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COMBINING ABILITY IN *VIGNA MUNGO* (L.) Hepper

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Abstract

Combining ability analysis was conducted for grain yield and yield components viz., plant height, branches per plant, pods per plant, pod length, seeds per pod, 100 grain weight in a five parent diallel population of mash (*Vigna mungo*) including parents, F_1's and reciprocals. Non-additive gene action (dominance or epistasis) contributed the major portion in total genetic variance for all the plant characters studied. Significant reciprocal effects were also observed for all the characters which indicated the importance of maternal contribution in the performance of hybrids. Therefore a biparental mating among the selected F_2 segregants followed by selection in advanced generations, F_6 or later, is suggested. The genotype 87/88 proved to be the best general combiner for pods per plant and grain yield and could be exploited in future mash breeding programme to develop high yielding varieties.

Introduction

Blackgram or mash (*Vigna mungo*) is an important legume crop in many South Asian countries including Pakistan, India, Bangladesh, Thailand and Korea. The identification of mash genotypes which are better combiners in different cross combinations is important for plant breeders for effective selection of future mash varieties.

Evaluation of available genetic stocks to assess the genetic variation for economically important plant traits is a prerequisite for combining desirable characters in a single genotype. The magnitude and type of genetic variation in a population helps in selection of parents, which after hybridization are likely to produce the best combination of desirable traits such as high yield, resistant to diseases etc. Combining ability analysis is one of the techniques frequently employed to study the nature of genetic variation for particular plant traits and to select the parents which would produce desirable combinations after crossing (Murty, 1975). The technique has been effectively used for such purposes in pea (Singh *et al.*, 1987), mungbean (Malhotra, 1979; Wilson *et al.*, 1985) and mash (Singh & Singh, 1971). Since information in this respect is meagre in mash, present study was designed to analyze selected mash genotypes regarding general and specific combining ability effects for grain yield and yield components.

Material and Methods

Five mash genotypes; 58/88, 60/88, 222/88, 535/88 and 87/88, all selected from indigenous germplasm resources, were used in the present study. The genotypes were crossed among each other in a diallel fashion under field and shade-house conditions during spring seasons of 1988 and 1989, respectively. The F_1's including reciprocals and parents were grown using randomized complete block design with three replications at the experimental fields of the National Agricultural Research Center, Islamabad during kharif-1989. One row of each hybrid and parent line were dibbled by keeping 35 and 10 cm spacings between and within rows, respectively.

At maturity 10 plants were selected at random from each experimental plot for data recording. The data were recorded for plant height (cm), branches per plant, pods per

Table 1. Mean, heritability and genetic advance for seven characters in five parent diallel population.

Characters/	Range	Means + SE	GP	PV	h	Gs	Gs (% of mean)
Plant height (cm)	27.33-39.98	33.31 + 1.30	5.316	10.354	0.51	2.89	8.67
Branches per plant	8.58-20.51	13.87 + 0.74	7.843	9.487	0.83	4.50	32.44
Pods per plant	20.21-61.70	37.18 + 1.32	77.413	82.624	0.94	15.04	40.45
Pod length (cm)	3.97-4.46	4.31 + 0.04	0.014	0.018	0.79	0.19	4.33
Seeds per pod	5.46-6.37	5.87 + 0.07	0.054	0.068	0.80	0.37	6.25
100-seed weight (g)	3.98-4.91	4.42 + 0.16	0.055	0.132	0.41	0.026	5.93
Grain yield plant (g)	4.46-13.66	7.55 + 0.31	3.975	4.256	0.93	3.38	44.72

GP- Genotypic variance, PV- phenotypic variance, h-heritability in broad sense, Gs-genetic advance at 10% selection differential and GS%- genetic advance expressed as percent of means.

plant, and grain yield per plant (g) on 10 plants. The observation for pod length (cm) and number of seeds per pod were recorded on 10 randomly selected pods from each of the ten selected plants and an average was taken for final analysis. The 100 seed weight was also recorded as weight (g) of 100 randomly selected seeds from 10 selected plants. Analysis of variance was performed for each plant character using the average values following the methods of Steel & Torrie, (1960). Combining ability analysis was conducted with the help of a computer program written in "BASIC" by one of the authors. The design of combining ability analysis corresponded to Method I, Model I of Griffing (1956).

Results and Discussion

The analysis of variance revealed significant differences among the parents and F_1's including reciprocals for all the characters measured in this study. Table.1 presents the ranges, mean, genotypic and phenotypic variance, heritability estimates (broad sense) and genetic advance for seven characters. High heritability estimates and high genetic advance for branches per plant, pods per plant and grain yield indicated substantial importance of additive genetic variance for these characters. Therefore, improvement for these characters is possible by simple selection in early generations. Sharma & Rao (1988) reported high heritability coupled with high genetic advance indicating the importance of additive genetic variance and suggested direct early generation (F_2) selection to improve yield potential in blackgram. High heritability alongwith high genetic advance were also observed by Luthra & Singh (1978) and Govindarasu & Sampath (1983), who considered weight of pods as most reliable index for selection to improve the productivity of legumes.

