COMBINING ABILITY FOR PROTEIN CONTENT IN MUNGBEAN*

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IN a purely vegetarian diet an appreciable portion of total protein requirement is met from pulses such as mungbean. Very little effort has been directed towards the study of genetics of this character. Need, therefore, arises to conduct genetic investigation on protein content. In a sound breeding prog-gramme, the choice of suitable parents is a pre-requisite and should be based on the ability of a particular line to nick well and produce superior progenies. The present investigation, was, therefore undertaken to estimate the extent of heterosis and combining ability of the parents for protein content.

MATERIALS AND METHODS

A diallel involving seven parents, namely Hyb. 4, Jawahar 45, L 24–2, No. 54, P 23–67, No. 305 and Jalgaon 781 was studied. Twenty eight (7 parents and their 21 hybrids) were grown in a randomized block design with four replications. Each plot was 3 m, × 60 cm, accommodating 10 plants spaced 30 cm. apart in each row. Protein content of the material was estimated from a random seed sample drawn from each experimental row of the replicated experiment by Microkjeldahl method. Combining ability analysis was conducted according the method II model I of Griffing (1956). Components of genetic variance were estimated according to Hayman (1954).

RESULTS

Analysis of variance of the design revealed that the variance due to progenies was significantly high (Table 1). Furthermore, the differences among the parents and hybrids were significant but not between parents vs. hybrids. Analysis of variance for combining ability (Table 2) showed that variances due to general and specific combining ability were significant; general combining ability variance was significantly higher than specific combining ability variance.

Protein content and the combining ability effects of the parents (Table 3) showed that the average protein content ranged from 22·87 to 25·52%. A correlation coefficient r=0·9146 was observed between protein content of the parents and their g.c.a. The parent Jawahar 45 has the highest protein content (25·52) and was the best combiner, and No. 305 having the lowest protein content was the second poorest combiner. The parents with average combining ability showed average protein content.

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TABLE 1

Analysis of variance of the design for protein content

Source	d.f.	M.S.
Progenies	27	5·4901**
Parents	6	3·6302*
Hybrids	20	6·6547**
Parents Vs. Hybrids	1	3·3561
Error	81	1·3443

*Significant at 5% level.
**Significant at 1% level.

TABLE 2

Analysis of variance for combining ability

Source	d.f.	M.S.
g.c.a.	6	3·43**
s.c.a.	21	0·78
error	81	0·34

**Significant at 1% level.

TABLE 3

Average protein content and combining ability of the parents

Parent	Protein content	General combining ability
Hyb. 4	24·99	0·2692
Jawahar 45	25·52	1·0525**
L 24–2	23·14	–0·7952*
No. 54	24·04	0·3370
P 23–67	23·62	–0·1197
No. 305	22·87	–0·5575*
Jalgaon 781	24·06	–0·1864
S. ±	0·66	0·1789
C.D. at 5%	1·96	0·5439

Protein content of the hybrids ranged from 21·56 to 25·68% (Table 4). Only three crosses viz. P 23-67×Jawahar 45, Jawahar 45×No. 305 and Jawahar 45×Hyb. 4 has portein content above 25%. A high degree of association (r=0·7925) between protein content of the crosses and their s.c.a. effects was noticed. The crosses with high s.c.a. effects viz. P 23-67×Jawahar 45, Jawahar 45×No. 305 and P 23-67×L 24-2 involved average×high, high×low and average×low combinations. The crosses L 24-2×Hyb. 4 and P 23-67×Jalgaon 781 had the lowest protein content and were the poorest combinations. These two crosses involved average×low and average×average combination of parents.

TABLE 4

Average protein content and specific combining ability effects of the crosses

Cross	Protein content (%)	Combining ability
Jawahar 45 × Hyb. 4	25·41	0·3536
L24–2 × Hyb. 4	21·50	–1·7086*
No. 54 × Hyb. 4	24·91	0·5692
P 23–67 × Hyb. 4	23·35	–0·5341
No. 305 × Hyb. 4	23·22	–0·2264
Hyb. 4 × Jalgaon 781	23·23	0·1125
Jawahar 45 × L 24–2	23·19	–0·8019
Jawahar 45 × No. 54	24·21	–0·9141
P 23–67 × Jawahar 45	25·68	1·0125
Jawahar 45 × No. 305	25·56	1·3303
Jawahar 45 × Jalgaon 781	24·26	–0·3408
No. 54 × L 24–2	23·33	0·1647
P 23–67 × L 24–2	24·14	1·3203
No. 305 × L 24–2	21·81	–0·5719
L 24–2 × Jalgaon 781	22·47	–0·2830
P 23–67 × No. 54	24·24	0·2881
No. 54 × No. 305	23·41	–0·1041
No. 54 × Jalgaon 781	24·73	0·8447
P 23–67 × No. 305	22·29	–0·7675
P 23–67 × Jalgaon 781	21·86	–1·5691*
No. 305 × Jalgaon 781	22·83	–0·1608
S.E. ±	0·53	0·5203
C.D. at 5% level	1·50	1·4894

