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COMBINING ABILITY STUDY FOR SEED YIELD IN COWPEA [*VIGNA UNGUICULATA* (L.) WALP]

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ABSTRACT

A study was carried out in half diallel fashion with twelve parents in cowpea. Parents were evaluated for estimation of *gca* and *sca* effects and variances for yield and yield contributing characters in four environments *i.e.*, two season in late *kharif* 2010 (E_1 and E_2) and two season in late *rabi* 2011 (E_3 and E_4). The combining ability analysis revealed significant differences among the parents for all the traits indicating the presence of preponderance of dominance gene action for all the traits. The parents GC- 4 and Re - 101 recorded significant gca effects for seed yield per plant and most attributes. Among the hybrids, the best mean performance and significant *sca* effects for seed yield per plant were noticed for cross CPD-103 x Re-79 followed by GC-4 x CPD-105 and Rev-7 x Re-79. These crosses need to be exploited and also one can explore the possibility of isolating transgressive segregants from the segregating generations of these crosses.

INTRODUCTION

The present investigation had been undertaken to know the type of gene action governing yield and yield contributing quantitative traits and to identify the parent and crosses, which could be exploited for future breeding programme. Significant and positive sca effects for seed yield and its component traits have also been reported by Manivannan and Sekar (2005); Indar singh *et al*. (2006); Chauhan *et al*. (2007) and Patel *et al*. (2007). The present investigation had been undertaken to know the type of gene action governing yield and yield contributing quantitative traits and to identify the parent and crosses, which could be exploited for future breeding programme.

MATERIALS AND METHODS

Twelve parents of cowpea *viz*., GC-5, GC-4, Pusa Phalguni, CPD-91, CPD-103, CPD-108,CPD-112, Rev-7, Re-79, Re-101, CPD-105 and CPD-107 and their complete set of 78 entries comprising 12 parents and their 66 F_1s were planted for evaluation in a Randomized Block Design (RBD) with three replications in four environments *i.e*., two season in late *kharif* 2010 (E_1 and E_2) and two season in late *rabi* 2011 (E_3 and E_4). Each treatment was planted in single row of 3 m long and spaced at 45 cm between and 15 cm within the row Chaudhary *et al*. (2008). The data were recorded on five random plants in each entry for 8 characters *viz*., days to 50 per cent flowering, plant height (cm), branches per plant, pods per plant, seeds per pod, 100-seed weight (g), seed yield per plant (g) and protein content (%). The general and specific combining ability effects of the parents were assessed by diallel analysis. To understand the real picture of genetic architecture of the hybrids and their parents, the data of both seasons were subjected to pooled analysis (Panse and Sukhatme,1985).

RESULTS AND DISCUSSION

The analysis of variance for seed yield and its component traits revealed significant differences among genotypes for all the characters, in all the environments, which indicated the presence of considerable amount of variability among genotypes for various characters under study (Table 1). Justifying the selection of the parents for study in pooled analysis there was substantial variability among the parents for all characters (Table 1). The variance component ratio (gca/sca) was less than unity for seed yield and its components which indicated greater role of non additive components in the inheritance of all these characters. Thus, it lays emphasis on the use of heterosis breeding approach to exploit available vigour in this crop. These results are in agreement with the findings of Bastian *et al*. (2000) and Kumar and Sangwan (2005). Nature and magnitude of combining ability effects helps in identifying superior parents and their utilization in further breeding programme. Looking to the estimates of *gca* effect for different characters, an overall appraisal of *gca* effects revealed that parents Re-101, CPD-112 and GC-4 were good general combiners for seed yield per plant and some of its direct components (Table 2). The parents Re-101 and CPD-112 were found to be best general combiners as they possessed significant and positive *gca* effects for seed yield, pods per plant, seeds per plant and 100-seed weight with

Table 1: Analysis of variance (mean squares) for combining ability and estimates of variance components for different characters pooled over environments