COMBINING ABILITY ANALYSIS

The estimates of General Combining Ability (GCA) differed significantly for grain yield, branches per plant, pods per plant and seeds per pod indicating the importance

Table 2. Mean squares for combining ability effects in five parent diallel population.

Source	DF	Plant height	Bran-ches per plant	Pods per plant	Pod length	Seeds perpod	100-seed weight	Grain yield per plant
G.C.A	4	3.1445	2.8704*	134.2949**	0.0021	0.0591**	0.0468	3.6891**
S.C.A	10	7.7740**	11.0549**	71.5344**	0.0198**	0.0779**	0.1291**	4.0364**
Reciprocal	10	7.7564**	12.9047**	64.7059**	0.0732**	0.0392**	0.0449**	4.2522**
Error	28	1.6798	0.7226	1.7373	0.0012	0.0046	0.0258	0.0939

*Significant at 5% level, **Significant at 1% level

of additive gene-action for these characters. However, highly significant specific combining ability (SCA) effects were also observed for all the characters under study which indicated the presence of non- additive gene-action coupled with additive ones. Therefore, total variance due to combining ability effects were further partitioned and expressed as percentage, to get precise information (Table 3). It is quite evident that the SCA effects contributed more in all the characters, therefore, non-additive gene-action (dominance or epistasis) was predominantly important for all the characters studied. Similar results have been observed by Malhotra *et al.*, (1979) in mungbean, who reported the importance of non-additive gene-action for seed yield.

The presence of high degrees of non-additive gene-action revealed that the population was not amenable to selection in early segregating generations till the genes become established in later generations. Highly significant reciprocal effects (Table 2) alongwith high percentage of variance contributed by reciprocal effects for almost all the characters

Table 3. Variance due to GCA, SCA, Reciprocal and Error for seven characters in five parent diallel population.

Variance due to	Plant height (cm)	Bran-ches per plant	Pods per plant	Pod length (cm)	Seeds per pod	100-seed weight (g)	Grain yield per plant (g)
G.C.A	-0.4339	-0.7712	6.6084	-0.0017	-0.0015	-0.0077	-0.0160
	-5.4843	-6.3189	8.2083	-9.0909	-2.3401	-8.6323	-0.3553
S.C.A	3.6275	6.1621	41.5459	0.0111	0.0437	0.0615	2.3467
	45.8498	50.4900	51.0543	59.3583	68.1747	68.9462	52.1060
Reciprocal	3.0383	6.0911	31.4843	0.0081	0.0173	0.0096	2.0791
	38.4026	49.9082	38.6900	43.3155	26.9891	10.7623	46.1643
Error	1.6798	0.7226	1.7373	0.0012	0.0046	0.0258	0.0939
	21.2318	5.9207	2.1349	6.4171	7.1763	28.9238	2.0850

The highlighted figures are the percentage variance contributed by a specific character exhibited the importance of maternal contribution of the parents used in hybridization. Further, high contribution of reciprocal effects also restricts the bulking of the hybrids and hence, these should be handled separately for selection, in later generations. Wilson *et al.*, (1985) reported the presence of both additive and non-additive gene-actions, but predominant importance of non additive for plant height, pods per plant, pod length, seeds per pod, 100-seed weight and seed yield in mungbean. Singh *et al.*, (1987) also reported similar pattern for plant height, branches, pods, 100-seed weight and seed yield in peas.

General Combining Ability (GCA) Effects; The genotypes 87/88 proved to be the best combiner for pods per plant and grain yield with GCA values of 3.951 and 0.829, followed by the genotype 222/88 for both the characters with GCA values of 3.795 and 0.248, respectively (Table 4). Both of these genotypes also have the highest mean values for the traits mentioned. The genotype 60/88 proved to be the best combiner for plant height and seeds per pod with GCA values of 0.442 and 0.112, respectively. It was followed by the genotype 58/88 for plant height and 87/88 for seeds per pod. For branches, genotypes 58/88 gave the promising value (0.721) among parents and was followed by 87/88 with GCA value of 0.373. The genotypes, 222/88 and 535/88 were the best combiners for pod length and 100-seed weight, respectively.

Among parents, genotype 87/88 appeared to be a good combiner for pods per plant and grain yield and, can be utilized in future mash breeding programmes to develop high yielding varieties. Further, every genotype proved its superiority in combination for one or other character and, plant breeding programmes can be geared to combine genes of economic importance scattered in the population in one synthetic cultivar.

Table 4. General combining ability (GCA) effects for seven characters in five parent diallel population.

