



Research Article

Combining ability analysis for yield and its component traits in Blackgram (*Vigna mungo* (L.) Hepper)

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Abstract:

A diallele analysis of 8 x 8 was studied in black gram (*Vigna mungo*) with a view to understand the combining ability, nature of gene action and potential for the exploitation of heterosis using nine quantitative characters viz., days to first flower, plant height, number of branches per plant, number of clusters per plant, number of pods per cluster, number of pods per plant, number of seeds per pod, hundred seed weight and seed yield per plant in 28 hybrids and their eight parents. The parent ADT 3 recorded relatively high *per se* performance for seed yield, hundred seed weight, number of clusters per plant, number of pods per cluster, number of pods per plant and number of branches per plant with early flowering and short stature. Among the hybrids, ADT 3/99V48, ADT 3/LBG 645 and 2KU 53/LBG 645 were found to have high mean performance for almost all the yield component characters besides seed yield. The *gca* effect of the genotypes ADT 3, LBG 645 and 2 KU 53 was high and significant for the traits seed yield per plant besides number of pods per cluster, number of pods per plant and number of seeds per pod. The SCA variance was greater than GCA variance for all the traits studied thus indicating the predominance of non-additive gene action. Among the hybrids, ADT 3/99V48 recorded the maximum significant *sca* effect indicating their suitability for heterosis breeding. The hybrids ADT 3/ LBG 645 and 2 KU 53/ LBG 645 recorded non significant *sca* effects for almost all the traits studied including seed yield per plant. Hence, these two crosses were adjudged as superior for recombination breeding based on *sca* effects.

Key words: Black gram, combining ability, *gca*, *sca*, *per se* performance, non-additive action

Introduction

Blackgram (*Vigna mungo* (L.) Hepper) is an important pulse crop of India. It is a cheap source of dietary protein (24 per cent), which also contains 67 per cent carbohydrates, 3-5 per cent fibre and 1.74 per cent fat. It also contributes a major portion of lysine in the vegetarian diet and fairly good source of vitamins like thiamine, niacin, riboflavin and much needed iron and phosphorus (Mishra, 1986). It also has a wide range of economic value. It is well known that 50 g pulses/person/day should be consumed in addition to other sources of protein such as cereals, milk, meat and egg which is a very difficult task to achieve as the production and productivity of pulse crop including blackgram is very low. Hence, there is strong need to improve the productivity of the crop. This could be achieved by studying the genetic architecture of this crop for yield improvement. Therefore, the aim of the present study is to identify suitable hybrid combinations with traits such as increased seed yield, ideal plant type and synchronous maturity. Several biometrical methods are being increasingly utilized to infer the underlying gene actions for different traits. The diallel analysis is one which has been considered to throw light on the nature of inheritance of quantitative traits in crop plants. The present study was therefore conducted to estimate the general and specific combining ability of

parents and hybrids, respectively for yield and its component traits in blackgram using diallel analysis.

Material and methods

Eight varieties of blackgram namely ADT 3, 99V 48, PHM 8, ADT 5, 2KU 53, LBG 645, LBG 685 and LBG 20 were used as parents in hybridization program. The seeds of the parent were obtained from the Department of Genetics and Plant Breeding, Annamalai University, Annamalai nagar, Tamilnadu during January 2008 to April 2008. Each genotype was crossed with each of the other genotypes in diallel fashion, excluding reciprocals. The parental lines and their resultant 28 F₁'s were evaluated with ADT 3 as standard check in RBD with three replications adopting a spacing of 30 cm x 10cm during July 2008 to September 2008. Twenty competitive plants were selected in each genotype at random for recording the details of observations for characters viz. days to 50 per cent flowering, plant height (cm), number of branches per plant, number of clusters per plant, number of pods per cluster, number of pods per plant, number of seeds per pod, hundred seed weight (g) and seed yield per plant (g). Recommended agricultural practices and need based plant protection measures were taken up to raise the crop. Analysis of data for general and specific combining ability was carried out following

Griffing's (1956) Method II, Model I (fixed effect model).

