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Combining ability analysis for yield and its components in cowpea *(Vigna unguiculata* (L.) Walp)

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Abstract : Combining ability analysis involving eight lines and three testers was made in cowpea and studied for 12 characters. The variance due to *gca* and *sca* showed that the gene action was predominantly additive for plant height, pod length, number of seeds per pod, hundred seed weight, green pod weight, protein content in pod, crude fibre content in pod and vegetable yield per plant and non-additive for number of branches per plant, number of clusters per plant, number of pods per plant and grain yield per plant. The genotypes VCP 24, VCP 29, VCP 34, CO 2 and VBN 2 were found to be the good general combiners. The hybrids VCP 24 x CO 2, VCP 24 x VBN 2 and VCP 29 x CO 2 were observed to have more *sca* effects for vegetable yield.

Keywords: cowpea, gca effect, sca effect,* GCA *variance,* SCA *variance

Introduction

Cowpea is grown since ancient times in India and it forms one of the components of the *'navadhanya'*. Cowpea is drought tolerant crop that withstands heat better than most other legumes but not cold and hence in Tamil Nadu it is grown in dry areas under limited soil moisture. To isolate high yielding genotypes, an understanding of genetic architecture of the crop is obligatory to the plant breeder. Combining ability analysis of the parents and their crosses provides information on the nature of gene action. Hence this present investigation was carried out with eight lines and three testers to study the nature of gene action governing different traits.

Materials and Methods

Eight female parents (L_1-VCP 16, L_2-VCP 24, L_3-VCP 29, L_4-VCP 34, L_5-VCP 36, L_6-VCP 37, L_7-VCP 39 and L_8-VCP 44) and three male parents (T_1-CO2, T_2-P152 and T_3 - VBN 2) were used for this study. The 11 parents and their F_1's were grown in randomized block design with two replications. Each genotype was represented by a row of 3m length with 45x15cm spacing. All the agronomic practices and plant protection measures were adopted as per package of practices. Observations were recorded from five randomly selected plants from each line/genotype for 12 characters *viz.* plant height number of branches per plant, number of clusters per plant, number of pods per plant, pod length, number of seeds per pod, 100 seed weight, green pod weight, protein content in pod, crude fibre content in pod, grain yield per plant and vegetable yield per plant.

Mean value of the five plants of each genotype in each replication was used for

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

S.No.	Source	df	Plant height	No. of branches per plant	No.of clusters per plant	No. of pods per plant	Pod length	No.of seed per pod	100 seed weight	Green pod weight	Protein content in pod	Crude fibre content in pod	Grain yield per plant	Vegetable yield per plant
1.	Hybrids	23	118.70*	3.31*	2.59*	12.48*	10.69*	6.09*	3.95*	22.61*	2.07*	1.72*	27.67*	267.43*
2.	Lines	7	338.09*	1.65*	4.44*	25.41*	32.32*	12.01*	7.77*	63.98*	3.67*	1.07*	56.61*	789.30*
3.	Testers	2	55.77*	0.71*	4.05*	12.66*	5.22*	18.48*	10.27*	21.93*	7.00*	14.16*	13.51*	236.36*
4.	Line x Tester interaction	14	17.99*	1.45*	1.45*	5.99*	0.66*	1.37*	1.13*	2.02*	0.57*	0.27*	15.23*	10.93*
5.	Error	23	0.20	0.35	0.08	0.19	0.18	0.04	0.02	0.07	0.03	0.02	0.13	0.32

* Significant at 5 per cent level.

statistical analyses following the method developed by Kempthorne (1957).

Results and Discussion

Analysis of variance (Table 1) revealed that the hybrids differed for all 12 characters. Significant differences were obtained between males and also for females for all characters, indicting sufficient variability in the lines and testers selected for the study. Line x tester interactions were also highly significant. The mean squares due to lines were of larger magnitude in comparison with those due to testers for plant height, number of branches per plant, number of clusters per plant, number of pods per plant, pod length, green pod weight, grain yield per plant and vegetable yield per plant. The results indicated the existence of more diversity in females for these characters. For number of seeds per pod, 100 seed weight, protein content in pod and crude fibre content in pod mean squares due to testers exceeded those for the lines indicating that for these characters there was more scope for exploitation in the male parents.

