Pak. J. Bot., 39(4): 1237-1244, 2007.

MODE OF INHERITANCE AND GENETIC VARIABILITY OF SOME OF THE TRAITS IN MUNGBEAN *VIGNA RADIATA* (L.) WILCZEK

MUHAMMAD ZUBAIR[1], SAIF ULLAH AJMAL[2*], MUHAMMAD MUNIR[2]
AND MUHAMMAD ANWAR[1]

[1]*Pulses programme, National Agricultural Research Centre, Islamabad, Pakistan.*
[2]*Department of Plant Breeding* and *Genetics, University of Arid Agriculture, Rawalpindi, Pakistan.*

Abstract

Combining ability analysis was carried out in an 8x8 parent complete diallel of mungbean. Significant differences were observed for GCA and SCA among parents and hybrids for all the traits under study. Estimates of variances due to GCA and SCA suggested predominance of additive gene action for plant height, days to maturity, pod length and 100 seed weight. High SCA variance for pods per plant, seeds per pod and grain yield per plant showed the importance of non-additive gene action for these traits. For the improvement of grain yield in mungbean, crosses involving the parents, NM 121-25, NM 51, VC 3902 and VC 4152, need special consideration. The cross combination, NM 121-25 x VC 4152, was the best for high grain yield on the basis of SCA. The specific crosses, NM 51 x VC 4982, NM 20-21 x VC 1163 and NM 51 x VC 3902, revealed high number of pods coupled with high grain yield.

Introduction

Proper choice of parents to get desirable recombinants through hybridization is very crucial in a crop improvement programme. The dilemma of utilization of parents to cross has now become more puzzling because of available genetic variability in a crop like mungbean is limited. Therefore, future mungbean breeding may endeavour on sound basis to achieve further increase in present stagnant yields. Combining ability analysis is a useful technique that provides information on breeding values of the parental material and nature of genetic variability in F_1 generation. Equipped with this information, a breeder can better select parents for hybridization and adopt appropriate breeding scheme to handle elite crosses. The diallel analysis approach (Griffing, 1956) is a precise test to ascertain relative contribution of general combining abilities (GCA), specific combining abilities (SCA) and reciprocal effects for quantitative traits among cross variations. Most investigations on gene action and combining ability studies in mungbean by diallel analysis have attributed preponderance of variability due to GCA (Thimmappa, 1987; Khattak *et al*., 2001). Some studies have also concluded predominance of SCA variance for most of the characters related to yield (Chowdhury, 1986; Ghafoor *et al.*, 1993; Chauhan & Singh, 1997). Present study was undertaken to evaluate 8 mungbean varieties with regard to genetic mechanism involved in controlling yield and its components in terms of combining ability which will be used for setting a suitable selection criteria.

Materials and Methods

The experimental material consisted of 8 mungbean genotypes/varieties (NM 20-21, NM 121-25, NM 51, VC 4982, VC 4152, VC 3902, VC 3301 and VC 1163) which were phenotypically different and of diverse nature. These 8 parents were crossed in all possible combinations (including reciprocals) at National Agricultural Research Centre,

---

[*]Corresponding author: E-mail: gondaldr@yahoo.com, Tel: 051-9062258

Islamabad (latitude 32.42^0N, longitude 73.08^0E and elevation 683 m above sea level) during the year 2002. In 2003, eight parental lines alongwith their F_1's and reciprocals, were planted in the field following Randomised Complete Block Design with three replications. One row of each genotype was dibbled keeping 35 and 10 cm spacing between and within rows, receptively. Basal fertilizer dose @ 25 kg N + 60 kg P_2O_5 per hectare was applied and during crop growth period agronomic practices were used as recommended for mungbean crop. Pesticide (Karate 2.5EC @ 750 ml/ha) was sprayed to save the crop from the infestation of pests especially white fly, a vector for MYMV. The data for days to maturity were recorded when about 90% pods turned brown/black. Other quantitative data i.e., plant height, number of pods per plant, and grain yield per plant (g) were recorded on 10 guarded plants selected randomly and then averaged to per plant basis. Pod length (cm) and seeds per pod were taken on 10 pods selected at random within each genotype. The seed weight was recorded for each genotype after counting 100 seeds by seed counter and weighed in grams. Analysis of variance was conducted for each character using the average values following the method of Steel & Torrie (1980). Combining ability analysis was performed using the design of combining ability analysis corresponding to the Method I, Model I of Griffing (1956).

