Madras Agric. J. 91 (1-3) : 79-82 January-March 2004

https://doi.org/10.29321/MAJ.10.A00072

Studies on combining ability and heterosis for yield and yield components in greengram (*Vigna radiata* (L.) Wilczek)

ANBUMALARMATHI, P. RANGASAMY AND S. BABU

Dept. of Plant Breed. and Genetics, Agricultural College and Res.Instt., Madurai - 625 104, Tamil Nadu

Abstract : Combining ability and heterosis for eight quantitative characters were studied through line x tester analysis involving five lines and four testers. The combining ability analysis revealed that variances due to hybrids, lines, testers and line x tester interaction were significant for all eight characters studied. The ratio of additive and dominance genetic variance (σA^2: σD^2) indicated that preponderance of non additive type of gene action for all the traits except number of branches per plant. The parents VGG 77, MI 267, Vamban 2 and KM 2 were found to be the best general combiners for most of the characters. The crosses with high sca effects were identified for each character. The hybrids ML 682 x Vamban 2 and VGG 77 x Vamban 1 recorded significant standard heterosis for all the traits except number of branches per plant. Three hybrids viz. K 851 x Vamban 1, VGG 77 x Vamban 1 and VGG 77 x KM 2 can be exploited in recombination breeding. Four cross combinations *viz.* ML 682 x Vamban 2, VGG 77 x Vamban 1, VGG 80 x KM 2 and ML 267 x Vamban 2 can be utilised for heterosis breeding.

Key words: Combining ability, Heterosis, Line x tester, Sca, Recombination breeding, Heterosis breeding, Greengram.

Introduction

Greengram is an important grain legume in India. Choice of the best parents is pre requisite in any crop breeding programmes. Evaluation of parents for their transmission potential for yield and yield components will give a way for better selection. Since all available parents with high order of performance may not be able to transmit their superior traits into their progenies. Therefore, selection of desirable parents based on their combining ability is increasingly used now a days in crop improvement programmes. Among the different methods, adopted the line x tester analysis has been recommended for early evaluation of parents, because of its simplicity in both experimentation and analysis (Dhillon, 1975). Such studies in greengram are useful in assessing the heterotic ability of parents and this aid in selecting parents, which on crossing would give rise to more desirable segregants with increased yielding ability.

Materials and Methods

Experimental material for the study comprised of five lines *viz.* K 851 (L_1), VGG 77 (L_2), VGG 80 (L_3), ML 267 (L_4) and ML 682 (L_5) and four testers *viz.* CO 6 (T_1), KM 2 (T_2), Vamban 1 (T_3) and Vamban 2 (T_4). Crosses were effected in line x tester mating design and F_1's were evaluated during 2002, at Agricultural College and Research Institute, Madurai. The 20 F_1's were raised in randomized block design with two replications. Each entry was raised in three metre row with 45 x 15 cm spacing. For estimating heterosis, parents were raised in adjacent plot with above mentioned spacing. Observations were recorded in the five randomly selected plants both in parents and hybrids on days to 50 per cent flowering, plant height, number of branches per plant, number of clusters per plant, number of pods per plant, number of seeds per pod, 100 seed weight and single plant yield. The data were subjected to combining ability analysis following the method proposed by Kempthorne (1957). Heterosis was worked out over better parent and standard parent.

Results and Discussion

The analysis of variance of combining ability revealed significant diversity among hybrids,

Table 1. Analysis of variance of combining ability for grain yield and its component traits

Source	df	Mean squares							
		Days to 50 per cent flowering	Plant height	No. of branches per plant	No. of clusters per plant	No. of pods per plant	No. of seeds per pod	100 seed weight	Single plant yield
Replication	1	0.22	0.74	0.01	0.005	0.82	0.02	0.001	0.01
Hybrids	19	21.94*	149.80*	3.09*	10.68*	72.26*	2.03*	0.41*	14.97*
Lines	4	44.31*	77.47*	10.72*	7.01*	60.38*	1.25*	0.47*	14.70*
Testers	3	6.95*	255.4*	2.44*	1.52*	2.90*	4.32*	0.49*	6.12*
Line x Tester	12	18.22*	147.5*	0.70*	14.19*	93.56*	1.71*	0.37*	17.27*
Error	19	0.75	0.45	0.03	0.02	0.63	0.006	0.003	0.01