The general combining ability variances and specific combining ability variances were also estimated and the data are presented in Table 2. The magnitude of GCA variance was more than SCA variance for plant height, pod length, number of seeds per pod, 100 seed weight, green pod weight, protein content in pod, crude fibre content in pod and vegetable yield per plant. Hence these characters were controlled by additive gene action. This was in agreement with the results of Danam Shashibushan and Chaudhari (2000) for plant height; Inigo (1998) for pod length; Danam Shashibushan and Chaudhari (2000) for number of seeds per pod; Sawant (1995) for 100 seed weight and Nagaraj *et al.* (2002) for

Table 2. Magnitude of genetic variance for different traits

Sl.No.	Characters	GCA variance	SCA variance	σ^2A	σ^2D	$\sigma^2A : \sigma^2D$
1.	Plant height	16.26	8.89	32.52	8.89	3.65
2.	No. of branches per plant	-0.02	0.55	-0.04	0.55	-0.07
3.	No. of clusters per plant	0.25	0.69	0.50	0.69	0.72
4.	No.of pods per plant	1.18	2.90	2.36	2.90	0.81
5.	Pod length	1.6	0.24	3.20	0.24	13.33
6.	No. of seeds per pod	1.26	0.67	2.52	0.67	3.76
7.	100 seed weight	0.72	0.56	1.40	0.56	2.50
8.	Green pod weight	3.72	0.98	7.40	0.98	7.55
9.	Protein content in pod	0.43	0.27	0.86	0.27	3.19
10.	Crude fibre content in pod	0.67	0.13	1.34	0.13	10.31
11.	Grain yield per plant	1.80	7.55	3.60	7.55	0.48
12.	Vegetable yield per plant	45.62	5.29	91.24	5.30	17.21

vegetable yield per plant. The magnitude of SCA variance was more than GCA variance for number of branches per plant. Hence these characters were under the control of dominance gene action. This was in agreement with the results of Janardhanam (2000) for number of branches per plant; Danam Shashibushan and Chaudhari (2000) for number of clusters per plant; Nagaraj *et al.* (2002) for number of pods per plant and Rangiah (2000) for grain yield per plant.

General combining ability data in respect of lines as well as testers are given in Table3. Significant *gca* effects for plant height were recorded by seven parents *viz.*, VCP29, VCP 39, L2-VCP 44, CO2 and P152. Similarly significant *gca* effect was seen for VCP 24 and VCP 29 for number of clusters per plant; VCP 24, VCP 29, VCP 37 and P152 for number of pods per plant; VCP24, VCP29, CO2 and VBN2 for pod length; VCP29, VCP44, CO2 and P152 for number of seeds per pod; VCP24, VcP29, VCP34, CO2 and P152 for 100 seed weight; VCP24, VCP29, CO2 and P152 for 100 seed weight; VCP24, VCP29, CO2 and VBN2 for green pod weight; VCP24, VCP29, VCP34, VCP36, VCP44, CO2, P152 and VBN2 for protein content in pod; VCP24, VCP29, VCP37, VCP44, CO2 and VBN2 for crude fibre content in pod; VCP24, VCP29, VCP34, VCP36, P152 and VBN2 for grain yield per plant and VCP24, VCP29, VCP34, CO2 and VBN2 for vegetable yield per plant.

The values for specific combining ability effect of hybrids for all characters and all crosses are presented in Table 4. Nine hybrids recorded significant and positive *sca* effect for plant height and green pod weight; seven hybrids recorded significant and positive *sca* effect for number of branches per plant and

Table 3. General combining ability *(gca)* of effects of parents for different traits.

