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HETEROSIS BREEDING IN BLACKGRAM (*VIGNA MUNGO* L. HEPPER)

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Abstract

The present investigation in blackgram (*Vigna mungo* L. Hepper.) was carried out at Department of Genetics and Plant Breeding farm, Faculty of agriculture Annamalai University, Annamalainagar to study the heterosis for seed yield and contributing traits. Seven lines and three testers *viz*., T-9, ADT-3 and VBN-5 and twenty one crosses obtained through L x T mating design were studied. In the analysis of variance, the mean sum of squares due to genotypes, crosses, lines, testers, were significant for most of the characters studied including seed yield per plant. The hybrids namely, L_1 x T_3 (2KU-53 x VBN-5), L_2 x T_1 (VBG-04-0012x T9), L_6 x T_3 (VBG-05-014 x VBN-5), L_4 x T_1 (AUB-08-13 x T9), and L_2 x T_3 (VBG 04-0012 x) recorded maximum heterobeltiosis for seed yield per plant. The cross combination L_1xT_3 (2KU-53 x VBN-5) showed maximum standard heterosis up to the tune of 27.34 percent followed by the crosses L_6x T_3 (VBG-05-014 x VBN-5), L_2x T_1 (VBG-05-014 x T9), L_2 x T_3 (VBG-04-0012 x VBN-5) and L_4 x T_1 (AUB 08-13 x T9). Among 21 hybrids analyzed, the cross combinations L_1 x T_3 (2KU-53 x VBN-5), L_6 x T_3 (VBG-05-014 x VBN-5) and L_2 x T_1 (VBG 04-0012 x T9) were found to have superior mean and standard heterosis for seed yield per plant. Hence these hybrids can be effectively utilized for commercial heterosis breeding programme.

Keywords: Blackgram, Relative heterosis , Heterobeltiosis & Standard heterosis *Corresponding author

Introduction

Among the pulses, blackgram (*Vigna mungo* (L.) Hepper) is one of the important grain legume. Blackgram belongs to the family Leguminaceae and sub family Papilionaceae. Due to its rapid growth and early maturity, black gram is adopted to multiple cropping systems. It is grown in various agro-ecological conditions and cropping systems with diverse agricultural practices. It is also cultivated in rice fallows after the harvest of the first or second crop of paddy. In India, the area under black gram was 2.36 million hectares in 2001-02 as against 2.89 million ha during 2007-08. The production and productivity was found to be in declining trend of 0.96 million tonnes and 407 kg/ha during 1999-2000. In Tamil Nadu also, the area under pulses had declined from 6.87 lack hectares in 2000-01 to 5.36 lakh hectares in 2007-08. India is the largest producer and consumer of pulses in the world, accounting for 33 per cent of world area and 22 per cent of world production of pulses. The area under pulses in India is around 23.28 million hectares with a production of 14.66 million tonnes and productivity of 630 kg ha^{-1} (GOI, 2012). Black gram (*Vigna mungo* (L.) Hepper) ranked third among all pulses in the country and contributes 10 per cent of the national pulse production from an area of 13 per cent. Both production and area under this crop had decreased by 15 per cent during the last decade.

The current level of production is well below the requirement, and future projected demand for 2017 and 2022 also mounting high to 14.3 and 16.1 million tonnes respectively to meet the specified per capita requirement (Praduman Kumar *et al*., 2009). In Tamil Nadu, the area under pulses is around 5.36 lakh hectare with a production of 2.04 lakh tonnes and average productivity of 381 kg ha^{-1}. The black gram occupies a unique place among the pulses in Tamil Nadu for its use as seed and vegetable. In Tamil Nadu, black gram is cultivated in an area of 1.38 lakh hectares with an annual production of 0.476 lakh tonnes and productivity of 345 kg ha^{-1} (GOTN, 2012). Being a highly self-pollinated crop, natural availability of variation in black gram is limited. Even so many varieties has been released in this crop, there was no major breakthrough in yield improvement. This is due to non-availability of high yielding varieties and information on inheritance of various characters. Further, it has been established that the quantitative traits in crop plants are governed by polygene and their cumulative effects are highly influenced by environmental factors (Mather and Jinks, 1971). Geneticists have developed different methods for the estimation of number of genes involved in determining such characters and their mode of action under varying environmental conditions precisely, so as to formulate appropriate breeding techniques. For improving the yield potential of varieties and hybrids, a decision should be made about the choice of the right parents for hybridization. The combining ability study aids in selecting the segregants. Of the several methods, Line x Tester analysis (Kempthorne, 1957) has been found to be the simple but efficient biometrical tool, provided the character is under control of additive-dominance system without non-allelic interaction.