Pooled over environments Source of variation	d.f.	Days to 50 % flowering	Plant height	Branches per plant	Pods per plant	Seeds per pod	100-seed weight	Seed yield per plant	Protein content
GCA	11	14.219**	43.852**	1.109**	24.045**	6.651**	89.515**	24.753**	6.422**
SCA	66	18.843**	67.114**	1.490**	37.119**	4.626**	93.345**	35.913**	8.758**
Environments	3	309.013**	233.322**	8.894**	54.218**	25.871**	65.907**	23.858**	11.406**
GCA* Env.	33	7.334**	38.274**	0.589**	7.036**	1.278**	29.846**	16.054**	2.396**
SCA* Env.	198	12.452**	33.625**	0.685**	10.630**	2.495**	22.910**	13.459**	2.246**
Error	616	1.024	2.584	0.240	1.133	0.637	0.891	2.221	0.238
σ^2 gca	-	0.236	0.737	0.016	0.409	0.107	1.582	0.402	0.110
σ^2 sca	-	4.455	16.133	0.312	8.997	0.997	23.113	8.423	2.130
σ^2 gca / σ^2 sca	-	0.053	0.046	0.050	0.045	0.180	0.068	0.048	0.052
gca x Env. /sca x Env.		0.588	1.138	0.859	0.661	0.512	1.302	1.192	1.066

*, ** Significance at 5 % and 1 % probability level, respectively

Table 2: General combining ability of parents for different characters in cowpea

Parents	Day to 50% flowering	Plant height	Branches per plant	Pod per plant	Seeds per pod	100- seed weight	Seed yield per plant	Protein content
GC-5	-0.262*	1.392**	-0.089	0.523**	0.023	0.262**	0.059	-0.285**
GC-4	-0.018	-0.745**	0.071	0.910**	-0.007	0.289**	-0.144	-0.031
Pusa Falguni	0.196	-1.007**	-0.149*	-0.174	0.273**	-0.203**	-1.144	0.213**
CPD-91	-0.262*	1.368**	0.262**	-0.281*	-0.382**	-0.407**	-0.447*	-0.301**
CPD-103	0.429**	0.606**	0.202**	-1.013**	-0.209*	-0.515**	-0.811**	-0.829**
Rev-7	-0.208	-1.299**	-0.060	-1.013**	0.148	0.209**	0.332	0.161*
CPD-107	0.508**	0.481*	0.054	-0.221	0.338**	0.131**	-0.537**	0.010
Re-101	0.423**	-0.406*	0.024	1.017**	0.309**	0.530**	0.993**	0.375**
CPD-112	-0.548**	-0.632**	-0.113	0.529**	0.392**	0.367**	0.535**	0.347**
CPD-105	0.327*	-0.049	-0.018	-0.293*	-0.156	-0.292**	0.166	0.243**
Re-79	0.452**	-0.269	0.042	0.088	0.064	0.314**	0.011	-0.005
CPD-108	-1.119**	0.559**	-0.226**	-0.072	-0.793**	-0.686**	0.987**	0.102
S.E (Gi) ±	0.12	0.20	0.062	0.13	0.10	0.38	0.19	0.062

*, ** Significance at 5 % and 1 % probability level, respectively

Table 3: Specific combining ability of hybrids for different characters in cowpea