Sr. No. Parents	Plant height (cm)	Branches/ plant	Pods/ plant	Pod length (cm)	Seeds per pod	100-seed weight (g)	Grain yield/ plant (g)
1-58/88	0.438	0.721	-1.496	0.002	-0.007	0.054	0.058
	30.110	11.630	27.700	4.250	5.830	4.660	5.330
2-60/88	0.442	-0.517	-2.140	-0.011	0.112	-0.030	-0.370
	30.280	10.810	31.060	4.260	5.980	3.980	5.940
3-222/88	0.345	-0.455	3.795	0.016	-0.002	-0.001	0.248
	33.500	13.250	38.260	4.140	5.390	4.620	6.670
4-535/88	-0.646	-0.121	-4.110	-0.018	-0.105	0.074	-0.765
	29.980	13.100	26.340	4.230	5.460	4.000	5.830
5-87/88	-0.578	0.373	3.951	0.012	0.001	-0.097	0.829
	31.190	16.170	43.220	4.100	5.570	3.990	7.870
SE (Gi-Gj)	0.336	0.145	0.348	0.0002	0.0009	0.005	0.019

The highlighted figures are the mean values of the parents for specific character.

Table 5. Specific combining ability (SCA) and reciprocal effects for seven characters in five parent diallel population.

Sr. No. Hybrids	Plant height (cm)	Branches per plant	Pods per plant	Pod length	Seeds per pod	100-seed weight	Grain yield per plant
1-58 X 60	-0.217	-0.495	-2.077	-0.054	-0.113	0.086	-0.367
	1.373	3.595	2.668	0.032	0.107	0.178	1.727
2-58 X 222	2.762	4.179	13.350	0.066	0.231	-0.270	3.241
	-4.125	-4.708	-8.917	-0.062	0.037	0.005	-2.557
3-58 X 535	-0.631	-0.294	-0.616	-0.052	-0.079	-0.146	-0.724
	-2.055	-3.245	-5.477	-0.077	-0.153	-0.047	-1.658
4-58 X 87/88	1.166	0.453	-4.215	0.106	-0.014	0.203	0.192
	-1.683	-2.450	-5.902	0.032	-0.092	0.182	-2.345
5-60 X 222	1.219	-0.979	-2.145	0.091	-0.005	0.058	-0.552
	0.483	-0.355	-3.908	0.003	-0.023	-0.095	-0.722
6-60 X 535	0.960	0.846	-1.477	-0.065	0.235	0.307	0.461
	-0.303	-2.747	-9.202	-0.247	-0.140	0.038	-1.398
7-60 X 87/88	0.956	2.815	7.497	0.050	-0.001	-0.067	1.333
	3.203	0.457	1.763	0.052	0.150	-0.043	0.725
8-222 X 535	-0.806	0.858	0.697	0.061	-0.008	0.159	-0.339
	-0.873	-0.422	0.150	-0.093	-0.233	-0.253	-0.577
9-222 X 87/88	-3.672	-3.939	-5.437	-0.019	0.263	-0.147	-0.974
	1.175	-1.425	-0.027	-0.050	-0.233	0.100	-0.050
10-535 X 87/88	1.521	-2.721	3.967	0.095	0.057	-0.249	0.793
	-0.277	-1.677	8.307	0.013	0.008	-0.267	0.397
SE (Sii-Sij)	2.184	0.939	2.258	0.002	0.006	0.034	0.122
SE (Rij-Rkl)	1.680	0.723	1.737	0.001	0.005	0.026	0.094

Specific Combining Ability (SCA) and Reciprocal Effects: The estimates of SCA and reciprocal effects (Table 5) showed that highest value of 3.241 for grain yield was produced by the hybrid "58/88 x 222/88" followed by the hybrid "60/88 x 58/88" with SCA value of 1.727. The highest SCA value for plant height (3.203) was exhibited by the hybrid "87/88 x 60/88" and it was followed by the hybrid "58/88 x 222/88" with SCA value of 2.762. The parent 60/88 was observed as the best combiner for plant height. The hybrid 58/88 x 222/88 was observed to be the best for branches per plant, pods per plant and grain yield per plant followed by 60/88 x 58/88 for branches and grain yield and 87/88 x 535/88 for pods per plant. Maximum SCA value for pod length (0.106) was noticed in the hybrid 58/88 x 87/88. It is clear that best combiners produced best cross combinations in the present study and progenies of such crosses should be looked for desirable transgressive segregants.

This study depicts that simple selection as suggested by the analysis of heritability and genetic advance could not prove its validity, because, both additive and non-additive gene-actions existed for yield and its components in the mash population. However, non-additive effects were found predominantly important as compared to additive effects for almost all the characters. According to Malhotra *et al.*, (1979), the manipulation of genetic variance by simple selection leads to only a portion of total genetic variance. Therefore, we suggest bi-parental mating among the selected F_2 segregants, especially including genotype 87/88 and 222/88 as one of the parents, for maximum utilization of available genetic variability and to get desirable plants in later generations. Similarly improvement in the population can be efficiently achieved through the use of better combiners and good segregants can be selected to establish pure-lines in mash by employing modified diallel selective system (Frey, 1975).

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