Results and Discussion

The combining ability analysis partitions the genotypic variability into variances due to general combining ability (GCA), specific combining ability (SCA) and reciprocal combining ability (RCA), which represent additive, dominance and reciprocal (cytoplasmic) effects, respectively. The combining ability analysis also helps in identifying desirable parents to be used for a given trait in a breeding programme. Similarly superior cross combinations can also be detected through this analysis. In the present study, the analysis of variance for 8 parent complete diallel revealed significant differences among parents and hybrids for all the characters under study (Table 1). Results of the combining ability analysis revealed significant differences for GCA and SCA among parents and hybrids for all the characters (Table 2). Reciprocal effects were also significant for all the characters except 100 seed weight. GCA variance contains additive x additive and additive x additive epistasis while SCA variance contains dominance, additive x dominance and dominance x dominance epistasis (Griffing, 1956), so the significant estimates of GCA and SCA variances indicated that both additive and non-additive gene actions were involved in controlling these characters in the present materials. Estimates of variances due to GCA and SCA suggested predominance of additive gene action for plant height, days to maturity, pod length and 100 seed weight. High SCA variance for pods per plant, seeds per pod and grain yield per plant revealed the importance of non-additive gene action for these characters and hence selection for the improvement of these characters is suggested by delayed selection in later generations when the genes are fixed and expressed fully. High reciprocal variances for pods per plant, seeds per pod and grain yield per plant indicated the importance of maternal contribution of the parents used in hybridization. Further, high contribution of reciprocal effects also restricts the bulking of hybrids sharing same parentage but reciprocally mated and hence, these should be handled separately for selection, in later segregating generations. The finding of the present study for the traits in which additivity plays a more important role than dominance is in conformity with the earlier findings (Thimmappa, 1987; Khattak *et al*., 2001). Chowdhury (1986), Ghafoor *et al.* (1993) and Chauhan & Singh (1997) reported predominance of SCA variance for most of the characters related to yield. Singh and Singh (1993) and Chauhan & Singh (1997) reported additive genetic variation involved for seed weight and non-additive for grain yield in lentil and expected transgressive segregants in the proceeding generations for both characters in some of the crosses. The presence of non-additive gene action suggests that hybrids may provide a desirable alternative to pure lines or higher potential yields, assuming epistasis is not additive x additive in nature (Saxena & Sharma, 1989). The cause of the differences in the results might be due to experimental material and environments under which the experiment is conducted because polygenic characters are more influenced by the environmental fluctuation. Estimates of the form of genetic variation have quite fundamental influence of the identification of breeding strategies and methods.

General combining ability effects: Estimates of GCA effects of the parents alongwith means are shown in Table 3. The best GCA effect for plant height was recorded in the parent "NM 121-25" (9.65) followed by "NM 51" (4.18) whereas, "VC 4982", "VC 4152" and "VC 1163" produced significantly negative GCA effects with values of -7.74, -6.39 and -4.39, respectively. As plant height in mungbean is highly influenced by the fluctuation in environments and hence short to medium stature genotypes are preferred to get maximum grain yield, therefore the genotypes with average plant height and intermediate GCA effect may be utilized in breeding programme for the development of high yielding mungbean cultivars. The genotype 'NM 121-25" also produced highest values of mean performance for days to maturity (68.31) and significant positive GCA effect (2.98). This genotype was followed by "NM51"and "VC 3902" with significant GCA values of 0.94 and 0.92, respectively. The parental line "NM 51" produced maximum pods (25.23) and significant positive effect while the genotype "VC 3301" had minimum pod number (20.44) with a negative significant GCA effect (-2.58). All other genotypes revealed non-significant GCA effects. The genotype "VC 3902" gave the highest mean performance (9.20) with maximum and significantly positive GCA effect (0.66) for pod length. For seeds per pod, the genotypes "NM 121-25", "NM 51" and "NM 20-21" exhibited significant positive GCA effects with the values of 0.35, 0.28 and 0.24, respectively. For 100 seed weight, five genotypes ("VC 4152", "VC 3902", "VC 1163", "VC 3301" and "NM 51") produced significant positive GCA effects with the values of 0.66, 0.64, 0.51, 0.46 and 0.20, respectively. As for grain yield per plant is concerned, highest mean performance (8.90) was exhibited by "NM 51" and only three genotypes ("NM 51", "VC 4152" and "VC 1163") revealed significant positive GCA effects with the values of 0.95, 0.62 and 0.61, respectively.