Crosses	Day to 50% flowering	Plant height	Branches per plant	Pods per plant	Seeds per pod	100- seed weight	Seed yield per plant	Protein content
GC-5 x GC-4	-0 355	-2.167**	-1.168**	-0.402	-0.895*	-1.483**	-1.223	-0.034
GC-5 x Pusa Falguni	0.598	6.345**	0.552*	-5.485**	-1.092**	0.479**	-2.973**	1.886**
GC-5 x CPD-91	0.389	-1.197	0.391	2.206**	0.063	-2.121**	2.663**	0.423
GC-5 x CPD-103	2.699**	1.898**	-0.216	-5.146**	0.307	2.379**	2.943**	1.260**
GC-5 x Rev-7	-2.748**	0.220	-0.370	1.021*	-0.883*	-0.101	2.217**	0.408
GC-5 x CPD-107	-5.795**	-3.977**	-0.067	-0.521	-1.490**	-0.358*	5.414**	-1.857**
GC-5 x Re 101	1.038*	2.160**	-0.287	1.658**	2.289**	0.053	-2.110**	0.052
GC-5 x CPD-112	3.758**	-1.03	-0.400	3.479**	0.956*	0.983**	0.348	1.657**
GC-5 x CPD-105	0.883	-1.614*	-0.912**	4.217**	1.754**	0.751**	1.967**	0.959**
GC-5 x Re-79	0.175	6.107**	0.028	1.087*	0.367	0.018	1.872**	-1.647**
GC-5 x CPD-108	0.913	3.196**	0.796**	-0.753	-1.359**	-1.687**	1.562*	-0.390
GC-4 x Pusa Falguni	1.853**	1.065	-0.025	0.628	-0.728*	1.234**	-0.854	-0.670**
GC-4 x CPD-91	-5.855**	-3.727**	-0.436	0.319	-0.407	-1.848**	-1.384*	-0.161
GC-4 x CPD-103	-2.129**	-6.548**	0.290	-3.533**	0.670	-1.086**	-4.938**	-1.071**
GC-4 x Rev-7	0.258	-2.143**	0.302	1.384**	2.813**	1.682**	-3.164**	-2.203**
GC-4 x CPD-107	2.377**	5.577**	0.772**	-2.158**	0.539	2.365*	-3.045**	1.999**
GC-4 x Re 101	-1.873**	2.964**	0.219	1.771**	-0.014	0.735**	-0.075	0.646**
GC-4 x CPD-112	1.431**	4.023**	0.106	2.342**	0.652	1.219**	-1.033	0.572*
GC-4 x CPD-105	-2.027**	10.020**	0.344	-3.003**	-1.383**	-1.474**	6.419**	3.163**
GC-4 x Re-79	0.848	-2.840**	-0.716**	1.783**	-1.437**	0.352*	1.491	-1.330**
GC-4 x CPD-108	2.169**	1.416	-0.198	-1.890**	-1.413**	-0.841**	-0.819	-1.253**
Pusa Falguni x CPD-91	-0.402	7.535**	-0.382	4.181**	-1.020**	-1.432**	2.199**	0.322
Pusa Falguni x CPD-103	-3.593**	-4.370**	0.761**	0.301	-0.276	0.342*	-1.188	0.101
Pusa Falguni x Rev-7	3.211**	-1.715*	-0.561*	2.134**	2.117**	2.202**	-0.164	-1.556**
Pusa Falguni x CPD-107	-0.587	1.922*	0.743**	4.259**	0.176	-0.255	4.955**	1.845**
Pusa Falguni x Re 101	3.413**	-2.774**	-0.394	-4.896**	1.206**	-1.985**	-1.575*	3.064**

Cont...Table 3: Specific combining ability of hybrids for different characters in cowpea

