ISSN NO. 2320-5407

Journal homepage:http://www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

Analysis of combining ability in Blackgram (*Vigna mungo* L.Hepper)

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Manuscript Info

Manuscript History:

Received: 22 January 2015
Final Accepted: 25 February 2015
Published Online: March 2015

Key words:

Combining ability, blackgram, GCA, SCA

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Abstract

Seven genetically diverse varieties of blackgram namely TAU-1, AKU-9904, NUL-7, LBG-402, BDU-1, Pant U-31 and Mesh-1008 were selected from germplasm maintained at Pulses Improvement Project, MPKV, Rahuri and Oil seeds Research Station, Jalgaon for making diallel cross to study combining ability during 2009-10. 21 F1s and their 7 parents were studied in RBD with three replications. Results indicating that the parents, LBG-402, BDU 1 and AKU-9904 were proved to be good general combiners with good *per se* performance for most of the traits studied, suggesting scope for their use in breeding programme. The crosses, LBG-402 x BDU-1, BDU-1 x Pant-U 31, AKU-9904 x Pant-U 31 and AKU-9904 x NUL-7 evinced high SCA effects for most of the traits, those can be further exploited for isolating superior genotypes.

INTRODUCTION

Blackgram belongs to family Fabaceae with diploid chromosome number 2n=22. Among pulses, Blackgram is one of the important grain legumes. Its seeds are highly nutritious with protein (24-25%), carbohydrates (60%), fat (1.5%), minerals, amino acids and vitamins. This crop is highly priced crop and the grain is richest source of phosphoric acid 5-10 times more than other pulses. Black gram is consumed in the form of '*Dal*'. The success of breeding procedure is determined by the useful gene combinations organized in the form of high combining lines and isolation of valuable germplasm. Some lines produce outstanding progenies on crossing with others, while certain others seem to be equally desirable may not produce good progenies on crossing. The lines which perform well in combinations are eventually of great importance to the plant breeder. Hence, investigation of general combining ability (G.C.A.) and specific combining ability (S.C.A.) would yield very useful information. Accordingly a good knowledge of gene action involved in the inheritance of quantitative characters of economic importance is required to frame an efficient breeding plan leading to rapid improvement in yield and yield components.

Material and Methods:

The present investigations aimed at studying combining ability in Blackgram (*Vignamungo* L. Hepper) were conducted during 2009-2010 at Pulses Improvement Project, MPKV, Rahuri. The parental material for the present investigation was selected from the germplasm maintained at Pulses Improvement Project, MPKV, Rahuri and Oil seeds Research Station, Jalgaon. These parents were crossed in 7 x 7 diallel fashion excluding reciprocals during summer and *kharif*, 2009 by hand emasculation and pollination.The experiment with twenty eight treatments

(7 parents + 21 F_1s) and one check (TPU-4) was laid out in a randomized block design (RBD) with three replications during *kharif* 2010 at Pulses Improvement Project, MPKV, Rahuri. All the 28 treatments were grown in single progeny row of 3 meter length with spacing of 45 cm between rows and 10 cm between plants. The experimental plots were surrounded by non-experimental border rows of variety TAU-4. Observations were recorded in all the replications on randomly selected competitive five plants in parents and F_1s. The combining ability analysis was carried out according to Model-I (Fixed effect), Method-2 (Parents and one set of F_1's without reciprocals) of Griffing (1956 a).

Result and discussions

The analysis of variance for combining ability (Table 1) indicated that general and specific combining ability variances were significant for all the characters studied. This suggested that both additive and non-additive gene effects were involved in the genetic control of seed yield and its attributes. However, the ratio of estimates of variance□^{2}GCA/□^{2}SCAsuggested predominant role of non-additive gene effects for seed yield and its attributes except characters like days to flowering and 100-seeds weight for which additive effects made a major role. These results are in general in accordance with those reported by Malhotra (1983), Sing *et al*. (1987), Dasgupta and Das (1991), Sharma and Pandey (1996), Santha and Veluswamy (1999b), Govindraj and Subramanain (2001). Vaithiyalingan *et al*. (2002), Kishnan *et al*. (2003) and Singh and Singh (2005).