Materials and Methods

The present investigation was carried out at the Plant Breeding Farm, Department of Genetics and Plant Breeding, Faculty of Agriculture, Annamalai University, Annamalainagar, Tamil Nadu. The experimental materials for the study consisted of seven lines and three testers obtained from Indian Institute of pulses Research, Kanpur, National Pulses Research Centre, Vamban, Tamilnadu Rice Research Institute (TRRI) Aduthurai and Plant Breeding Farm Annamalai University. The details of the selected parental materials for the study are furnished in Table 1. The testers used in the study were agronomically well adapted to this region.

The seven lines (female parents) and three testers (male parents) were raised in three rows of 5 metre length, with a spacing of 30 x 15 cm at Plant Breeding Farm. Each of the seven lines was crossed with each of the three testers and a total of 21 cross combinations were obtained by following the method of Line x Tester analysis (Kempthorne, 1957). The 10 parents (7 lines and 3 testers) and 21 crosses were raised in a randomized block design with three replications. Each genotype was accommodated in a single row of 2m length with a spacing of 30 x 10 cm. A uniform population of twenty plants per replication was maintained in each genotype. The recommended agronomic practices were followed throughout the crop period. Observations were recorded for ten traits *viz*., Days to first 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, Pod length (cm), 100 Seed weight (g) and Seed yield per plant (g) in five randomly selected plants.

Statistical Analysis

The estimation of mean, variance and standard error was worked out by adopting the standard methods of Panse and Sukhatme (1964). The test of significance was carried out by referring to the 'F' table given by Snedecor (1961). Heterosis refers to the superiority of F_1 hybrid over its parents. In other words, heterosis refers to increase in fitness and vigour of F_1 over the parental values. The term heterosis was coined by Shull in 1914. The magnitude of heterosis in hybrids was expressed as percentage of increase or decrease of a character over mid parent (di), better parent (dii) and standard parent (diii) and was estimated by following the method of Fonseca and Patterson (1968).

Results and Discussion

The analysis of variance revealed that the genotypes, crosses, lines, testers, Line x Tester, parents and parents Vs crosses differed among themselves for all characters studied. This indicated the presence of high genetic variability in the reference population. Therefore, further analysis of heterosis is appropriate. The extent of hybrid vigour was assessed in terms of heterosis over mid parent (relative heterosis), better parent (heterobeltiosis) and standard parent (standard heterosis). Though there are three types of heterosis standard heterosis is given importance for exploitation of heterotic vigour. Swaminathan *et al*. (1972) stressed the need for computing standard heterosis for commercial exploitation of hybrid vigour. Hence, for the evaluation of hybrid, standard heterosis is to be given importance rather than other two.

Performance of best crosses selected based on heterobeltiosis

The hybrids namely, L_1 x T_3, L_2 x T_1, L_6 x T_3, L_4 x T_1 and L_2 x T_3 which exhibited high heterobeltiosis for seed yield showed favourable heterobeltiosis for days to first flowering, plant height, number of branches per plant except the hybrid L_1 x T_3 and L_2 x T_3 and number of pods per plant (Table 3). Similar results were obtained by Santha and Velusamy (1999), Singh *et al*. (2003) and Thomas *et al*. (2008). Hence, selection and manipulation of any of these characters, is likely to improve seed yield per plant. A direct selection for seed yield per plant will also be rewarding.