Crosses	Day to 50% flowering	Plant height	Branches per plant	Pods per plant	Seeds per pod	100- seed weight	Seed yield per plant	Protein content
Pusa Falguni x CPD-112	0.133	-2.548**	0.326	-0.491	1.706**	-1.604**	-0.866	-0.409
Pusa Falguni x CPD-105	-2.908**	1.452	-0.603	3.081**	0.920*	1.858**	-1.664*	-1.804**
Pusa Falguni x Re-79	-1.533**	-2.245**	-0.579*	-0.134	-1.467**	-1.836**	-4.592**	-2.640**
Pusa Falguni x CPD-108	1.038	-4.822**	0.106	0.360	0.141	-0.214	1.265	-1.164**
CPD-91 x CPD-103	3.365**	-0.078	-0.650	1.575**	-0.371	0.297*	0.283	-1.302**
CPD-91 x Rev-7	-1.748**	0.160	1.362**	-1.509**	-1.645**	-1.048**	-1.360*	0.207
CPD-91 x CPD-107	-0.045	-2.786**	-0.168	2.283**	1.664**	0.060	3.425**	0.858**
CPD-91 x Re 101	3.038**	-0.816	-0.055	0.378	0.611	1.849**	1.896**	1.327**
CPD-91 x CPD-112	0.342	-3.173**	0.082	1.950**	-0.889*	-0.000	-1.396*	-0.396
CPD-91 x CPD-105	2.550**	-0.840	-0.597*	4.104**	-0.092	-2.252**	-0.694	1.293**
CPD-91 x Re-79	-1.658**	2.630**	0.261	4.027**	-0.645	-1.704**	-4.456**	-1.127**
CPD-91 x CPD-108	-3.254**	-4.030**	-0.222	-0.449	0.462	1.128**	-3.515**	0.267
CPD-103 x Rev-7	0.645	-2.661**	0.505*	-1.777**	0.349	0.233	-1.581*	0.069
CPD-103 x CPD-107	2.014**	1.476*	-0.609*	3.515**	0.075	0.525**	3.038**	0.470
CPD-103 x Re 101	-2.319**	-0.971	0.255	2.944**	0.938*	1.650**	-0.741	-0.895**
CPD-103 x CPD-112	2.401**	3.505**	-1.025**	0.848	-0.728*	-1.082**	1.300	0.549*
CPD-103 x CPD-105	-0.224	-1.328	0.463*	-0.413	-2.181**	-0.600**	-1.997**	-0.179
CPD-103 x Re-79	-2.016**	8.441**	1.320**	6.122**	0.766*	-0.981**	7.824**	3.068**
CPD-103 x CPD-108	-3.361**	5.315**	-0.579*	-2.717**	-0.127	-0.704**	-2.235**	-0.538*
Rev-7 x CPD-107	2.318**	7.214**	-0.597*	-1.318*	0.301	2.892**	-2.604**	-1.604**
Rev-7 x Re 101	-0.599	1.934*	0.183	-0.890	-0.252	-0.089	-4.384**	-2.051**
Rev-7 x CPD-112	-0.295	3.327**	-0.763**	0.932	-0.169	-0.918**	2.991**	-0.524*
Rev-7 x CPD-105	-0.670	6.994**	-0.359	4.087**	0.712	-0.840**	3.777**	0.414
Rev-7 x Re-79	0.371	5.370**	0.832**	1.706**	0.325	-1.957**	4.265**	1.245**
Rev-7 x CPD-108	1.526**	6.447**	-0.067	3.283**	-0.818*	0.580**	2.955**	0.555
CPD-107 x Re 101	1.103*	3.096**	0.737**	3.985**	-0.193	0.405**	3.985**	1.679**
CPD-107 x CPD-112	-1.343**	-2.536**	-0.21	-0.360	-0.276	-0.682**	-4.807**	-1.215**
CPD-107 x CPD-105	-0.718	-4.120**	0.112	2.212**	0.188	-1.438**	1.062	-1.869**
CPD-107 x Re-79	0.574	-1.566*	0.636**	-1.669**	0.635	-0.036	-3.200**	-1.096**
CPD-107 x CPD-108	-3.105**	5.023**	0.237	-2.175**	-0.008	-0.129	1.074	-1.798**
Re 101 x CPD-112	-1.593**	3.434**	-0.347	-6.431**	-1.580**	0.408**	0.663	1.326**
Re 101 x CPD-105	-1.801**	-2.649**	0.391	0.640	0.718	2.246**	0.366	-1.962**
Re 101 x Re-79	1.324**	-1.346	-1.001**	-0.658	-1.252**	-3.306*	-0.979	-0.861**
Re 101 x CPD-108	-0.105	4.410**	-0.900**	2.837**	0.522	-0.443**	-1.456*	-0.965**
CPD-112 x CPD-105	0.336	2.660**	0.612**	0.712	0.051	-0.507**	-2.926**	-1.367**
CPD-112 x Re-79	0.211	-2.870**	-0.531*	2.164**	0.081	2.355**	1.479*	0.733**
CPD-112 x CPD-108	0.199	-4.780**	0.403	-5.925**	0.355	-1.167**	0.669	1.743**
CPD-105 x Re-79	1.752**	2.714**	0.957*	-2.265**	0.379	3.145**	5.902**	-1.245**
CPD-105 x CPD-108	1.407**	0.803	-0.109	-4.271**	0.069	-0.037	-1.628*	-1.060**
Re-79 x CPD-108	-0.968	-7.810**	-0.168	1.015*	1.099**	-0.144	3.027**	-0.104
S.E (Sij) ±	0.47	0.74	0.22	0.49	0.37	0.13	0.69	0.22

*, ** Significance at 5 % and 1 % probability level, respectively

Table 4: Promising hybrids for seed yield per plant with sca effects and component traits showing significant desired heterosis based on pooped over environments in cowpea