The estimates of general combining ability effects of seven parents for twelve characters are presented in Table 2. The specific combining ability effects of 21 F_1 crosses are given in Table 3. High GCA coupled with high *per se* performance is the indication of an outstanding best parent with reservoir of superior genes. Therefore, GCA effects along with mean performance may be taken into account for parental selection.The summary of relative magnitude and sign of general combining ability effects of the parents included in the study (Table 2) revealed that, none of the parents was all round good general combiner for all the twelve characters studied. However, parent LBG-402 was good combiner for seed yield and yield components while average combiner for earliness. BDU-1 was good combiner for all the characters except days to flowering and days to maturity for earliness and was poor combiner for earliness. AKU-9904 was good combiner for seed yield and most of the yield components, but this variety was found poor combiner for earliness, pod length, 100-seed weight and protein content. AKM-8802 exhibited good GCA effects for plant height, number of primary branches per plant, number of clusters per plant and number of seeds per pod and for other characters it was either average or poor combiner. The variety TAU-1 showed good general combining ability for earliness but poor combiners for seed yield and yield components. The varieties from north zone of India Pant U-31 and Mesh-1008 were found good combiners for days to flowering and maturity but they are poor combiners for seed yield and all other yield components. Similar findings have been reported by various workers, Malhotra (1983), Dasgupta and Das (1987), Singh *et al.* (1987) Sood and Gartan (1991), Sawant (1992), Shanmugasundaram and Rangaswamy (1994), Neog and Talukdar (1999), Dana and Dasgupta (2001), Krishnan *et al.* (2003), Thangavel *et al.* (2004), Srividhya *et al.* (2005)Chakrabotty *et al*. (2010).

The specific combining ability effects and heterosis can be regarded as arising primarily from non-additive genetic effects, which are non-fixable (Sprague and Tatum, 1942). Hence specific combining ability does not contribute much in the improvement of self-pollinated crops like Blackgram. However, it can be used for identifying transgressive segregants from segregating populations of the promising cross combinations. Specific combining ability effects for seed yield per plant (Table 3) indicated that, the top yielding cross AKU-9904 x NUL-7 (good X good) exhibited significant SCA effects for seed yield and yield components. The cross LBG-402 x BDU-1 showed highest (0.769) SCA effect for seed yield per plant and also exhibited significant negative SCA effect for days to 50% flowering and days to maturity, while for number of clusters per plant, number of pods per cluster, pod length, number of seeds per pod, 100-seed weight and protein content it showed positive significant SCA effect. The desirable combination for days 50% flowering and days to maturity was BDU-1 x Mesh-1008 which showed negative SCA effect. The cross TAU-1 x BDU-1 was best specific cross for plant height. Significant positive SCA effect for Number of primary branches per plant, number of clusters per plant, number of pods per cluster, pod length, number of seeds per pod, 100-seed weight and protein content was exhibited by cross, BDU-1 x Pant U-31. The cross NUL-7 x Mesh-1008 showed highest significant SCA effect for protein content. Among four crosses with positive significant SCA effects for seed yield per plant, the best specific combiner was LBG-402 x BDU-1 followed by BDU-1 x Pant U-31, AKU-9904 x Pant U-31 and AKU-9904 x NUL-7. These crosses gave higher seed yield than the highest yielding parent AKU 9904.

In these superior combinations, the crosses LBG-402 x BDU-1 and AKU-9904 x NUL-7 exhibited significant positive SCA effects for most of the yield components with high GCA x high GCA type combination, which indicated additive and additive x additive gene effects were predominant in the expression of these characters.

Therefore, due to possibility of fixation, single plant selection could be practiced in segregating generations to isolate superior lines from such combinations. Some of the combinations though had both the parents with high GCA effects did not show high SCA effect revealing that high x high type combinations not necessarily result into high SCA effects. This might be due to internal cancellation of gene effects in such parents as suggested by Jinks and Jones (1953). However, in the crosses, BDU-1 x Pant U-31 and AKU-9904 x Pant U-31 one parent was good general combiner and other was poor general combiner for most of the traits. This might be due to presence of genetic diversity in the form of heterozygous loci for these characters. The best specific combinations for different characters in the present study were combination of good x good, good x average, good x poor combiners. This suggested that information on GCA effect should be supplemented by SCA effects and hybrid performance of cross combination to predict the transgressive types possibly be available in segregating generations. Selection is rapid if the GCA effects of the parents and SCA effects of the crosses are in same direction. Further crosses involving good x good general combining parent with high SCA effect can be handled by simple varietal improvement programmes for respective characters. Krishnan *et al.* (2003), Thangavel *et al.* (2004), Vaithiyalingan (2004b), Srividhya *et al.* (2005) Yadav *et al.* (2005) advocated practicing *inter se* mating in F_2 generation using biparental approach. It would help in accumulation of the additive genetic variance.

