

Research Article**Studies on hybrid vigour and combining ability for seed yield and contributing characters in cowpea (*Vigna unguiculata*)**

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Abstract

The combining ability aids in better selection of parents besides elucidating the nature and magnitude of gene action. Heterosis and combining ability analysis were carried out in line x tester model using five lines viz., Kanakamany, Subadra, TC 49-1, Lola and Sarika and five testers viz., CO2, CO4, CO6, CO (CP) 7 and VBN 1. The results revealed that TC 49-1, Lola, Sarika, VBN1, CO2 and CO (CP)7 were found to be good general combiners for seed yield. Among the parents, TC 49-1, Lola and VBN1 were found good general combiners for days to 50% flowering, plant height, cluster / plant, pods / plant, length of pod and number of seeds / plant. The crosses Lola x VBN 1, Sarika x VBN 1 and Sarika x CO (CP) 7 were the best specific combination for grain yield. The two crosses Lola x VBN 1 and Sarika x CO 4 showed significant heterosis over the standard latest variety CO (CP)7 for seed / pod, cluster / plant, pods / plant and 50% flowering. The crosses TC 49-1 x CO 2 showed high heterosis over standard variety for plant height and clusters/plant. Hence, these hybrids can be utilized for commercial cultivation.

Key words: Combining ability, heterosis, seed yield, cowpea

Introduction

Cowpea is an important grain legume, which is tolerant to drought and other soil stresses. Cowpea has the unique ability to fix nitrogen in very poor soils. It is shade tolerant and compatible as an inter crop with a number of cereals, root crops as well as with cotton, sugarcane and several plantation crops. Cowpea is cultivated in 12.5 million hectare with an annual production of over 3 million tones world wide. In Tamil Nadu, cowpea is grown in 1.2 lakh with a production of 0.25 lakh tons and the productivity is very low with 205 kg/ha.

In India, cowpea is cultivated for seed, fodder, green pods, green manure and cover crop (Rachie, 1985). Many constraints are identified for low productivity. So improvement on cowpea is possible by strengthening the genetic potentiality by utilizing available variability. The combining ability studies provide useful information for the selection of parents for effective breeding besides elucidating the nature and magnitude of gene action involved. Success of hybridization programme depends upon

the magnitude of heterosis which also helps in the identification of potential cross combination to be used in the conventional breeding programme to create wide array of variability in the segregating generations. Therefore, the present study was undertaken to estimate combining ability and heterosis for yield attributes in cowpea.

Materials and Methods

The present investigation on cowpea was conducted at Agricultural College and Research Institute, Madurai during 2007. Using five lines viz., Kanakamany, Subadra, TC 49-1, Lola and Sarika and five testers viz., CO2, CO4, CO 6, CO (CP)7 and VBN 1 were crossed in a line x tester mating design. Twenty five hybrids combinations were obtained. The F1s along with the parents were raised in Randomized Block Design with two replications. A plot size of 3 meters length of single row was adopted for each genotype, with a spacing of 30 x 15 cm standard package of practices were followed with a basal dose of 10 kg nitrogen, 30 kg phosphorus and 30 kg potash per hectare. Observations were recorded on five plants chosen randomly in each replication. Observations on plant height, cluster / plant, pods /

plant, length of pod, 50% flowering, number of seed / pod and grain yield were recorded and mean values were used for statistical analysis. Heterosis was expressed as percentage increase (or) decrease of F1 as heterosis over mid parent, over better parent and over standard check variety and combining ability analysis was carried out as per the method described by Kempthorne (1957). The analysis was done using the GENRES statistical package.

Results and Discussion

Selection of the parents in the hybridization programme is very important for getting desirable recombinants in crop improvement. The results of analysis of variance for different characters are presented in Table 1. It revealed that parents and crosses were significant for all the characters viz., plant height, cluster / plant, pods / plant, length of pod, 50% flowering, number of seed / pod and grain yield, indicating the presence of variability. Higher and significant mean squares for lines than testers indicated greater contribution of lines to higher “sca” effects than that by the testers. The interaction between lines and testers were significant for clusters/plant, pods / plant, length of pod, 50% flowering, number of seed / pod and grain yield at 1% level and plant height at 5% level suggest that there is considerable variation among the crosses.