Parents	Plant height	No.of branches per plant	No.of clusters per plant	No.of pods per plant	Pod length	No.of seeds per pod	100 seed weight	Green pod weight	Protein content in pod	Crude fibre content in pod	Grain yield per plant	Vegetable yield per plant
Lines												
L1	-4.40*	-0.89*	-0.42*	-1.39*	-1.90*	-0.59*	-1.46*	-2.60*	-0.92*	0.73*	-3.30*	-6.17*
L2	4.84	0.78*	1.08*	1.87*	3.01*	-0.30*	1.36*	3.61*	0.35*	-0.12*	2.59*	13.90*
L3	6.75*	0.39*	1.45*	2.39*	4.13*	3.30*	1.54*	6.21*	0.81*	-0.76*	3.74*	20.03*
L4	-9.08*	0.14	-1.12*	-1.86*	0.13	-0.60*	0.28*	-0.10	0.60*	0.28*	3.64*	4.05*
L5	-12.26*	-0.31	-0.12	-0.66*	-0.79*	-0.62*	0.08	-0.80*	0.38*	0.13*	0.89*	-10.34*
L6	4.70*	-0.32	0.10	3.01*	-1.54*	-0.72*	0.03	-2.25*	-0.40*	-0.19*	-3.36*	5.34*
L7	6.54*	-0.16	-0.44*	-1.73*	-2.00*	-1.05*	-0.21*	-3.09*	-1.32*	-0.07	-1.60*	-9.90*
L8	2.91*	0.36	-0.52*	-1.63*	-1.04*	0.58*	-1.61*	-0.97*	0.50*	0.01	-2.58)	-6.23*
SE	0.14	0.19	0.09	0.14	0.13	0.06*	0.04	0.08	0.05	0.05	0.12	0.18
Testers												
T1	0.94*	0.01	-0.06	-0.22*	0.65*	0.16*	0.05*	0.90*	0.24*	-0.15*	-1.04*	1.00*
T2	1.21*	-0.21*	-0.47*	0.76*	-0.41*	0.99*	0.78*	-1.32*	-0.75*	1.01*	0.70*	-4.25*
T3	-2.15*	0.20*	0.53*	0.98*	0.24*	-1.15*	-0.82*	0.42*	0.51*	-0.85*	0.34*	3.25*
SE	0.08	0.10	0.05	0.07	0.07	0.03	0.02	0.05	0.03	0.02	0.006	0.10

* Significant at 5 per cent level

number of clusters per plant; nine hybrids recorded significant and positive *sca* effect for number of pods per plant; four hybrids recorded significant and positive *sca* effect for pod length; eight hybrids recorded significant and positive *sca* effect for number of seeds per pod, grain yield per plant and vegetable yield per plant; 11 hybrids recorded significant and positive *sca* effect for 100 seed weight; ten hybrids recorded significant and positive *sca* effect for protein content in pod and seven hybrids recorded significant and positive *sca* effect for crude fibre content in pod

The hybrids VCP 34 x P152, VCP 36 x P152 exhibited significant and positive *sca* effects. Since the parents of these hybrids were good general combiners these hybrids could be exploited through pedigree system of breeding technique. Another hybrid namely VCP 29 x CO2 which was also resulted from good general combiners showed significant *sca* effect for vegetable yield. So this hybrid could be exploited for developing variety. The appropriate breeding technique is pedigree system of selection. In addition to the above three hybrids, yet another set namely

Table 4. Specific combining ability effects *(sca)* of hybrids for different traits.