Table 1 **Analysis of variance for combining ability for twelve characters in a 7 X 7 half diallel cross in Blackgram**

Source	GCA	SCA	Error	$\sigma^2 gca$	$\sigma^2 sca$	$\sigma^2 gca/\sigma^2 sca$
d.f.	6	21	54	-	-	-
Days to 50% flowering	21.38**	1.06**	0.37	2.33	0.71	3.30
Days to maturity	44.11**	9.27**	1.29	4.76	7.97	0.60
Plant height	16.59**	8.29**	2.02	1.62	6.28	0.26
Number of primary branches per plant	0.17**	0.04**	0.01	0.02	0.03	0.63
Number of clusters per plant	0.98**	0.20**	0.02	0.11	0.18	0.60
Number of pods per cluster	0.18**	0.06**	0.01	0.02	0.05	0.40
Number of pods per plant	28.23**	9.87**	1.18	3.05	8.69	0.35
Pod length	0.42**	0.07**	0.04	0.05	0.06	0.75
Number of seeds per pod	0.17**	0.08**	0.01	0.02	0.07	0.28
100-seed weight	0.56**	0.06**	0.04	0.06	0.05	1.16
Seed yield per plant	1.86**	0.42**	0.09	0.20	0.32	0.61
Protein content	2.55**	1.67**	0.13	0.27	1.54	0.18

*, ** Significant at 5 and 1 per cent levels, respectively

Table 2 **Estimates of general combining ability effects of the parents for different characters in a 7 X 7 diallel cross in Blackgram**

Parents	Days to 50% flowering	Days to maturity	Plant height	Number of primary branches per plant	Number of clusters per plant	Number of pods per cluster	Number of pods per plant	Pod length	Number of seeds per pod	100-seeds weight	Seed yield per plant	Protein content
TAU-1	-0.17	-2.21**	-0.07	-0.07*	-0.23**	-0.20**	-1.15**	-0.20**	-0.02	-0.25**	-0.76**	-0.32**
AKU-9904	0.87**	2.38**	1.62**	0.11**	0.14**	0.13**	1.89**	-0.09**	0.11**	-0.02	0.64**	-0.38**

NUL-7	1.46**	3.42**	0.88*	0.15**	0.12**	0.04	0.21	-0.17**	-0.01	-0.02	0.26**	-0.19
LBG-402	-0.06	-0.10	-0.04	0.03	0.39**	0.15**	2.18**	0.29**	0.15**	0.25**	0.19*	0.78**
BDU-1	1.79**	0.19	0.96*	0.12**	0.34**	0.09**	0.89*	0.31**	0.13**	0.42**	0.13	0.15
Pant U-31	-2.47**	-2.25**	-2.42**	-0.14**	-0.40**	-0.06*	-2.29**	-0.12**	-0.21**	-0.18**	-0.28**	-0.65**
Mesh-1008	-1.43**	-1.43**	-0.93*	-0.19**	-0.36**	-0.16**	-1.74**	-0.02	-0.15**	-0.20**	-0.18	0.60**
SE (g_i)	**0.19**	**0.35**	**0.44**	**0.03**	**0.04**	**0.03**	**0.34**	**0.02**	**0.03**	**0.02**	**0.09**	**0.11**
CD at 5%	**0.37**	**0.70**	**0.88**	**0.06**	**0.08**	**0.04**	**0.67**	**0.04**	**0.06**	**0.04**	**0.19**	**0.23**
CD at 1%	**0.49**	**0.94**	**1.17**	**0.08**	**0.12**	**0.07**	**0.89**	**0.05**	**0.08**	**0.05**	**0.26**	**0.30**

*, ** Significant at 5 and 1 per cent levels, respectively

Table 3Estimates of specific combining ability effects of crosses for different characters in Blackgram

Sr. No.	**Cross (F_1)**	**Days 50% to flowering**	**Days to maturity**	**Plant height**	**No. of primary branches/plant**	**No. of clusters/plant**	**No. of pods/cluster**
1	TAU 1 X AKU 9904	1.278*	-0.907	2.807*	0.257**	0.376**	0.276**
2	TAU 1 X NUL 7	-0.648	-5.944**	2.074	-0.187*	0.450**	0.218**
3	TAU 1 X LBG 402	0.204	1.574	0.867	0.198*	0.250	0.054
4	TAU 1 X BDU 1	-0.315	0.278	3.726**	0.183*	0.376**	-0.280**
5	TAU 1 X Pant U 31	-0.722	-0.944	0.511	-0.098	0.383**	-0.198*
6	TAU 1 X Mesh 1008	-0.426	-0.759	0.356	-0.172	-0.261*	-0.169*
7	AKU 9904 X NUL 7	-2.352**	-3.537**	2.452*	0.228*	0.680**	0.298**
8	AKU 9904 X LBG 402	-0.167	0.315	1.911	0.080	-0.254**	-0.080
9	AKU 9904 X BDU 1	1.315*	4.685**	0.637	-0.135	-0.261**	0.120
10	AKU 9904 X Pant U 31	-0.759	1.796	1.622	-0.083	-0.120	0.002
11	AKU 9904 X Mesh 1008	0.204	-1.352	0.467	0.043	-0.298**	0.031
12	NUL 7 X LBG 402	-0.093	2.611*	1.844	0.235**	0.287**	0.009
13	NUL 7 X BDU 1	2.056**	3.981**	0.104	-0.046	-0.120	0.143
14	NUL 7 X Pant U 31	0.981	4.093**	0.822	0.072	-0.246	-0.043