The estimates of variances for general combining ability and specific combining ability have been presented in Table 1. The ratio of specific combining ability component of variance to the general combining ability variance was found to be high for all the characters viz., plant height, clusters / plant, pods / plant, length of pod, 50% flowering, number of seed / pod and single plant yield indicating the preponderance of non-additive gene action governing the characters. As non-additive gene action was found to be predominant, all these traits can be improved through heterosis breeding. However, since cowpea is being a completely self pollinated crop and hybrid seed production is also very difficult without CMS, resorting to heterosis breeding will not be feasible. Therefore, hybridization followed by selection at later generations will be useful to improve all the traits and identify superior cowpea varieties. Rangiah (2000 and Nagaraj *et al.* (2002) also reported the importance of non-additive gene addition for yield contributing traits.

The (General Combining Ability) effect (Table 2) revealed that among the lines, TC 49-1, Lola, Sarika, VBN 1, CO 2 and CO (CP) 7 were found to be good general combiners for seed yield / plant. Among the

parents, TC 4901, Lola and VBN 1 were found good general combiners for days to 50% flowering, plant height, clusters / plant, pods / plant, length of pod and number of seeds / plant. Lola was a good general combiner for plant height, length of pod, number of seed / pod and pod yield. TC 49-1 for cluster / plant, pods / plant and pod yield. Sarika for 50% flowering, pods / plant number of seed / pod and VBN 1 showed positive gca effects for cluster / plant, pods / plant and number of seeds / pod. The lines TC 49-1 and VBN 1 and testers Lola and CO 2 showed negative gca effects for 50% flowering and TC 49-1 and Sarika showed negative gca effects for plant height and they may be used in breeding programme aimed at short duration types.

The specific combining ability effects for all crosses are presented in Table 3). The best specific cross of grain yield / plant was $L_4 \times T_2$ and $L_3 \times T_2$. This crosses showed high sca effects for 50% flowering, number of seeds / pod, cluster / plant. These crosses may be advanced through recurrent selection procedures to exploit both additive and non-additive gene actions. The cross $L_1 \times T_1$, $T_3 \times T_2$, $L_4 \times T_4$, $L_1 \times T_5$ and $L_5 \times T_4$ recorded significant negative sca effects in the 50% flowering.

Hence, present combining ability analysis revealed that predominance of non-additive gene action for all the traits studies. Among the parents, TC 49-1, Lola, Sarika, VBN 1, CO 2 and CO (CP) 7 was found to be good general combiners for grain yield and most of the yield components. The crosses, Lola x VBN 1, Sarika x VBN 1 and Sarika x CO (CP) 7 were the best specific combination for grain yield / plant.

The prime objective of hybrid programme is to converge the desirable genes from the parents on to a single genetic back ground. Scope for exploitation of hybrid vigour will depend upon per se performance of hybrid and magnitude of heterosis. The real performance of a hybrid can not be predicted based on relative heterosis and heterobeltiosis. A hybrid is commercially valuable only when it exhibits significantly high standard heterosis over best locally adopted variety. Standard heterosis is also a reflection of pre se performance. Swaminathan *et al.* (1972) and Siddiq (1987) also emphasized the need for computing heterosis over standard variety.

The mean performance of hybrids and parents for different traits in cowpea are presented in Table 4. Among the twenty five hybrids eleven and ten hybrids exhibited shorter plant type and earlier flowering respectively and twelve hybrids recorded



positive significant for cluster / plant and pods / plant. Out of 25 hybrids, 11 and 18 hybrids recorded positive significant for length of pod and number of seeds / pod respectively. High values of grain yield / pod was exhibited for various yield contributing traits viz., plant height, cluster / plant, pods / plant, length of pod, 50% flowering, number of seed / pod and grain yield / plant were selected. The hybrids Kanakamony x CO 2, TC 49-1 x CO (CP)7 and TC 49-1 x VBN 1 recorded positive significant for plant height, length of pod, 50% flowering and number of seed / pod.