The heterosis observed for protein content ranged from –10·64 to 5·66% over mid parent and from –13·96 to 2·78% over the better parent. A marginal increase in protein content over the best parent was shown by two crosses involving Jawahar 45 as one of the parents. Close examination of protein content of the hybrids having Jawahar 45 as one of the parents revealed that this parent always produced hybrids with protein content higher than the other parent, while L 24-2 as one of the parents produced hybrids with protein content less than the second parent except with P 23-67 (Table 5). The parent, No. 305 also produced hybrids having protein content less than the other parent involved, except with Jawahar 45, where it was high.

Estimates of genetic components of variance revealed that both additive and non-additive components of variance were important but the non-additive component was greater in magnitude (Table 6). The estimates of gene frequency (uv) suggested a departure from the expected value of 0·25 but the non-significant value of F indicated equal distribution of dominant and recessive genes. Estimate of heritability in narrow sense was 73·48%.

TABLE 5

Increase or decrease in protein content of the F_1 hybrid over one parent keeping the other parent as common

	Hyb. 4	Jawahar 45	L24–2	No. 54	P 23–67	No. 305	Jalgaon 781
Hyb. 4		—	—	+	—	+	—
Jawahar 45	+		+	+	+	+	+
L 24–2	—	—		—	+	—	—
No. 54	—	—	+		+	—	—
P 23–67	—	+	+	+		—	—
No. 305	—	+	—	—	—		—
J 781	—	—	—	+	—	—	

+ and — signs respectively indicate the increase and decrease in protein content.

TABLE 6

Genetic components of variance, gene frequency and heritability estimates for protein content

Component				Gene frequency	Heritability %
D	H_1	H_2	F		
0·5720*	2·4128**	2·0404**	–0·9120	0·2114	73·48

Discussion

Significant differences for protein content among the parents and hybrids have been indicated by significant variances attributed to these sources. The non-significant variance due to parent vs. hybirds suggested absence of heterosis. Significant variance due to general and specific combining ability indicates that the both additive and non-additive type of gene action were playing an important role in the inheritance of protein content in mungbean. However higher magnitude of general combining ability variance compared to specific combining ability variance suggested predominant role of additive variance in the inheritance of protein content. The lack of heterosis manifestation may be attributed to the presence of genes with oppositional dominance. This hypothesis is further supported by the observation that Jawahar 45 as one parent always produced hybrids with protein content higher than the protein of the other parent suggesting that this parent contributed certain favourable dominant genes, while the parent L 24-2 on the other hand produced hybrids with protein content less than the protein of the second parent suggesting that this parent has some genes with negative effect on protein content. Singh (1970) through graphical analysis has reported that the parents Jawahar 45 and L 24-2 had more concentration of dominant genes. The hybrid Jawahar 45 × No. 305 involving dominant and recessive parents produced the F_1 with protein content equal to that of Jawahar 45 which suggested that there is complete dominance of the genes. Partial to complete dominance for high protein content in soybean have been reported by Viljoen (1937) and Williams (1948).

A high degree of association observed between protein content and the combining ability effects of the parents and hybrids suggested that additive variance was playing an important role. This findings is supported by high estimates of g.c.a. variance and heritability in narrow sense. The importance of non-additive variance in the inheritance of protein content, however, cannot be minimized as is evident from the significant estimate of H_1 and the variance due to s.c.a. The discrepancy in the relative importance of additive and non-additive components of variance in combining ability and component analysis may be attributed to the differential confounding of interaction deviations with g.c.a. and the H_1 component in the two analyses.

From the present investigation it can, therefore, be concluded that the parent Jawahar 45 in general was the best combiner for protein content and may be used in hybridization programme. Out of the two best crosses namely P 23-67 × Jawahar 45 and Jawahar 45 × No. 305 involving average × high and high × low combinations respectively, the superiority of the former seems to be due to the concentration and interaction between favourable genes contributed by the two parents, while the superiority of the latter may simply be due to the possible dominance action of the genes contributed by Jawahar 45. It is, therefore, expected that the former cross may result in some transgressive segregates if the procedure of bi-parental progeny selection as suggested by Andrus (1963) is followed.

SUMMARY

Heterosis and combining ability for protein content was studied in a diallel involving seven parents. The study revealed that the magnitude of heterosis observed for protein content was small. Close examination of the protein content of hybrids revealed the presence of genes showing dominance both in positive and negative direction for protein content. The combining ability and components of genetic variance analyses indicated the importance of both additive and non-additive (dominance and epistasis) gene action for protein content. The parent Jawahar 45 in general and the cross P 23-67 × Jawahar 45 in particular can be used to obtain pure lines with protein content still higher than what is available in the present material. Breeding procedure based on the gene action observed has been suggested.

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