Results and discussion

The analysis of variance for combining ability for yield and its attributing characters is presented in Table 1. The ANOVA revealed that mean squares due to genotypes, parents, and hybrids were highly significant for all the traits under evaluation, which indicated the presence of sufficient variability among genotypes, parents, and hybrids. The ratio of GCA to SCA variance was less than unity for all the characters studied, thus indicating the pre dominance of non-additive gene action governing the traits. Similar results were reported by Seenaiyah *et al* (1993), Shanti priya and Hariprasad Reddy (1999), Govindaraj and Subramanian (2001) and Manivannan (2002).

The success of any breeding programme largely depends on the choice of the parent used in the hybridization. In addition to it, high mean was also considered as the main criterion for the selection of superior parents for breeding programme. Gilbert (1958) suggested that the parents with good *per se* performance would result in better hybrids. Further the parents having high *gca* effects could be useful since, the *gca* effect is due to additive gene action and is fixable (Sprague and Tatum,1942). In the present study the genotypes *Viz.*, ADT 3, 2KU 53, LBG 645 and 99V 48 (Table 2) recorded high mean values for seed yield per plant. Besides ADT 3, 99V 48, 2KU 53 and LBG 645 exhibited superior performance for number of branches per plant, number of clusters per plant, number of pods per cluster, number of pods per plant and number of seeds per pod. Among the genotypes studied, the genotype ADT 3 also recorded less number of days to 50 per cent flower with short stature plant and bold seeded nature. The *gca* effects of the genotypes *viz.*, ADT 3, 99V 48, 2KU 53 and LBG 645 were found to be high and positively significant (Table 3) for seed yield and most of the component characters *Viz.*, number of branches per plant, number of clusters per plant, number of pods per cluster, number of pods per plant and number of seeds per pod besides recording negative *gca* effects for days to first flower and plant height. Thus, it is observed that the parents ADT 3, 2KU 53, LBG 645 and 99V 48 were adjudged as superior based on *per se* and *gca* effects which would therefore result in the identification of superior segregants with favourable genes for seed yield and its component traits.

Among the hybrids, ADT 3/ 99V 48, ADT 3/ LBG 645 and 2KU 53 /LBG 645 were found to have high

mean performance for almost all the yield components besides seed yield (Table 4). The specific combining ability is the deviation from the performance predicted on the basis of general combining ability (Allard,1956).The *sca* effect is an important criterion for the evaluation of hybrids. High *sca* effect alone may not be the appropriate choice of the hybrid for heterosis exploitation because the hybrids with low mean value may also possess high *sca* effects, if the *gca* effects of the parents were very low or even negative (Grakh and Chaudhary,1985).It is observed from the present study, the hybrid ADT 3/ 99V 48 showed significant negative *sca* effect for days to first flower and plant height besides having positive and significant *sca* effect for number of branches per plant, number of clusters per plant, number of pods per cluster, number of pods per plant, number of seeds per pod, hundred seed weight and seed yield per plant (Table 5). This cross also possessed high mean seed yield with desirable yield components along with desirable plant stature. Hence this cross combination could favourably be considered for exploiting its vigor through heterosis breeding. However employing hybridization techniques in pulses including blackgram is very tedious as the flowers are very small and delicate with cleistogamous nature. It is practically observed that through hand emasculation and pollination technique less than 5 per cent seed set is possible. Hence, heterosis could be favourably exploited only if proper male sterility system is available.

The crosses involving the parents *viz.*, ADT3/ LBG 645 and 2KU 53/ LBG 645 recorded non-significant *sca* effect for most of the characters including seed yield. The presence of highly significant *gca* and non-significant *sca* may be due to additive and additive x additive interaction. Hence these two crosses may be utilized for recombination breeding for further exploitation as these hybrids would throw segregants for high seed yield. However, the ratio of GCA/SCA variance indicated the predominance of non additive gene action and hence, selection could be postponed to later generations.