The general combining ability effects pointed out close association between mean performance of genotypes and their GCA effects for all the characters under study. The genotype producing highest mean performance for a particular character, revealed the maximum GCA effect for that trait. In the present investigation, it is evident that the genotype "NM 121-25" produced the highest GCA effects for plant height, days to maturity and seeds per pod and hence proved to be the best general combiner for these characters (Table 3). Similarly the genotype "NM 51" was the best general combiner for pods per plant and grain yield per plant as it had highest GCA effects for these characters. The genotypes "VC 3902" and "VC 4152" were observed to be the best general combiner for pod length and 100 seed weight, respectively. One genotype (VC 4982) did not produce any worth as for general combining ability was concerned because it produced negative GCA effects for all the characters except pods per plant.

Table 1. Analysis of variance for seven agronomic characters in 8x8 parent complete diallel of mungbean.

Source of variation	d.f.	Mean squares						
		Plant height	Days to maturity	Pods per plant	Pod length	Seeds per pod	100 seed weight	Grain yield per plant
Replications	2	188.34*	22.23*	495.22**	0.09	5.75**	0.06	53.11**
Genotypes	63	309.96**	29.61**	162.37**	2.08**	1.53**	3.14**	24.50**
Error	126	48.13	5.79	43.42	0.26	0.67	0.44	5.43

* and ** are significant at 5 and 1% level of probability.

Table 2. Mean squares for combining ability in 8x8 parent complete diallel of mungbean.

Source of variation	d.f.	Plant height	Days to maturity	Pods per plant	Pod length	Seeds per pod	100 Seed weight	Grain yield per plant
GCA	7	126.33**	1676.64**	123.35**	13.50**	3.69**	23.70**	29.61**
SCA	28	10.02*	153.82**	176.60**	0.59**	1.40**	0.92**	25.68**
Reciprocal	28	25.03**	124.18**	157.59**	0.71**	1.11*	0.22^{NS}	22.26**
Error	126	5.79	48.05	42.96	0.26	0.67	0.44	5.40

* and ** are significant at 5 and 1% level probability.

Table 3. Mean performance and general combining ability effects in 8x8 complete diallel of mungbean.