The standard heterosis and better parent heterosis for hybrids presented in Table 5. Shorter plant type is an important character of hybrid to withstand lodging. In the present study, eight hybrids exhibited negative standard heterosis for plant height. Om Prakash (1999) also supported negative heterosis for plant height, TC 49-1 x CO 4 and Sarika x CO 4 hybrids recorded negative heterosis for plant height. Days to 50% flowering is an important characters for improvement of yield characters. All twenty five hybrids recorded significant negative heterosis for days to 50% flowering.

Clusters / plant is generally associated with higher productivity. Seventeen hybrids recorded significant positive standard heterosis and produced more number of clusters per plant. Among them, TC 49-1 x CO2 and Sarika x CO 2 recorded positive significant standard heterosis for clusters per plant. Heterosis for length of pod, in general relatively low in all hybrids, but only three hybrids recorded positively significant for length of pod. Pods per plant and number of seeds per pod are one of the most important components of yield and this character will be helpful in breaking the yield plateau.

Among the twenty five hybrids, 21 and 20 hybrids recorded significant positive standard heterosis for pods per plant and number of seeds per pod, respectively. Loganathan et al. (2001) also reported that pods per plant to increase the grain yield of plant. The hybrid Sarika x VBN 1 recorded positively significant heterosis for pods / plant and among the hybrids, Lola x VBN 1 and Sarika x CO (CP) 7 recorded positively high significant heterosis for number of seeds per pods. Only six hybrids exhibited significant positive standard heterosis for grain yield / plant. These results suggest developing hybrids from the parents possessing early maturity, semi dwarf height with higher yield.

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Table 1. ANOVA for combining ability (mean squares) for grain yield and its components in F₁ generation

Source of variation	Df	Plant height	Cluster / Plant	Pods / Plant	Length of pod	50% flowering	No. of seed / pod	Single plant yield
Parents	9	239.726**	8.778**	23.450**	7.210**	27.644**	3/911**	15.840**
Hybrids	24	174.729**	13.546**	59.996**	8.792**	8.421**	6.503**	101.000**
Lines	4	837.276**	30.530**	295.980**	18.295*	22.880**	9.070	201.512*
Tester	4	35.100	17.030	28.280**	1.886	11.180*	5.420	82.093
Line x Testers	16	44.020*	8.430**	8.930**	8.141**	4.117**	6.132**	80.608**
Error	34	17.593	1.498	1.831	1.250	0.420	0.686	2.770
σ^2 gca		1.876	0.547	0.605	0.500	0.289	0.370	0.744
σ^2 sca		4.195	1.224	1.353	1.118	0.648	0.828	1.665

* significant at 5% level

** significant at 1 % level

Table 2. General combining ability effects of parents for different characters

Parents	50% flowering	Plant height	Cluster / Plant	Pods / Plant	Length of pod	No. of seed / pod	Single plant yield
Lines							
L ₁	-0.460*	6.313**	0.760	-3.740**	-0.106	-0.080	1.466**
L ₂	0.940**	7.7480**	-2.040**	-4.940**	0.274	-0.980**	-5.914**
L ₃	-1.460**	-12.494**	2.160**	2.160**	-1.016	-0.880*	1.256*
L ₄	-1.160**	5.448**	-1.540**	-1.940**	1.824**	1.020**	5.886**
L ₅	2.140**	-7.012**	0.660	8.460**	-1.976**	0.920**	-2.604**
SE	0.2050	1.326	0.387	0.428	0.354	0.262	0.526
Tester							
L ₁	-0.560*	0.383	1.760**	-0.440	-0.196	0.220	2.046**
L ₂	0.340	2.338	-0.640	-1.040*	-0.566	-1.180	-1.794**
L ₃	1.340**	0.273	-0.440	-0.440	0.014	-0.080	3.996**
L ₄	0.340	-2.882*	-1.540**	-1.040*	0.614	0.220	-1.654**
L ₅	-1.460**	-0.112	0.860*	2.960**	0.134	0.820**	-2.594**
SE	0.205	1.326	0.387	0.428	0.354	0.262	0.526