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

Source	df	Mean Squares								
		Days to first flower	Plant height (cm)	Number of branches per plant	Number of clusters per plant	Number of pods per cluster	Number of pods per plant	Number of seeds per pod	Hundred seed weight (g)	Seed yield per plant (g)
Replication	2	2.56	3.51	6.25	0.79	1.75	2.16	0.95	1.80	1.69
Genotype	35	11.65**	34.25**	5.29**	6.81**	0.25*	0.69*	0.52*	0.21*	3.57**
Parents	7	4.65**	8.92**	2.14**	5.10**	0.58**	0.36*	0.12*	0.20*	1.45
Hybrid	27	9.42**	27.61**	3.47**	2.95**	1.28**	0.52*	0.43**	0.18*	2.97
Error	70	0.79	1.25	0.58	1.21	0.19	0.24	0.09	0.65	0.59
GCA		0.14	3.05	0.06	0.27	0.05	19.25	0.04	0.02	2.99
SCA		0.16	13.03	0.08	1.12	0.07	23.73	0.07	0.17	3.74
GCA/SCA		0.88	0.23	0.76	0.24	0.71	0.81	0.57	0.11	0.79

Table 2. Mean performance of parents for Yield and Yield attributing traits in Blackgram

Trait/Genotypes	Days to first flower	Plant height (cm)	Number of branches per plant	Number of clusters per plant	Number of pods per cluster	Number of pods per plant	Number of seeds per pod	Hundred seed weight(g)	Seed yield per plant(g)
ADT 3	31.07**	21.32**	2.93**	7.13**	3.72**	21.61**	6.60	5.29**	10.17**
99V 48	31.87**	27.87	2.60	6.60*	3.65	18.13	6.80**	4.81	8.91
PHM 8	31.53**	27.39	2.35	6.13	3.57	11.07	6.20	4.98	7.94
ADT 5	31.53**	28.79	2.46	6.40	3.71*	19.33**	6.53	4.99	8.67
2KU 53	36.73	23.96**	2.78**	5.67	3.68*	20.40**	6.87**	4.72	9.72**
LBG 645	34.57	26.29	2.61*	7.73**	3.70*	19.67**	6.98**	5.14*	9.52**
LBG 685	33.25	25.61	2.40	6.05	3.15	17.65	6.32	5.34**	7.21
LBG 20	35.69	26.59	2.50	5.80	3.50	18.95**	6.40	5.21*	8.06
Mean	33.28	25.97	2.53	6.43	3.58	18.35	6.58	5.06	8.77
SE	0.41	0.52	0.06	0.05	0.02	0.14	0.02	0.03	0.20
CD(P=.05)	0.84	0.95	0.10	0.11	0.10	0.31	0.07	0.09	0.42
CD(P=.01)	1.12	1.10	0.13	0.18	0.14	0.57	0.09	0.16	0.53

* Significant at P=0.05, ** Significant at P=0.01.

Table 3. General Combining ability effects of Parents for different traits in Blackgram

Trait/Genotypes	Days to first flower	Plant height(cm)	Number of branches per plant	Number of clusters per plant	Number of pods per cluster	Number of pods per plant	Number of seeds per pod	Hundred seed weight(g)	Seed yield per plant(g)
ADT 3	-0.25*	-0.50*	0.04*	0.22*	0.12**	5.21**	0.13**	0.02	0.74**
99V 48	0.15	0.46	-0.04*	0.16*	-0.12**	-0.55	-0.06	0.06*	0.65*
PHM 8	-0.06	-0.21	-0.01	-0.10	-0.20**	-2.07**	-0.14**	-0.04	-0.64
ADT 5	0.17	0.47	0.02	-0.07	0.03	-2.30*	-0.09*	0.08*	-0.90**
2KU 53	-0.26*	0.40	0.09*	-0.31**	0.09**	1.51*	0.09*	-0.07	0.66*
LBG 645	0.24	-0.57*	0.11**	0.10	0.08**	1.67*	0.07	-0.04	0.69*
LBG 685	0.19	-0.30	-0.19**	-0.12	-0.07	-0.65	0.09*	0.06*	-0.56
LBG 20	-0.18	0.15	-0.02	0.11	0.06	0.66	-0.08	-0.07	-0.64
SE	0.09	0.26	0.01	0.09	0.02	0.49	0.04	0.12	0.27

* Significant at P=0.05, ** Significant at P=0.01.