Parents	Plant height		Days to maturity		Pods per plant		Pod length		Seeds per pod		100 seed weight		Grain yield per plant	
	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA	Mean	GCA
NM 20-21	85.88	2.14*	64.33	-0.99**	23.50	0.48	7.82	-0.72**	11.96	0.24*	4.20	-0.96**	6.98	-0.98**
NM 121-25	93.40	9.65**	68.31	2.98**	22.32	-0.70	8.18	-0.37**	12.06	0.35**	4.52	-0.64**	7.65	-0.30
NM-51	87.93	4.18**	66.27	0.94**	25.23	2.21*	8.63	0.09	11.99	0.28**	5.36	0.20*	8.90	0.95**
VC-4982	76.00	-7.74**	64.48	-0.85**	24.20	1.20	7.86	-0.69**	11.33	-0.39**	4.29	-0.87**	6.76	-1.19**
VC-4152	77.36	-6.39**	63.85	-1.47**	22.76	-0.25	8.85	0.30**	11.41	-0.30**	5.83	0.66**	8.58	0.62*
VC-3902	86.76	3.02**	66.25	0.92**	21.40	-1.62	9.20	0.66**	11.55	-0.16	5.80	0.64**	8.39	0.43
VC-3301	83.29	-0.46	65.73	0.40	20.44	-2.58**	9.05	0.50**	11.62	-0.09	5.62	0.46**	7.82	-0.13
VC-1163	79.35	-4.39**	63.40	-1.93**	24.28	1.26	8.77	0.23**	11.78	0.07	5.68	0.51**	8.55	0.61*
Se[g (i)]		0.93		0.32		0.88		0.07		0.11		0.09		0.31
Se[g(i)-(j)]		1.41		0.49		1.34		0.10		0.17		0.14		0.47

* and ** are significant at 5 and 1% level probability.

Specific combining ability effects: The estimates of specific combining ability (SCA) effects alongwith means are presented in Table 4. SCA effects of the crosses for plant height showed that significant positive effects were observed in four cross combinations (“NM 20-21 x VC 3902”, “NM 121-25 x VC 3301”, “NM 20-21 x VC 4152” and “VC 4982 x VC 1163”). The highest mean performance was revealed by the hybrid “NM 121-25 x VC 3902” which could not produce significant effect for this character. The same hybrid produced highest mean performance for days to maturity with a non-significant SCA effect. For days to maturity, significant and positive SCA effects were noticed in three cross combinations (“VC 4982 x VC 3301”, “NM 20-21 x VC 3902” and “NM 121-25 x NM 51”). Highest mean performance coupled with high and significant positive SCA effect was observed in the hybrid “NM 51 x VC 4982” for pods per plant. Other cross combinations which revealed significant and positive SCA effects for this character were identified as “NM 20-21 x VC 1163”, “NM 121-25 x VC 4152” and “NM 51 x VC 3902”. The hybrid “VC 3902 x VC 3301” gave highest mean performance for pod length with a significant positive SCA effect. The cross combinations; “NM 20-21 x VC 4982”, “VC 4982 x VC 3902”, “NM 121-25 x NM 51”, “VC 3301 x VC 1163” and “VC 4152 x VC 1163” also showed significant positive effects with high mean performance for pod length. As regards seeds per pod, high mean values with significant positive SCA effects were revealed by three cross combinations (“NM 20-21 x VC 3902”, “NM 51 x VC 3902” and “NM 121-25 x NM 51”). For 100 seed weight, highest mean performance with significant positive SCA effect was exhibited by the hybrid “VC 3902 x VC 3301”. Significant positive SCA effects for this character were also revealed by two other cross combinations (“VC 4982 x VC 3301” and “NM 20-21 x NM 121-25”). There were a good number of crosses having significant and positive effects for grain yield per plant (“NM 121-25 x VC 4152”, “NM 20-21 x VC 1163”, “NM 51 x VC 4982”, “NM 51 x VC 3902”, “VC 3301 x VC 1163”, “NM 51 x VC 3301” and “NM 20-21 x VC 3902”). A few of these crosses also showed significant and positive SCA effects for some of the yield components. When all the characters under study were considered, the cross combination “NM 20-21 x VC 3902” had greater estimates of significant positive SCA effects which was followed by the hybrid “NM 51 x VC 3902”. The crosses with significant SCA effects indicated presence of non-additive (dominance and epistasis) gene action.