S. No.	Hybrids	Seed yield per plant (g)	scaeffect	Useful heterosis for component traits over BP
1	CPD-103 x Re-79	29.50 (P x A)	8.441**	DF, PH, BP, PP,
2	GC-4 x CPD-105	28.92 (A x A)	10.020**	DF, PP, SW,
3	Rev-7 x Re-79	27.08 (A x A)	5.370**	PH, PP,
4	CPD-107 x Re-101	26.92 (A x G)	3.096**	PP, PL, PC
5	Rev-7 x CPD-108	26.75 (A x G)	6.447**	PH,
6	Pusa Falguni x CPD-107	25.75 (A x P)	1.922**	-
7	GC-5 x CPD-108	25.08 (A x G)	3.196**	PP, SW, PC

* and ** indicates significant at p = 0.05 and p = 0.01, respectively; DF = Days to 50 per cent flowering; SP = Seeds per pod; PH = Plant height (cm); SW = 100-seed weight (g); BP = Branches per plant; SY = Seed yield per plant (g); PP = Pods per plant; PC = Protein content (%)

days to 50% flowering, plant height and protein content. The parent GC-4 was also good general combiner for seed yield per plant, pods per plant and 100-seed weight along with plant height. While, parent Pusa Falguni was also found to be best general combiner for the trait protein content. The estimates of *gca* effects further revealed that the parental lines showing high *gca* effects for seed yield also exhibited high to average gca effects for one or other yield components. Sawant (1995) and Danam and Chaudhary (2000) also reported similar results which supported the present findings. These parents can be intensively used in the hybridization programme aimed at amelioration of seed yield.

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The estimates of sca effects revealed that none of the crosses showed significant and desirable *sca* effects for all the characters (Table 3). 22 crosses exhibited significant positive *sca* effects for seed yield per plant. Significant and desirable sca effects were noticed in 19 crosses each for days to 50 per cent flowering and protein content, 21 for plant height, 13 for branches per plant, 30 for pods per plant, 6 for seeds per pod and 25 for 100-seed weight on pooled basis. Significant and positive sca effects for seed yield and its component traits have also been reported by Manivannan and Sekar (2005); Indar singh *et al*. (2006); Chauhan *et al*. (2007) and Patel *et al*. (2007). The highest sca effect for seed yield per plant was recorded by GC-4 x CPD-105 (10.020**) followed by CPD-103 x Re-79 (8.441**) and Rev-7 x Re-79 (5.370**). These cross combinations also reported desirable sca effects for pods per plant, seeds per pod and 100-seed weight. This suggested the role of yield attributing traits towards high yield.

The best three crosses selected each for sca effects, per se performance and the heterobeltiosis for yield and related traits are presented in the Table 4. The crosses viz., CPD-103 x Re-79, GC-4 x CPD-105 and Rev-7 x Re-79 which recorded significantly higher sca effects for seed yield per plant resulted from poor x average, average x average and average x average general combiners respectively. This indicated inconsistent expression of sca in the specific crosses irrespective of *gca* effects of the parents. However, comparative study of the crosses on the basis of sca effects and *per se* performance revealed that the majority of the crosses which registered higher seed yield had not parent as good general combiner (Table 4). High sca effects due to good x good combiners reflect additive x additive type of gene interaction and superiority of favourable genes contributed by their parents, while those involving good x poor or poor x poor indicated the interaction of additive x dominance and dominance x dominance, respectively. Biparental progeny selection suggested by Andrus (1963) might be useful to get some useful transgressive segregants from crosses involving good x good and good x poor combinations. The overall results of the present study exhibited that on the basis of *per se* performance and gca effects, parents Re-101, CPD-112 and GC-4 were identified as the most promising parents for seed yield and most of the characters. Similarly on the basis of *per se* performance, sca effects and heterobeltiosis, the best crosses for seed yield per plant were CPD-103 x Re-79, GC-4 x CPD-105 and Rev-7 x Re-79. These crosses (based on sca effects) generally involved at least one parent with desirable gca effects. It is therefore, suggested that these promising parents and crosses may be exploited for further amelioration of seed yield in cowpea.

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