-0.44	-0.11	1.15**	0.32	-7.71**	0.87**	4.32	-1.32	-1.31**
4.	JCPL 2000-2	-15.22**	3.93**	3.26**	-0.24	-0.39	13.62**	0.82**	24.06**	-2.85**	0.79**
5.	GC-3	-12.96**	1.52**	1.19*	-1.04**	-2.46**	-5.81**	0.22	-8.31**	0.53	-0.77**
6.	GC-4	9.97**	5.59**	4.93**	0.18	2.59**	33.70**	-0.44**	27.84**	-11.32**	0.92**
7.	Pusakomal	-5.59*	-2.78**	-2.41**	0.11	-1.13**	-28.87**	-0.08	-5.34*	3.57**	0.23
	S. E. (gi) ±	2.61	0.49	0.55	0.15	0.27	1.88	0.12	2.44	0.68	0.58
	S.E. (gi-gj) ±	3.68	0.76	0.84	0.22	0.41	2.87	0.19	3.73	1.03	0.21

*, ** = Significant at 5% and 1% levels, respectively.

Table 2 : Mean pod yield and hybrids showing significant positive SCA effects for pod yield along with its component traits in cowpea

Hybrids	Pod yield Per plant (g)	Significant positive SCA effects for pod yield alongwith its component traits									
		Pod yield per plant	Days to 50 % flowering	Days to first Picking	Number of seeds per pod	Pod length	Leaf area	Number of branches per plant	Plant height	Number of pods per plant	Protein content
P_5xP_6	211.67	53.79**	-5.44**	-1.94	2.66**	1.96*	-45.09**	1.13**	-13.88	9.80**	-2.02**
P_3xP_5	185.67	44.64**	-1.74	-0.57	-2.84**	-1.70*	20.32**	1.42**	-31.69**	16.61**	0.73
P_2xP_4	222.00	43.45**	-9.48**	-7.69**	0.63	0.75	32.86**	0.14	62.34**	10.56**	2.74**
P_2xP_6	246.00	42.27**	2.19	2.31	0.51	1.45	-60.86**	1.13**	48.23**	1.63	0.16
P_4xP_7	167.33	27.27**	-1.48	-2.69	1.20**	1.03	25.34**	0.89*	34.94**	4.30*	-2.84**
P_2xP_5	206.67	25.86**	-3.41*	-4.28**	0.46	1.87	31.87**	1.01**	4.38	11.05**	-2.52**
P_1xP_4	167.33	23.90**	-7.89**	-5.98**	0.49	-0.54	-4.88	0.61	-54.92**	10.18**	2.15**
P_1xP_7	176.67	23.60**	-3.19*	-3.98*	0.51	1.04	-41.77**	-0.25	26.16**	13.03**	-0.03
P_2xP_7	210.67	22.49**	-2.44	-2.02	0.08	-0.25	8.29	-0.02	-9.92	3.35	1.79**
P_1xP_5	167.67	21.97**	-4.81**	-3.91*	-2.67**	-1.31	0.05	0.78*	-22.21**	9.27**	2.61**
P_2xP_3	207.00	20.12**	-3.78**	-2.98	0.41	-0.45	-33.04**	-0.18	-15.58*	6.97**	-0.16
S.E..(Sij)±	-	7.58	1.44	1.61	0.43	0.80	5.46	0.36	7.09	1.97	0.58

P_1=JCPL 2000-7, P_2=JCPL 2000-10, P_3=GC-2, P_4=JCPL 2000-2, P_5=GC-3, P_6=GC-4 and P_7= Pusakomal
* and ** indicate of significance of values at P = 0.05 and 0.01, respectively,

An analysis of the GCA effects of the parents for 11 crosses (Table 2) with regards to pod yield per plant revealed that five crosses *viz.*, GC-3 x GC-4, JCPL 2000-10 x JCPL 2000-2, JCPL 2000-10 x GC-3, JCPL 2000-10 x Pusakomal and JCPL 2000-10 x GC-2 showing high SCA effects involved one good general combiner indicating an additive x dominance type of gene interaction. These crosses could be utilized to produce desirable transgressive segregants in subsequent generations as suggested by Langham (1961) and Sawant (1995). The cross with both good general combiner parents (JCPL 2000-10 x GC-4) had also exhibited high SCA effects, indicating the role of additive x additive type of gene action and hence, a good scope for fixation of the heterotic effects through the isolation of high yielding homozygous lines in advance generations. GC-2 x GC-3 and JCPL 2000-2 x Pusakomal recorded high SCA effects, which involved both parents with low GCA effects indicating a dominance x dominance type of gene interaction. Thus, the crosses JCPL 2000-10 x GC-4, JCPL 2000-10 x JCPL 2000-2, and GC-3 x GC-4 were most promising on the basis of *per se* performance and SCA effects, which are expected to throw transgress segregates.

REFERENCES

Buhecha, K.V. (1981). A genetic study of yield and its component in cowpea. M. Sc. (Ag.), Thesis Gujarat Agricultural University, Sardarkrushinagar, India.

Godhani, P.R. (1986). Stability parameters and combining ability studies in cowpea. Ph.D., Thesis Gujarat Agricultural University, Sardarkrushinagar, India.

Griffing, B, (1956). *Australian J. Biol. Sci.*, **9** : 463-493.

Jackson, M.L. (1973). *Soil Chemical Analysis,* Prentice Hall of India, Private Limited, New Delhi.

Langham, D.G.(1961). The high low method of crop improvement. *Crop Sci.*,**1**: 376-378.

Sawant, D.S.(1995). Combining ability studies in cowpea. *Ann. agric. Res.*, **16**(2): 206-211.

Thiyagarajan, K., Natrajan, C., Rathnaswamy, R. and Rajasekaran, S.(1993). Combining ability for yield and its component in cowpea. *Madras agric. J.*, **80**(3) : 124-129.

Received : June, 2009; Accepted : September, 2009