Reciprocal effects: Reciprocal effects were also investigated and the results are presented in Table 5. The results revealed that for plant height the hybrid “VC 4982 x NM 51” showed highest and significant positive RCA effect followed by the crosses “VC 1163 x NM 121-25” and “VC 3902 x NM 51”. In case of days to maturity, four cross combinations; “VC 3902 x NM 121-25”, “VC 4982 x NM 121-25”, “VC 4152 x NM 121-25” and “NM 51 x NM 121-25” exhibited significant positive RCA effects. Two cross combinations (“VC 3301 x VC 4982” and “NM 51 x NM 20-21”) were observed to produce significant positive RCA effects for pods per plant and similarly other two hybrids (“NM 51 x NM 121-25” and “VC 3902 x NM 51”) were found to be the best for pod length. For seeds per pod, three cross combinations (“VC 4152 x VC 4982”, “VC 1163 x NM 51” and “NM 51 x NM 121-25”) exhibited significant positive RCA effects. None of the crosses showed significant positive RCA effects for 100-seed weight and grain yield per plant. Although RCA effects were not much pronounced in the present material, however the crosses revealing good RCA effects indicated the importance of maternal contribution of the parents used in hybridization.

Table 4. Mean performance and specific combining ability effects in 8x8 complete diallel of mungbean.

Crosses	Plant height		Days to maturity		Pods per plant		Pod length		Seeds per pod		100 seed weight		Grain yield per plant	
	Mean	SCA	Mean	SCA	Mean	SCA	Mean	SCA	Mean	SCA	Mean	SCA	Mean	SCA
NM 20-21x NM 121-25	86.97	-2.58	65.67	1.35	17.33	-7.03**	7.43	0.23	12.00	-0.23	4.10	0.49*	4.09	-2.50**
NM 20-21x NM 51	91.17	3.52	64.00	-0.28	29.80	-1.51	7.79	-0.03	12.77	0.18	4.02	-0.34	7.97	-0.92
NM 20-21x VC 4982	83.77	4.23	62.00	-1.82*	26.73	1.29	7.34	0.80**	12.07	0.06	3.28	0.13	5.47	-0.09
NM 20-21x VC 4152	73.87	6.78**	62.33	0.80	15.63	1.26	7.83	-0.04	11.50	0.03	4.58	-0.59*	4.12	1.07
NM 20-21x VC 3902	95.50	8.80**	69.00	2.08*	21.73	3.56	8.18	-0.01	12.77	0.90**	4.78	-0.12	7.49	1.64*
NM 20-21x VC 3301	88.00	4.74	62.33	0.93	18.27	-0.50	7.72	-0.14	11.77	-0.30	4.57	0.20	5.20	-0.48
NM 20-21x VC 1163	78.10	-4.11	63.00	-0.40	19.63	10.84**	7.94	-0.13	11.87	0.29	4.71	0.06	5.65	3.82**