Performance of best crosses selected based on standard heterosis

Standard heterosis for seed yield was maximum with the hybrids namely, L_1 x T_3, L_6 x T_3, L_2 x T_1, L_2 x T_3 and L_4 x T_1. Standard heterosis up to 27.34 per cent was recorded by L_1 x T_3 for seed yield per plant (Table 4). The hybrid L_1 x T_3 also portrayed high favourable standard heterosis for almost all other traits. The hybrid L_6 x T_3 registered favourable standard heterosis for days to first flowering, number of branches per plant, number of pods per plant and 100 seed weight. The other hybrids namely L_3 x T_1, L_6 x T_1, and L_7 x T_1 recorded favourable standard heterosis for plant height, number of pods per plant and 100 seed weight. Similar results were also reported by Santha and Velusamy (1999) for all the traits mentioned above. Singh *et al*. (2003) reported for all traits except number of clusters per plant while Govindaraj (1989) reported the same results for all traits except for plant height and number of pods per plant. Thomas *et al*. (2008) reported similar results for number of pods/plant, number of seeds/pod, 100 seed weight and seed yield/plant.

Relationship between *per se* performance and standard heterosis of hybrids

Selection based on any one criteria does not always give the expected results. Hence selection based on *per se* performance and heterosis is a reliable indicator to get better results. Therefore, selection of hybrids based on high *per se* performance and heterotic expression would be more useful as reported by Pethani and Kapoor (1984) and Jiji Joseph and Santhoshkumar (2000). All the crosses which portrayed high mean seed yield per plant were endowed with high commercial heterosis.

F_1 Hybrids selected for heterosis breeding

The scope for exploitation of heterosis in hybrid breeding depends upon the *per se* performance and standard heterosis. The present investigation showed that the hybrids namely, L_1 x T_3 (2KU-53 x VBN-5), L_6 x T_3 (VBG-05-014 x VBN-5) and L_2 x T_1 (VBG 04-0012 x T9) exhibited superiority for most of the traits studied and could be effectively utilized for commercial heterosis breeding programme.

Table 1: Blackgram genotypes utilized for the study

Lines		Testers	
2KU-53	(L_1)	T9	(T_1)
VBG04-0012	(L_2)	ADT3	(T_2)
PS-1	(L_3)	VBN5	(T_3)
AUB-08-13	(L_4)		
RGRU-448	(L_5)		
VBG-05-014	(L_6)		
RU-08-702	(L_7)		

Table 2: Relative Heterosis

Hybrids	Days to first 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	Pod length (cm)	100 Seed weight (g)	Seed yield per plant (g)
L_1 X T_1	**-5.30****	-5.57**	0.73	-4.23		1.56	12.50**	-2.39**	15.29**	25.45**
L_1 X T_2	-1.83	-1.42**	-5.51	-3.67	-22.01**	-4.00**	-1.89	-4.75**	20.66**	-3.11**
L_1 X T_3	-9.02**	-14.33**	44.19**	30.61**	6.12	12.33**	33.57**	6.35**	12.32**	33.45**
L_2X T_1	0.93	-3.75**	5.48	-2.63	7.43*	2.06**	1.33	-6.96**	13.07**	30.44**
L_2 X T_2	5.49**	0.28	-2.94	-6.44**	-21.57**	-4.84**	-17.58**	-11.58**	16.06**	12.16**
L_2 X T_3	-4.71**	-9.72**	0.00	9.55**	30.50**	6.42**	15.07**	-1.95**	12.60**	28.27**
L_3 X T_1	7.10**	-9.54**	-22.97**	-3.33	-12.42**	3.41**	-23.92**	-0.02**	6.05**	6.05**
L_3 X T_2	-3.17**	4.32**	-28.26**	-11.84**	-16.87**	-10.53**	-28.38**	1.54**	14.93**	-1.58
L_3 X T_3	-0.72	-11.20**	15.71**	1.01	5.19	5.53**	-7.96*	1.39**	6.38**	25.45**
L_4 X T_1	-3.51**	1.03	-30.14**	-5.18*	-2.65	6.47**	-22.74**	2.07**	7.24**	24.86**
L_4 X T_2	-1.31	7.28**	-2.94	-21.70**	-5.77	1.33	-28.21**	1.30**	18.70**	-1.85*
L_4 X T_3	-8.04**	-11.30**	-4.35	-8.43**	5.56	6.28**	42.49**	-2.22**	3.99**	10.63**
L_5 X T_1	-8.21**	-6.36**	-3.36	-6.67**	5.52	-3.20**	-16.39**	-1.83**	14.83**	19.93**
L_5 X T_2	-4.32**	-6.93**	14.39*	1.74	-24.00**	-5.73**	-36.36**	-4.67**	-12.58**	-10.34**
L_5 X T_3	-9.83**	-6.80**	8.51	-10.11**	13.04**	-3.00**	-5.03	7.89**	8.58**	1.87*
L_6 X T_1	-3.85**	4.56**	-26.03**	-11.41**	-10.26**	4.44**	2.16	7.46**	13.37**	26.28**
L_6 X T_2	2.04*	-8.00**	-2.94	-2.84	-18.01**	-10.68**	3.90	1.13*	22.82**	-4.65**
L_6 X T_3	-6.37**	-13.46**	21.74**	-02.16	3.36	0.54	0.74	11.25**	9.06**	29.53**
L_7 X T_1	-1.69	-5.87**	-8.86	0.61	-5.92	5.41**	1.73	7.08**	10.58**	22.84**
L_7 X T_2	-4.45**	2.12**	-35.14**	-23.45**	-8.28**	3.63**	-22.34	2.00**	13.78**	-7.30**
L_7 X T_3	4.48**	-12.75**	-28.00**	1.98	15.86**	2.55**	-13.61	4.68**	4.25**	-2.25*