* significant at 5% level

** significant at 1 % level

Table 3. Specific combining ability effects of hybrids for different characters

Parents	50% flowering	Plant height	Cluster / Plant	Pods / Plant	Length of pod	Number of seed / pod	Single plant yield
L ₁ x T ₁	-1.740**	-7.703*	-1.760*	0.640	1.196	1.080	1.744
L ₁ x T ₂	1.860**	-3.683	-2.360**	-0.260	0.416	-2.520**	-9.916**
L ₁ x T ₃	-0.640	-1.818	-0.060	-0.360	0.936	0.880	4.644**
L ₁ x T ₄	1.860**	4.286	3.040**	-0.760	-1.414	-1.420*	1.394
L ₁ x T ₅	-1.340**	8.917**	1.140	0.740	-1.134	1.980**	2.134
L ₂ x T ₁	0.360	-0.263	-0.460	0.840	0.766	-0.520	-3.976**
L ₂ x T ₂	0.960*	0.182	-0.060	1.440	1.986*	-0.120	-1.186
L ₂ x T ₃	-1.040**	-3.153	-0.260	0.340	0.656	0.280	1.524
L ₂ x T ₄	-1.040**	0.652	-0.160	1.440	-2.894**	0.480	3.224**
L ₂ x T ₅	0.760	2.582	0.940	-4.060**	-0.514	-0.120	0.414
L ₃ x T ₁	-0.740	1.831	1.40	1.240	-0.894	0.380	-5.546**
L ₃ x T ₂	-1.640	4.027	-0.260	0.340	-0.174	-0.220	0.294
L ₃ x T ₃	0.860	-3.403	0.640	1.340	0.146	0.380	-5.496**
L ₃ x T ₄	1.860	-3.403	0.640	1.340	0.146	0.380	0.294
L ₃ x T ₅	-0.340	-1.023	-3.260**	-2.660**	-0.124	0.780	-5.496**
L ₄ x T ₁	1.960**	0.287	-0.960	0.340	-2.134*	-1.520*	-0.346
L ₄ x T ₂	-0.940*	1.082	-0.560	-1.060	-2.104*	1.380*	11.094**
L ₄ x T ₃	0.060	1.797	1.240	-1.660	-2.594**	0.280	5.424**
L ₄ x T ₄	-1.440	0.802	-1.160	-1.060	4.806**	-1.520*	2.564**
L ₄ x T ₅	0.360	-3.968	1.440	3.440**	1.936*	1.380**	-3.176**
L ₅ x T ₁	0.160	5.846	1.840*	-3.060**	1.066	0.580	2.354
L ₅ x T ₂	-0.240	-1.608	3.240**	-0.460	-0.214	1.480*	8.244**
L ₅ x T ₃	0.760	4.607	-2.460**	1.940	-0.044	-0.120	2.504**
L ₅ x T ₄	-1.240*	-2.338	-2.60**	-0.960	-0.644	2.080**	-7.946**
L ₅ x T ₅	0.560	-6.508*	-0.260	2.540*	-0.164	-4.020**	-5.156**
SE	0.458	2.966	0.866	0.957	0.791	0.586	1.177