NM 121-25 x NM 51	99.43	3.03	74.00	1.91*	24.80	-4.68*	9.40	0.56**	12.70	0.58*	4.77	0.08	9.60	-1.09
NM 121-25x VC 4982	86.50	0.13	70.67	-1.46	17.80	1.82	7.97	0.25	11.40	-0.01	3.79	0.13	5.79	0.35
NM 121-25x VC 4152	87.80	2.71	71.33	0.99	28.70	9.40**	8.41	-0.33	12.37	0.29	4.98	0.10	11.37	3.99**
NM 121-25x VC 3902	102.33	0.97	75.33	0.60	17.27	0.32	8.26	-0.48*	12.40	0.30	4.81	-0.06	6.83	0.41
NM 121-25x VC 3301	102.00	8.51**	69.00	-0.05	18.33	-0.82	8.57	-0.08	12.30	0.01	5.07	-0.26	7.16	0.18
NM 121-25 x VC 1163	97.93	-0.28	66.33	-1.05	20.90	-1.05	8.35	-0.12	12.53	-0.12	4.60	-0.39	7.24	-1.08
NM 51 x VC 4982	93.50	3.04	67.00	0.41	33.27	9.73**	7.67	-0.63**	12.47	0.35	4.23	-0.27	11.98	3.03**
NM 51 x VC 4152	82.77	0.69	64.33	-0.63	25.83	-0.14	9.22	0.10	11.97	0.19	5.76	0.06	10.17	-0.08
NM 51 x VC 3902	94.90	-5.06*	66.33	0.47	25.83	7.60**	9.61	-0.25	12.33	0.70*	5.91	-0.08	11.90	2.63**
NM 51 x VC 3301	85.60	1.07	68.33	0.33	19.80	2.57	9.25	-0.10	11.50	-0.27	5.51	-0.05	8.30	2.01*
NM 51 x VC 1163	85.23	-0.81	67.00	1.33	24.67	2.15	8.39	-0.16	12.50	-0.54	6.07	0.16	8.39	-0.11
VC 4982 x VC 4152	72.83	2.08	63.33	-0.17	22.30	2.86	7.87	-0.01	11.10	-0.89**	4.67	-0.15	6.55	-1.66*
VC 4982 x VC 3902	71.97	3.12	65.67	-0.73	19.57	-0.27	8.14	0.59**	11.30	0.30	4.48	-0.32	4.95	-0.53
VC 4982 x VC 3301	74.90	-1.30	65.00	2.29**	26.47	-2.23	7.95	-0.01	12.03	0.36	5.63	0.79**	7.89	-0.01
VC 4982 x VC 1163	77.23	5.13*	64.00	1.45	19.10	0.61	8.03	0.08	11.32	-0.03	5.04	0.15	6.03	0.94
VC 4152 x VC 3902	77.77	-2.14	64.00	-0.60	19.17	-0.99	9.59	-0.08	11.52	-0.33	6.83	0.40	6.71	0.88
VC 4152 x VC 3301	74.83	-0.55	62.67	-1.26	17.40	2.15	8.27	0.05	11.33	0.26	5.92	-0.09	6.34	-0.10
VC 4152 x VC 1163	81.23	1.10	62.33	0.24	19.23	-4.43	9.76	0.42*	12.23	0.49	6.46	-0.01	8.23	-1.50
VC 3902 x VC 3301	89.30	-2.22	64.33	-0.98	14.37	-0.78	10.33	0.44*	10.47	-0.36	6.92	0.66**	6.64	-0.63
VC 3902 x VC 1163	81.37	3.04	65.00	-0.32	19.87	-0.58	9.23	-0.27	11.32	-0.13	6.10	-0.53*	8.67	-0.27
VC 3301 x VC 1163	77.90	-2.28	64.33	-0.46	22.37	3.53	10.03	0.43*	12.03	0.56	6.23	-0.04	9.37	2.01*
Se[s (I, i)]		3.50		1.22		3.31		0.26		0.41		0.34		1.17
Se[s (I, j)]		2.50		0.87		2.37		0.18		0.30		0.24		0.84