Table 3: Heterobeltiosis

Hybrids	Days to first 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	Pod length (cm)	100 Seed weight (g)	Seed yield per plant (g)
L_1 X T_1	-6.75**	-6.94**	-10.39	-10.53**	3.85	-2.57**	-0.00	-3.64**	5.40**	19.96**
L_1 X T_2	-2.42*	-5.46**	-10.45	-11.76**	-23.46**	-8.28**	-18.75**	-6.65**	4.54**	-6.63**
L_1 X T_3	-9.20**	-16.62**	34.78**	18.52**	0.00	8.21**	21.43**	2.78**	8.45**	27.34**
L_2X T_1	-0.61	-4.02**	0.00	-2.63	4.61	0.86	-6.17	-8.59**	5.77**	26.68**
L_2 X T_2	4.85**	-2.19**	-4.35	-8.40**	-25.93**	-6.37**	-29.17**	-12.50**	2.73**	9.80**
L_2 X T_3	-4.91**	-10.61**	0.00	6.17*	27.78**	5.62**	9.09*	-2.33**	11.40**	24.30**
L_3 X T_1	5.99**	-12.92**	-25.97**	-7.94**	-17.06**	0.54	-28.65**	-2.02**	-3.62**	2.04
L_3 X T_2	-4.24**	3.21**	-30.28**	-14.29**	-18.82**	-13.38**	-29.69**	0.80	-0.98**	-4.55**
L_3 X T_3	-1.03	-13.46**	14.08*	-0.79	-4.71	3.02**	-15.68**	-0.78	2.08**	20.45**
L_4 X T_1	-5.65**	-0.58	-33.77**	-10.20**	-3.29	2.14*	-23.46**	0.00	-3.69**	24.78**
L_4 X T_2	-1.41	2.73**	-4.35	-24.31**	-9.26**	-3.18**	-34.38**	-1.46**	1.15**	-1.10
L_4 X T_3	-8.87**	-13.80**	-4.35	-10.59**	1.33	2.38**	40.25**	-6.20**	-1.47**	10.31**
L_5 X T_1	-10.60**	-7.68**	-6.49	-7.89**	0.66	-3.61**	-25.00**	-5.67**	5.88**	18.67**
L_5 X T_2	-4.80**	-8.20**	10.42	-1.68	-29.63**	-5.73**	-38.24**	-9.04**	-1.68**	-10.56**
L_5 X T_3	-11.00**	-6.93**	6.25	-13.99**	13.04**	-3.82**	-16.67**	1.55**	5.80**	0.57
L_6 X T_1	-5.13**	1.54*	-29.87**	-13.16**	-12.50**	3.21**	-12.35**	2.02**	5.29**	23.63**
L_6 X T_2	1.21	-13.02**	-4.35	-6.72*	-18.52**	-12.10**	-16.67**	-4.65**	7.98**	-5.90**
L_6 X T_3	-6.37**	-17.00**	21.74**	-7.00**	-3.75	-0.22	-11.69**	3.49**	7.08**	26.53**
L_7 X T_1	-1.90	-7.53**	-11.11*	-5.75*	-5.92	2.14*	-4.35	4.05**	1.50**	20.88**
L_7 X T_2	-6.67**	1.09	-40.74**	-26.82**	-11.11**	0.00	-23.96**	-1.60**	-1.05**	-8.04**
L_7 X T_3	2.87*	-13.20**	-33.33**	-1.53	10.53**	-0.22	-20.65**	-0.39	1.08**	-4.02**