* significant at 5% level

** significant at 1 % level

Table 4. Mean performance of parents and hybrids for different traits in cowpea

Parents Vs hybrids	Plant height (cm)	Cluster / plant	Pods / Plant	Length of pod (cm)	Days to 50% flowering	No. of seeds / pod	Single plant yield (g)
L ₁	52.60	9.5	9.0	15.7	37.50	15.5	23.8
L ₂	47.25	7.5	9.5	13.1	37.00	13.0	24.7
L ₃	40.00	13.5	9.5	13.0	42.50	15.5	29.6
L ₄	65.60	9.0	7.5	14.5	44.50	17.5	24.0
L ₅	67.70	9.5	11.5	14.5	45.50	14.5	2.2
T ₁	70.30	8.5	13.0	19.1	41.50	15.5	31.4
T ₂	47.55	7.5	8.5	17.6	45.50	15.5	29.4
T ₃	42.60	8.5	11.0	15.5	47.50	13.5	24.7
T ₄	48.25	8.5	11.0	15.5	47.00	14.5	25.5
T ₅	46.50	13.0	16.5	15.5	47.00	14.5	25.5
L ₁ x T ₁	47.88	12.5	14.0	16.6	37.50	17.0	29.8
L ₁ x T ₂	53.85	9.5	12.5	15.5	42.00	12.0	14.3
L ₁ x T ₃	53.65	12.0	13.0	16.6	40.50	16.5	34.6
L ₁ x T ₄	56.60	14.0	12.0	14.9	37.00	14.5	25.7
L ₁ x T ₅	64.00	14.5	17.5	14.7	41.00	18.5	25.5
L ₂ x T ₁	56.75	11.0	13.0	16.6	42.50	14.5	16.7
L ₂ x T ₂	59.15	9.0	13.0	13.8	40.50	15.5	24.1
L ₂ x T ₃	53.75	9.0	12.5	16.7	40.50	15.5	20.2
L ₂ x T ₄	54.40	8.0	13.0	13.8	40.50	15.5	16.4
L ₂ x T ₅	59.10	11.5	11.5	15.7	37.50	15.5	16.4
L ₃ x T ₁	38.60	17.0	20.5	14.7	37.50	13.5	22.3
L ₃ x T ₂	42.75	13.0	19.0	16.8	41.00	13.5	24.3
L ₃ x T ₃	35.23	15.0	19.0	16.8	41.00	13.5	24.3
L ₃ x T ₄	30.10	13.0	20.0	16.5	41.00	15.5	23.8
L ₃ x T ₅	35.25	11.5	20.0	15.8	37.00	16.5	34.3
L ₄ x T ₁	55.00	11.0	15.5	15.3	40.50	15.5	37.9
L ₄ x T ₂	57.75	9.0	13.5	15.0	38.5	17.0	31.2
L ₄ x T ₃	56.40	11.0	13.5	15.5	40.50	17.0	31.2
L ₄ x T ₄	52.25	7.5	13.5	23.0	38.00	15.5	32.4
L ₄ x T ₅	50.25	12.5	22.0	19.7	38.00	19.0	19.3
L ₅ x T ₁	48.10	16.0	22.5	14.7	42.00	17.5	26.2
L ₅ x T ₂	42.60	15.0	24.5	13.0	42.50	17.0	28.3
L ₅ x T ₃	46.75	6.5	27.5	13.8	44.50	16.5	28.3
L ₅ x T ₄	36.65	8.5	24.0	13.8	41.50	19.0	12.2
L ₅ x T ₅	35.25	13.0	31.5	13.8	41.50	13.5	14.1