* and ** are significant at 5 and 1% level probability.

Table 5. Mean performance and reciprocal effects in 8x8 complete diallel of mungbean.

Crosses	Plant height		Days to maturity		Pods per plant		Pod length		Seeds per pod		100 seed weight		Grain yield per plant	
	Mean	RE	Mean	RE	Mean	RE	Mean	RE	Mean	RE	Mean	RE	Mean	RE
NM 121-25x NM 20-21	98.93	-5.98*	71.67	-3.00**	14.20	1.57	7.95	-0.26	12.17	-0.08	3.99	0.05	4.27	-0.09
NM 51 x NM 20-21	96.00	-2.42	66.00	-1.00	18.60	5.60*	7.96	-0.09	12.07	0.35	4.09	-0.04	6.07	0.94
VC 4982 x NM 20-21	80.97	1.40	61.33	0.33	25.23	0.75	7.09	0.12	11.20	0.43	3.64	-0.18	5.91	-0.22
VC 4152 x NM 20-21	71.57	1.15	65.00	-1.33	33.37	-8.87**	8.34	-0.26	11.87	-0.18	3.98	0.30	13.22	-4.55**
VC 3902 x NM 20-21	99.90	-2.20	65.67	1.67	29.13	-3.7	8.75	-0.28	12.63	0.07	4.66	0.06	10.62	-1.56
VC 3301 x NM 20-21	92.33	-2.17	69.00	-3.33**	22.57	-2.15	8.64	-0.46*	11.37	0.20	5.16	-0.30	7.52	-1.16
VC 1163 x NM 20-21	76.67	0.72	61.00	1.00	51.57	-15.97**	7.90	0.02	12.77	-0.45	4.88	-0.07	17.13	-5.74**
NM 51 x NM 121-25	101.77	-1.17	68.33	2.83**	14.90	4.95	8.26	0.57**	12.13	0.78*	4.82	-0.03	5.42	2.09*
VC 4982 x NM 121-25	85.07	0.72	61.33	4.67**	32.87	-7.53**	7.50	0.23	11.93	-0.27	3.77	0.01	7.83	-1.02
VC 4152 x NM 121-25	91.63	-1.92	64.33	3.50**	34.23	-2.77	7.89	0.26	11.73	0.32	5.59	-0.30	13.17	-0.90
VC 3902 x NM 121-25	92.43	4.95	64.33	5.50**	24.77	-3.75	8.46	-0.10	11.47	0.47	5.38	-0.28	10.17	-1.67
VC 3301 x NM 121-25	100.90	0.55	68.33	0.33	19.50	-0.58	8.64	-0.03	11.67	0.32	4.37	0.35	8.24	-0.54
VC 1163 x NM 121-25	79.50	9.22**	64.33	1.00	24.17	-1.63	8.23	0.06	11.50	0.52	4.68	-0.04	7.11	0.06
VC 4982 x NM 51	72.93	10.28**	64.67	1.17	39.03	-2.88	6.97	0.35	11.43	0.52	4.21	0.01	9.51	1.24
VC 4152 x NM 51	81.70	0.53	64.00	0.17	23.83	1.00	8.85	0.18	11.80	0.08	6.40	-0.32	8.73	0.72
VC 3902 x NM 51	76.87	9.02**	69.00	-1.33	36.60	-5.38*	8.48	0.56**	12.73	-0.20	5.93	-0.01	12.03	-0.07
VC 3301 x NM 51	92.27	-3.33	65.67	1.33	30.63	-5.42*	8.83	0.21	11.73	-0.13	6.03	-0.26	13.27	-2.48**
VC 1163 x NM 51	80.20	2.52	64.33	1.33	32.63	-3.98	9.01	-0.31	10.65	0.88**	6.00	0.04	10.40	-1.00
VC 4152 x VC 4982	70.57	1.13	62.33	0.50	19.90	1.20	8.44	-0.28	9.18	0.96**	4.94	-0.14	4.90	0.82
VC 3902 x VC 4982	92.30	-10.17**	63.67	1.00	25.07	-2.75	10.07	-0.96**	11.63	-0.17	4.74	-0.13	8.38	-1.17
VC 3301 x VC 4982	73.60	0.65	69.33	-2.17*	12.33	7.07**	8.77	-0.41*	11.17	0.43	5.46	0.08	5.34	1.28
VC 1163 x VC 4982	76.23	0.50	64.00	0.00	33.07	-6.98**	8.32	-0.14	11.40	-0.04	5.61	-0.28	10.57	-2.27*
VC 3902 x VC 4152	78.70	-0.47	64.33	-0.17	21.13	-0.98	9.26	0.16	10.33	0.59	6.89	-0.03	13.07	-3.18**
VC 3301 x VC 4152	77.87	-1.52	63.33	-0.33	27.27	-4.93	9.97	-0.57**	11.83	-0.25	6.47	-0.27	10.35	-2.00*
VC 1163 x VC 4152	66.90	7.17*	62.00	0.17	19.97	-0.37	9.22	0.27	11.70	0.27	6.22	0.12	7.12	0.55
VC 3301 x VC 3902	78.87	5.22	67.00	-1.33	21.70	-3.67	9.96	0.18	11.73	-0.63	6.93	-0.01	8.62	-0.99
VC 1163 x VC 3902	89.47	-4.05	63.00	1.00	24.30	-2.22	9.08	0.07	11.67	-0.17	5.48	0.31	8.76	-0.47
VC 1163 x VC 3301	75.33	1.28	62.33	1.00	28.10	-2.87	9.37	0.33	12.47	0.22	5.97	0.13	11.5	-1.07
Se (i, j)		2.83		0.98		2.68		0.21		0.34		0.27		0.95

* and ** are significant at 5 and 1% level probability.