Hybrids	Plant height	No.of branches per plant	No.of clusters per plant	No.of pods per plant	Pod length	No.of seeds per pod	100 seed weight	Green pod weight	Protein content in pod	Crude fibre content in pod	Grain yield per plant	Vegetable yield per plant
L_1 x T_1	5.00*	-0.38	-0.30*	-1.25*	0.06	0.52*	-0.48*	0.75*	-0.21*	0.05	-1.18*	-0.20
L_1 x T_2	-1.53*	0.95*	1.15*	2.79*	-0.02	0.45*	1.29*	-0.78*	0.48*	-0.16*	2.98*	-2.15*
L_1 x T_3	-3.47*	-0.57*	-0.85*	-1.55**	-0.04	-0.97*	-0.81*	0.03	-0.28*	0.10	-1.80*	0.13
L_2 x T_1	3.01*	0.25	0.00	0.59*	0.35	0.84*	0.10	0.08	0.53*	0.25*	1.09*	2.36*
L_2 x T_2	-3.11*	-0.42	0.20	-0.47*	-0.79*	-0.19*	-0.03	0.11	-1.14*	-0.11	-1.10*	-2.32*
L_2 x T_3	0.10	0.17	-0.20	-0.11	0.44*	-0.65*	-0.08	-0.19	0.61*	-0.15*	0.01	2.19*
L_3 x T_1	-1.20*	0.69*	0.03	0.19	0.20	0.04	-1.08*	0.93*	0.36*	-0.31*	-0.26	2.55*
L_3 x T_2	1.82*	-1.24*	0.54*	-0.07	-0.44*	-0.39*	0.19*	0.69*	-0.60*	0.33*	0.00	-3.30*
L_3 x T_3	-0.62*	0.55*	-0.56*	-0.11	0.24	0.35*	0.89*	-0.24	0.24*	-0.01	0.26	0.76
L_4 x T_1	1.03*	-0.01	-1.20*	-0.78*	-0.77*	-1.26*	-0.41*	-0.50*	-0.37*	-0.15*	0.29	-1.47*
L_4 x T_2	-0.55*	1.11*	-0.20	-0.14	0.69*	1.31*	0.16*	0.92*	0.41*	0.09	0.35*	0.03
L_4 x T_3	-0.48*	-1.10*	1.40*	0.92*	0.08	0.05	0.26*	-0.42*	-0.04	0.05	-0.64*	1.44*
L_5 x T_1	-5.59*	-0.66*	0.50*	0.82*	-0.50*	-0.24*	0.44*	0.15	-0.01	0.60*	-2.41*	0.86*
L_5 x T_2	2.34*	1.06*	-0.60*	-1.54*	0.71*	0.13	-0.99*	-0.58*	0.18*	0.19*	1.25*	-2.53*
L_5 x T_3	3.25*	-0.40	0.10	0.72*	-0.1	0.11	0.56*	0.43*	-0.17*	-0.80*	1.16*	1.66*
L_6 x T_1	1.15*	-0.40	0.43*	-1.55*	0.70*	0.51*	0.54*	0.75*	0.23*	-0.23*	-0.96*	0.66
L_6 x T_2	-0.28	-0.27	-0.61*	1.19*	-0.49*	-0.52*	-0.09	-1.03*	-0.24*	0.01	-3.10*	1.41
L_6 x T_3	-0.87*	0.67*	0.19	0.35*	-0.21	0.01	-0.44*	0.28*	0.01	0.22*	4.06*	-2.08
L_7 x T_1	-1.64*	0.44	0.96*	3.19*	-0.19	0.04	0.47*	-2.17*	-0.41*	-0.05	4.77*	-0.87
L_7 x T_2	1.49*	-0.49	-0.08	-1.17*	0.63	-1.14*	0.09	1.56*	0.53*	-0.36*	-3.67*	-1.56*
L_7 x T_3	0.15	0.05	-0.88*	-2.01*	-0.44	1.10*	-0.56*	0.61*	-0.13	0.40*	-1.10*	2.43*
L_8 x T_1	-1.75*	0.07	-0.40*	-1.21*	0.15	-0.44*	0.42*	0.01	-0.12	-0.18*	-1.34*	-1.65*
L_8 x T_2	-0.18	-0.70*	-0.40*	-0.57*	-0.29	0.33*	-0.61*	0.49*	0.36*	0.01	3.31*	-0.56
L_8 x T_3	1.93*	0.63*	0.80*	1.79*	0.14	0.11	0.19*	-0.50*	-0.24*	0.17*	-1.97*	2.25*
SE	0.20	0.27	0.13	0.11	0.19	0.09	0.06	0.12	0.07	0.07	0.16	0.26

* Significant at 5 per cent level

VCP 24 x CO2 and VCP 36 x VBN 2 also displayed significant *sca* effects. Their parents are one poor and one good general combiner. From this type of parental combination one may expect transgressive segregants in later generation. To obtain such progenies with high grain yield, the best approach would be biparental method of plant breeding.

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