**Table 5. Estimates of heterosis % over better parent (BP) and standard check (SC) in the F1 generation**

Crosses	Plant height		Cluster / Plant		Pods / plant		Length of pod		50% flowering		No. of seed/pod		Single plant yield	
	SC	BP	SC	BP	SC	BP	SC	BP	SC	BP	SC	BP	SC	BP
L ₁ x T ₁	-0.777	-	47.059**	31.579**	27.273**	7.692**	7.491	-	-	-9.639**	30.469**	9.677**	9.779**	-5.104
L ₁ x T ₂	11.606*	31.899**	11.765	0.000	13.639	38.88**	0.000	-	21.053**	-7.692**	-7.692	-	-	-
L ₁ x T ₃	11.192*	1.996	41.176**	26.316**	18.182*	36.842**	7.097	-2.353	-	-	26.923**	6.452	27.675**	40.365**
L ₁ x T ₄	17.306**	7.605	64.706**	47.368**	9.091	9.091	-4.194	-5.414	-	-	11.538**	-6.452	-5.166	-5.166
L ₁ x T ₅	32.642**	21.673**	70.588**	11.538*	59.091**	-10.256*	-5.484	-6.688	-	-	42.308**	19.355**	-5.904	-0.196
L ₂ x T ₁	17.617**	-	29.412**	29.412**	18.182**	0.000	7.097	-	-13.684	-1.205	11.538**	-6.452	-	-46.890
L ₂ x T ₂	22.591**	19.275**	5.882	20.000*	18.182**	36.842**	12.580**	-0.852	-	-6.593**	3.846	-	-	-
L ₂ x T ₃	-11.399	13.757*	5.882	5.882	13.636	31.579**	7.742	-1.765	10.526**	-8.797**	15.385**	11.111**	-	46.939**
L ₂ x T ₄	12.746*	5.882	5.882	5.882	13.636	31.579**	7.742	-1.765	12.632**	-8.791**	15.385**	11.111**	-	-2.231
L ₂ x T ₅	22.487**	25.079**	35.294**	-11.538*	4.545	-41.026**	0.968	-0.968	-	-	19.231**	6.897	-	-
L ₃ x T ₁	-	-	100.00**	25.926**	86.364**	57.692**	-5.484	-	14.737**	14.737**	19.231**	19.231**	39.483**	35.812**
L ₃ x T ₂	20.000**	45.092**	52.941**	-3.704	72.727**	10.00**	-3.226	-	23.298**	21.053**	11.765**	3.846	-	25.646**
L ₃ x T ₃	-11.399*	-10.095	76.471**	11.111*	72.727**	100.00**	8.387	-1.176	14.773**	21.053**	17.582**	12.903**	10.517**	17.517**
L ₃ x T ₄	-	-	52.941**	-3.704	81.818**	81.818**	6.452	6.452	-	-	19.231**	0.000	26.384**	17.496**
L ₃ x T ₅	26.143**	24.194**	28.412**	22.222*	27.727**	58.824**	-3.226	-	13.684**	13.684**	30.769*	-2.857	14.945**	5.952
L ₄ x T ₁	13.990*	-	28.412**	22.222*	40.909**	19.231**	-1.613	-	14.773**	18.947**	19.231**	-	39.668**	20.734**
L ₄ x T ₂	19.689**	21.764**	5.882	0.000	22.727**	58.824**	-3.226	-	20.157**	14.737**	30.769*	-2.857	14.945**	5.952
L ₄ x T ₃	16.891**	11.966**	29.412**	22.222	22.727**	42.105**	-3.226	-11.765**	14.773**	18.947**	15.850**	-	15.129**	26.572**
L ₄ x T ₄	8.290	14.024**	-11.765	-16.667*	22.727**	22.727**	48.387**	48.387**	14.737**	18.947**	15.850**	-	19.557**	19.557**
		20.351**							20.000**	20.000**		11.429**		



L ₄ x T ₅	4.145	-	47.059**	-3.846	100.00**	12.821**	26.727**	48.387**	48.387**	-	19.231**	-	19.557**	19.557**
		23.399**								20.000**		11.429**		
L ₅ x T ₁	-0.311	-	88.235**	68.421**	104.545**	73.077**	-5.484	-	-	-7.692**	34.615**	12.903**	-3.321	-
		31.579**						23.298**	11.579**					16.427**
L ₅ x T ₂	-11.710*	-	76.471**	57.895**	122.727**	113.043**	-	-	-	-6.593**	30.469**	9.677**	4.244	-3.952
		37.075**					16.129**	26.136**	10.526**					
L ₅ x T ₃	-3.109	-	11.765	0.000	150.000**	139.130**	-11.290*	-	-6.316**	-2.198*	26.923**	13.793**	24.428	14.807**
		30.945**						19.118**						
L ₅ x T ₄	24.041**	45.846**	0.000	-10.526	48.182**	108.696**	-11.290*	-11.290*	-	-	-	-31.034	-	-
									12.632**	12.632**	46.154**			54.982**
L ₅ x T ₅	-	-	52.941**	0.00	186.364**	61.538**	-11.290*	-11.290*	-	-	3.846	-6.897	-	-
	26.943**	47.942**							12.632**	11.702**			48.155**	45.010**

* significant at 5% level

** significant at 1 % level