15	NUL 7 X Mesh 1008	-0.722	-1.389	1.667	0.131	0.376**	-0.013
16	LBG 402 X BDU 1	-1.093*	-5.167**	1.674	0.006	0.346**	0.246**
17	LBG 402 X Pant U 31	-0.167	-2.056*	1.081	-0.143	0.287*	0.246**
18	LBG 402 X Mesh 1008	1.130*	3.130**	0.126	0.117	0.376**	0.143
19	BDU 1 X Pant U 31	-0.019	-1.019	1.674	0.376**	0.346**	0.246**
20	BDU 1 X Mesh 1008	-0.056	-3.833**	1.585	0.035	0.235	0.143
21	Pant U 31 X Mesh 1008	-1.130*	0.611	0.970	0.087	-0.024	0.157*
	SE (S_{ij})	**0.544**	**1.012**	**1.213**	**0.088**	**0.127**	**0.078**
	CD at 5%	**1.088**	**2.024**	**2.427**	**0.176**	**0.253**	**0.156**
	CD at 1%	**1.452**	**2.702**	**3.239**	**0.234**	**0.339**	**0.208**

*, ** Significant at 5 and 1 per cent levels, respectively

Table 3Contd..

Sr. No.	**Cross (F_1)**	**No. of pods per plant**	**Pod length**	**Number of seeds per pod**	**100-seeds weight**	**Seed yield per plant**	**Protein content**
1	TAU 1 X AKU 9904	1.995**	0.356**	0.224*	0.184**	-0.380	1.640**
2	TAU 1 X NUL 7	1.813	0.167**	0.076	0.088	1.035	1.584**
3	TAU 1 X LBG 402	3.839**	-0.130	0.446**	0.021	0.133	-0.588
4	TAU 1 X BDU 1	3.061**	-0.285**	0.135	-0.216**	-0.039	-0.623
5	TAU 1 X Pant U 31	-3.079	-0.152**	0.009	-0.153*	-0.481	-0.671*
6	TAU 1 X Mesh 1008	-0.509	0.044	0.009	-0.027	0.009	-0.606
7	AKU 9904 X NUL 7	4.302**	0.356**	0.483**	0.455**	0.594*	0.375
8	AKU 9904 X LBG 402	1.461	-0.307**	-0.013	0.088	0.126	1.069**
9	AKU 9904 X BDU 1	1.350	-0.063	-0.191*	-0.149*	0.454	-0.399
10	AKU 9904 X Pant U 31	2.410*	0.070	-0.183	-0.186**	0.611*	-1.131**
11	AKU 9904 X Mesh 1008	-0.220	-0.033	0.017	0.040	0.369	1.084**
12	NUL 7 X LBG 402	-0.787	-0.230**	-0.028	0.025	-0.093	-0.103
13	NUL 7 X BDU 1	-0.164	-0.352**	0.128	-0.112	0.369	0.079
14	NUL 7 X Pant U 31	1.862	-0.119*	0.069	-0.116	0.193	0.214
15	NUL 7 X Mesh 1008	-0.201	-0.022	0.069	-0.256**	0.517	2.512**
16	LBG 402 X BDU 1	-0.590	0.496**	0.394**	0.314**	0.769**	1.373**
17	LBG 402 X Pant U 31	3.721**	0.285**	-0.161	0.384**	0.524	1.842**
18	LBG 402 X Mesh 1008	-1.376	0.315**	0.306**	-0.390**	0.231	0.056
19	BDU 1 X Pant U 31	-0.590	0.406**	0.394**	0.314**	0.669**	1.373**
20	BDU 1 X Mesh 1008	1.913	0.159**	0.128	0.373**	0.193	-0.079

21	Pant U 31 X Mesh 1008	1.173	0.026	-0.265**	0.136*	-0.100	0.223
	SE (S_{ij})	**0.976**	**0.057**	**0.093**	**0.059**	**0.283**	**0.328**
	CD at 5%	**1.952**	**0.114**	**0.186**	**0.118**	**0.567**	**0.656**
	CD at 1%	**2.606**	**0.152**	**0.248**	**0.158**	**0.757**	**0.876**

*, ** Significant at 5 and 1 per cent levels, respectively

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