* Significant at 5 per cent level

Table 2. General combining ability (gca) effects of parents for grain yield and its component traits

Parents	Days to 50 per cent flowering	Plant height (cm)	No. of branches per plant	No. of clusters per plant	No. of pods per plant	No. of seeds per pod	100 seed weight (g)	Single plant yield (g)
K 851	-0.62*	-4.16*	1.08*	-0.02	-0.31	-0.53*	-0.09*	-0.26*
VGG 77	-3.00	4.32*	0.84*	0.53*	3.00*	0.58*	0.35*	1.90*
VGG 80	2.88	-1.36*	-1.74*	-1.59*	-4.43*	0.02	-0.33*	-1.65*
ML 267	-1.50	0.88*	0.38*	0.77*	0.92*	-0.02	0.05*	0.69*
ML 682	0.00	0.32	-0.56*	0.30*	0.82*	-0.05*	0.03*	-0.68*
SEd	0.30	0.23	0.06	0.05	0.27	0.03	0.02	0.04
Co 6	-0.72	-3.07*	-0.67*	-0.51*	-0.77*	-0.29*	-0.17*	-0.65*
KM 2	-0.42*	-1.80*	-0.08	0.44*	0.40	-0.50*	0.06*	-0.17*
Vamban 1	-0.03*	-2.66*	0.35*	0.01	0.02	-0.17*	-0.18*	-0.32*
Vamban 2	1.17	7.54*	0.40*	0.06	0.35	0.96*	0.29*	1.13*
SEd	0.27	0.21	0.05	0.04	0.25	0.02	0.02	0.03

*Significant at 5 per cent level

lines, testers and line x tester interaction. The estimates of dominance genetic variance (σD^2) was higher than additive genetic variance (σA^2) for all the traits except number of branches per plant, which revealed the predominance of non additive gene action (Table 1). This was in accordance with the findings of Mansuria (1991) for days to 50 per cent flowering, Jiji Joseph and Santhoshkumar (2000) for plant height, number of pods per plant, number of seeds per pod, 100 seed weight. Tiwari *et al.* (1993) for number of branches per plant, Ram (1997) for number of clusters per plant and Kute *et al.* (1999) for single plant yield. To exploit dominance gene action of these traits heterosis, breeding or hybridization followed by selection in later generation is recommended for the improvement of all these traits in greengram.

The *gca* effects (Table 2) indicated that among the lines, VGG 77 and MI 267 were good general combiners for single plant yield. The lines VGG 77 and MM 267 also served as best combiners for other yield contributing characters in addition to single plant yield. These lines may help to produce high yielding segregants through their contribution of additive genes. Among the testers, Vamban 2 was found to be the good general combiner for plant height, number of branches per plant, number of seeds per pod, 100 seed weight and single plant yield. Besides this, KM 2 exhibited high sca effects for days to 50 per cent flowering, number of clusters per plant and 100 seed weight. These testers may contribute desirable genes for increasing the grain yield in any breeding programme.

The estimation of *sca* effects (Table 3) indicated that the cross, VGG 80 x KM 2 showed significant positive *sca* effects for plant height, number of branches per plant, number of clusters per plant, number of pods per plant, number of seeds per pod, 100 seed weight and single plant yield. NM 682 x Vamban 2 recorded significant positive sca effects for days to 50 per cent flowering, plant height, number of clusters per plant, number of pods per plant, number of seeds per pod, 100 seed weight and single plant yield. Besides above two crosses the following hybrids *viz.* K 851 x CO 6, K 851 x KM 2, VGG 77 x CO 6, VGG 77 x KM 2, VGG 77 x Vamban 1, ML 267 x CO 6; ML 267 x Vamban 1, ML 267 x Vamban 2 and ML 682 x Vambanl were also found to be best specific combiners for single plant yield.