Table 4. Mean performance of Hybrids for different traits in Blackgram

Trait/ Hybrids	Days to first flower	Plant height (cm)	Number of branches per plant	Number of clusters per plant	Number of pods per cluster	Numbe r of pods per plant	Numbe r of seeds per pod	Hundr ed seed weight (g)	Seed yield per plant(g)
ADT3x99V48	31.13	22.50	3.81	11.40	4.20	30.33	8.23	4.80	14.99
ADT3xPHM8	31.13	27.17	3.00	07.07	3.26	21.33	7.04	4.65	09.72
ADT3xADT5	31.80	37.08	2.91	06.67	3.63	21.13	6.87	4.70	11.74
ADT3x2KU53	28.13	35.14	3.05	05.97	3.92	21.13	6.67	4.17	10.93
ADT3xLBG645	31.27	24.25	3.07	09.53	3.92	27.93	7.27	4.78	13.44
ADT3x LBG685	32.61	32.65	2.45	06.65	3.65	14.25	5.85	5.07	09.65
ADT3xLBG20	37.25	37.21	3.65	06.60	3.30	16.65	6.10	4.20	07.97
99V48 x PHM8	32.00	32.21	2.76	06.67	3.58	21.93	6.40	4.69	11.60
99V48 x ADT5	35.60	28.07	2.85	05.77	3.39	19.47	5.60	4.72	09.29
99V48 x 2KU53	34.33	28.12	3.18	04.27	2.74	12.00	6.33	4.69	07.26
99V48 x LBG645	30.53	27.83	2.95	05.80	3.61	20.27	6.27	4.85	10.06
99V48 x LBG685	34.50	41.50	2.65	06.20	3.75	20.25	6.25	4.78	07.25
99V48 x LBG20	33.20	42.65	2.83	06.87	3.05	17.15	6.40	4.80	08.06
PHM8 x ADT5	34.80	29.92	3.20	06.40	3.68	15.20	6.47	5.16	07.45
PHM8 x 2KU53	34.53	27.99	2.95	06.27	3.80	21.80	6.47	4.79	10.72
PHM8 x LBG645	35.40	27.36	2.82	06.47	3.65	21.20	6.40	4.97	09.71
PHM8 x LBG685	36.13	47.75	2.35	05.90	3.65	15.25	6.55	5.09	08.91
PHM8 x LBG20	31.58	28.21	2.20	06.70	3.15	16.75	6.35	5.28	06.52
ADT5 x 2KU53	32.67	26.85	3.25	07.33	3.44	15.80	6.27	5.07	08.70
ADT5 x LBG645	36.00	28.01	2.91	06.67	3.66	16.53	6.93	5.71	08.42
ADT5 x LBG685	34.95	25.25	2.56	08.25	2.86	18.25	5.95	4.97	07.45
ADT5 x LBG20	33.58	28.62	2.48	05.60	3.25	17.16	6.40	5.18	09.25
2KU53 x LBG645	29.65	28.16	3.08	08.53	3.76	24.27	7.60	4.53	12.30
2KU53 x LBG685	32.50	31.65	3.25	06.25	3.03	16.86	6.10	4.72	07.85
2KU53 x LBG20	33.05	32.61	3.26	06.80	3.51	17.05	6.05	4.84	10.05
LBG645xLBG685	35.31	30.95	2.89	04.98	3.05	18.05	6.55	5.42	09.56
LBG645 x LBG20	37.50	28.25	2.71	05.65	2.85	17.75	6.75	5.28	08.25
LBG685 x LBG20	36.85	29.61	3.58	05.65	3.25	15.95	6.05	5.24	09.65
Mean	34.62	31.00	2.91	6.67	3.45	18.99	6.50	4.89	09.52
SE	0.41	0.52	0.06	0.05	0.02	0.14	0.02	0.03	0.20
CD(P=.05)	0.84	0.95	0.10	0.11	0.10	0.31	0.07	0.09	0.42
CD(P=.01)	1.12	1.10	0.13	0.18	0.14	0.57	0.09	0.16	0.53

* Significant at P=0.05, ** Significant at P=0.01.