The analysis of combining ability in an eight parent complete diallel indicated that both additive and non-additive gene effects were important for grain yield and its components in mungbean, however, the additive gene effects were predominant for plant height, days to maturity, pod length and 100 seed weight. As in the present study, SCA and RCA components of variance were more important for pods per plant, seeds per pod and grain yield per plant indicating the importance of non-additive genetic variation for phenotypic expression of these characters. The parents with higher magnitude of GCA produced best recombinants in most of the cases. Close relationship between performance and combining ability effects may be due to the presence of both additive and non-additive genetic variation for yield and its components. Breeding by pedigree method would result in partial exploitation of additive and additive x additive types of gene action. Under such situation any suitable method of recurrent selection programme should be adopted (Singh *et al.,* 1987). It is also proposed to utilize diallel selective mating system to capitalize on additive genetic variance and enhance genetic recombinants. Therefore, for the improvement of grain yield in mungbean, other breeding methods including biparental mating among selected F_2 segregants from crosses involving the parents “NM-121-25”, “NM-51”, “VC-3902” and “VC-4152” need special considerations. From the further segregating generation of these biparental populations, the desirable plants can be selected and used in other conventional breeding programme. Simultaneously, the hybrids involving the parents “NM-121-25”, “NM-51”, “VC-3902” and “VC-4152” may be exploited through modified diallel selective mating system. By this technique the improvement in the population can be effectively made and at the same time superior segregants selected and carried further for the development of high yielding pure lines of mungbean. GCA and SCA information shows the kind of progeny which must be evaluated for the relevant traits. If SCA effects are significant, specific hybrid combinations must be evaluated. Alternatively, if GCA is significant and SCA not, then the performance of a single cross progeny can adequately be predicted on the basis of GCA. In the present experiment, GCA mean squares was high for plant height, days to maturity, pod length and seed weight and thus the performance of a particular single-cross for these characters could successfully be predicted on the basis of GCA.

References

Chauhan, M.P. and I.S. Singh. 1997. Combining ability analysis for seed yield and seed size over two years in exotic and Indian crosses of lentil. *LENS Newsletter*, 24(1/2): 15-18.

Chowdhury, R.K. 1986. Combining ability analyses for seed yield and its components in mungbean. *Crop Improv*., 13(1):95-97.

Ghafoor, A., M. Tahir, M. Zubair and B.A. Malik. 1993. Combining ability in *Vigna mungo* L. *Pak. J. Bot*., 25(1): 1-6.

Griffing, B. 1956. Concept of general and specific combing ability in relation to diallel crossing systems. *Aust. J. Biol. Sci*., 9: 463-493.

Khattak, G.S.S., M.A. Haq, M. Ashraf and T. McNeilly. 2001. Genetic basis of variation of yield and its components in mungbean *Vigna radiata* (L.) Wilczek. *Hereditas*, 134(3): 211-217.

Saxena, K.B., D.E. Byth, E.S. Wallis and I.H. De Lacy. 1989. Gene action in short-duration pigeonpea. *Legume Res*., 12(3): 103-109.

Singh, I.B., H.G. Singh, U. Singh and P. Singh. 1987. Combining ability for yield and its components in blackgram. *Ind. J. Genet*., 47(1): 99-103.

Steel, R.G.D. and J.H. Torrie. 1980. *Principles* and *Procedures of Statistics*. McGraw-Hill Book Co. Inc., New York, USA.

Thimmappa, A.S. 1987. Genetic analysis of quantitative traits in greengram *Vigna radiata* (L.) Wilczek. *Mysore J. Agri. Sci*., 21: 1, 94.

(Received for Publication 25 August 2005)