Table 3. Specific combining ability (*sca*) effects of parents for grain yield and its component traits

Hybrids	Days to 50 per cent flowering	Plant height (cm)	No. of branches per plant	No. of clusters per plant	No. of pods per plant	No. of seeds per pod	100 seed weight (g)	Single plant yield (g)
K 851 x Co 6	0.47*	-5.10*	0.28*	1.09*	3.99*	0.55*	0.10*	1.50*
K 851 x KM 2	-0.83*	-3.15*	-0.26*	2.33*	1.11	-0.16*	0.05	0.44*
K 851 x Vamban 1	1.29	1.39*	-0.43*	-3.07*	-6.22*	0.37*	-0.25*	-1.70*
K 851 x Vamban 2	-0.92*	6.86*	0.41*	-0.35*	1.12	-0.77*	0.10*	-0.25*
VGG 77 x Co 6	0.60*	3.59*	-0.39*	-0.47*	-1.33*	-0.50*	-0.17*	0.85*
VGG 77 x KM 2	-1.70	-1.61*	0.02	-0.31*	3.15*	-0.26*	0.03	0.53*
VGG 77 x Vamban 1	-3.10	8.84*	-0.13	2.23*	3.76*	1.18*	0.49*	1.02*
VGG 77 x Vamban 2	4.20	-10.82*	0.50*	-1.45*	-5.59*	-0.42*	-0.36*	-2.39*
VGG 80 x Co 6	0.22*	-3.30*	0.33*	-1.59*	-3.68*	-0.19*	-0.27*	-1.06*
VGG 80 x KM 6	0.92*	17.54*	0.53*	3.94*	11.06*	1.64*	0.85*	5.39*
VGG 80 x Vamban 1	0.03*	-7.10*	-0.76*	0.24*	-1.00	-0.66*	-0.24*	-1.38*
VGG 80 x Vamban 2	-1.17*	-7.14*	-0.10	-2.58*	-6.38*	-0.79*	-0.35*	-2.95*
ML 267 x Co 6	-3.90	2.21*	0.03	2.13*	5.90*	-0.11*	0.34*	0.76*
ML 267 x KM 2	1.80	-5.84*	-0.47*	-4.25*	-11.15*	-0.86*	-0.65*	-4.73*
ML 267 x Vamban 1	-1.10*	-0.22	1.20*	0.27*	1.26*	-0.07	0.01	1.86*
ML 267 x Vamban 2	3.20	3.84*	-0.76*	1.85*	3.99*	1.03*	0.30*	2.11*
ML 682 x Co 6	2.60	2.60*	-0.25*	-1.16*	-4.88*	0.25*	0.01	-2.04*
ML 682 x KM 2	-0.20*	-6.95*	0.18	-1.70*	-4.17*	-0.37*	-0.29*	-1.63*
ML 682 x Vamban 1	2.90	-2.90*	0.12	0.33*	2.20*	-0.82*	-0.02	0.19*
ML 682 x Vamban 2	-5.30	7.25*	-0.05	2.53*	6.85*	0.95*	0.30*	3.48*
SE	0.61	0.47	0.11	0.10	0.56*	0.05	0.05	0.08

* Significant at 5 per cent level

Standard heterosis for yield and its components indicated that among the hybrids, ML 682 x Vamban 2 and VGG 77 x Vamban 1 recorded significant standard heterosis for all the traits except number of branches per plant. It was followed by VGG 80 x --KM 2 and ML 267 x Vamban 2 for six traits except days to 50 per cent flowering and number of branches per plant. Similar results were also reported by Jiji Joseph and Santhoshkumar (2000) and Loganathan *et al.* (2001). Heterosis for single plant yield was associated with heterosis for plant height, number of clusters per plant, number of pods per plant, number of seeds per pod and 100 seed weight in all the above four high yielding crosses. This indicated that heterosis for single plant yield was through heterosis for individual yield components. Similar observations were reported by Singh and Jain (1970) and Reddy Sekhar *et al.* (1994).

Hybrids involving parents with significant gca effects and non significant *sca* ettects are useful in recombination breeding. Three hybrids *viz.* K 851 x Vamban 1, VGG 77 x Vamban 1 and VGG 77 x KM 2 can be exploited in recombination breeding for improvement of earliness, number of branches per plant and 100 seed weight respectively.

Based on *sca* effects and standard heterosis four cross combinations *viz.* ML 682 x Vamban 2, VGG 77 x Vamban 1, VGG 80 x KM 2 and ML 267 x Vamban 2 were found to be superior for yield and its components and these hybrids can be utilised for heterosis breeding.

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(Received: December 2002; Revised: September 2003)