Table 5. Specific Combining ability effects of Hybrids for different traits in Blackgram

Trait/ Hybrids	Days to first flower	Plant height (cm)	Number of branches per plant	Number of clusters per plant	Number of pods per cluster	Number of pods per plant	Number of seeds per pod	Hundr ed seed weight (g)	Seed yield per plant (g)
ADT3x99V48	-0.59*	-3.10**	-0.09*	2.74**	0.14**	6.77**	0.26	0.25	2.53
ADT3xPHM8	-0.19	-1.35**	0.01	0.40*	-0.25**	1.36*	0.07	0.01	0.75
ADT3xADT5	0.35*	7.68**	0.12*	0.06	0.11**	3.38**	0.19	0.21	1.45
ADT3x2KU53	-0.36*	5.90**	0.16**	-0.40*	0.42**	-0.37	0.15	0.61	0.55
ADT3xLBG645	-0.26	0.39	0.02	0.42*	0.16**	1.74**	0.35	0.81	2.32
ADT3x LBG685	0.09	0.21	-0.10*	-0.26	0.10*	-1.65*	0.20	0.12	0.65
ADT3xLBG20	-0.39*	0.82*	0.02	1.25**	0.06	1.98**	0.09	0.05	1.89
99V48 x PHM8	0.46**	3.48**	0.08*	0.23	0.12**	4.18**	0.05	0.06	1.40
99V48 x ADT5	-0.06	-1.54**	0.01	-0.61*	-0.08**	-1.06	0.05	0.37	0.73
99V48 x 2KU53	0.62**	-1.33**	-0.16**	-1.87**	-0.70*	-9.27**	0.15	0.49	2.84
99V48 x LBG645	-0.21	-0.24	0.06*	-0.81**	0.11**	-2.22**	0.32	0.02	0.79
99V48 x LBG685	-0.42*	1.32*	0.09*	0.41*	-0.05	-0.61	0.15	0.15	1.69
99V48 x LBG20	0.15	0.87	-0.07*	-1.21**	-0.12**	2.23**	0.01	0.11	0.52
PHM8 x ADT5	0.16	0.81*	0.02	0.02	0.04	-1.74**	0.01	0.11	1.58
PHM8 x 2KU53	-0.16	-0.58	0.06*	0.13	0.19**	4.11**	0.18	0.23	1.61
PHM8 x LBG645	-0.31*	0.17	-0.08*	-0.15	-0.01	2.29**	0.01	0.42	0.14
PHM8 x LBG685	0.45*	4.26**	0.18**	-0.80**	0.30**	-2.68**	0.11	0.25	0.42
PHM8 x LBG20	-0.25*	-2.81**	0.12**	-0.05	-0.25**	1.21	0.25	0.19	1.61
ADT5 x 2KU53	-0.15	-1.60**	0.08*	0.25	-0.18**	-2.67**	0.23	0.18	0.25
ADT5 x LBG645	0.16	-0.07	0.04	0.12	-0.02	-3.15**	0.34	0.07	1.26
ADT5 x LBG685	-0.07	0.65	0.08*	-0.32	-0.06	-4.25**	0.25	0.41	0.12
ADT5 x LBG20	0.19	-0.35	-0.21**	-0.21	0.15**	0.85	0.15	0.09	0.54
2KU53 x LBG645	-0.24	0.25	0.07	0.23	0.11**	1.83**	0.17	0.24	1.54
2KU53 x LBG685	0.42*	2.65*	0.07	0.45*	0.16**	-4.25**	0.08	0.12	0.61
2KU53 x LBG20	-0.35*	-1.25*	-0.08*	-0.15	-0.25**	-3.15**	0.06	0.39	0.05
LBG645xLBG685	-0.61*	0.80*	0.12**	-1.65**	-0.04	-1.25*	0.05	0.19	0.41
LBG645 x LBG20	-0.17	-1.35**	-0.13**	0.65*	0.05	-2.65**	0.12	0.08	0.52
LBG685 x LBG20	0.10	0.45	0.03	0.08	0.02	0.58	0.10	0.61	0.46
SE	0.16	0.70	0.05	0.25	0.08	1.34	0.11	0.34	0.75

* Significant at P=0.05, ** Significant at P=0.01.