Table 4: Standard heterosis

Hybrids	Days to first 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	Pod length (cm)	100 Seed weight (g)	Seed yield per plant (g)
L_1 X T_1	-6.37**	-9.30**	0.00	-16.05**	17.39**	-1.73	5.19	-7.75**	13.20**	19.43**
L_1 X T_2	-0.82	-2.54**	-13.04*	-13.58**	-10.14*	-6.70**	1.30	-9.30**	12.27**	-8.55**
L_1 X T_3	-8.83**	-16.62**	34.78**	18.52**	13.04**	8.21**	21.43**	2.78**	16.47**	27.34**
L_2X T_1	-0.21	-5.92**	11.59	-8.64**	15.22**	1.73	-1.30	-9.30**	8.06**	26.12**
L_2 X T_2	6.57**	0.85	-4.35	-10.29**	-13.04**	-4.75**	-11.69**	-13.18**	4.46**	7.54**
L_2 X T_3	-4.52**	-10.61**	0.00	6.17*	33.33**	5.62**	9.09*	-2.33**	13.82**	24.30**
L_3 X T_1	5.34**	-8.26**	-17.39**	-4.53	2.17	1.40	-14.29**	-6.20**	4.87**	1.59
L_3 X T_2	-2.67*	8.73**	-28.26**	-11.11**	0.00	-11.88**	-12.34**	-2.07**	7.75**	-6.52**
L_3 X T_3	-1.03	-8.83**	17.39**	2.88	17.39**	3.02**	1.30	-0.78	11.07**	20.45**
L_4 X T_1	-3.90**	-3.10**	-26.09**	-5.76*	6.52	3.02**	-19.48**	-4.26**	7.62**	24.23**
L_4 X T_2	0.41	5.92**	-4.35	-20.58**	6.52	-1.51	18.18**	-4.26**	13.02**	-3.14**
L_4 X T_3	-7.19**	-13.80**	-4.35	-6.17*	10.14*	2.38**	44.81**	-6.20**	10.10**	10.31**
L_5 X T_1	-8.21**	-7.42**	4.35	-13.58**	10.87**	-1.94*	-0.65	-9.69**	11.60**	18.15**
L_5 X T_2	-2.26*	-5.35**	15.22*	-3.70	-17.39**	-4.10**	-18.18	-11.63**	3.63**	-12.40**
L_5 X T_3	-8.62**	-6.67**	10.87	-13.99**	13.04**	-2.16*	10.39*	1.55**	11.51**	0.57
L_6 X T_1	-5.33**	-1.03	-21.74**	-18.52**	1.45	4.10**	-7.79	-2.33**	9.26**	23.08**
L_6 X T_2	2.87*	-10.33**	-4.35	-8.64**	-4.35	-10.58**	3.90	-7.36**	12.05**	-7.84**
L_6 X T_3	-6.37**	-17.00**	21.74**	-7.00**	11.59**	-0.22	-11.69**	3.49**	11.12**	26.53**
L_7 X T_1	-4.52**	-6.57**	4.35	1.23	3.62	3.02**	14.29**	-0.39	8.06**	20.34**
L_7 X T_2	-5.13**	4.23**	-30.43**	-21.40**	4.35	1.73	-5.19	-4.39**	5.34**	-9.94**
L_7 X T_3	2.87*	-12.30**	-21.74**	5.76*	21.75**	-0.22	-5.19	-0.39	7.62**	-4.02**

References

Govindaraj, P. (1989). Line x Tester analysis in black gram (*Vigna mungo* (L) Hepper). M.Sc ., (Ag) Thesis Tamil Nadu Agric. Univ.,Madurai.

Jiji Joseph and A.V. Santhoshkumar (2000). Genetic analysis of metric traits in greengram (*Vigna radiata* (L). Wilczek). *Inter. J. Trop. Agric.,* **18(2):** 133-139.

Kempthorne, O. (1957). An introduction to genetic statistics. *John Wiley and Sons Inc .,* New York.

Mather, K. And J.L. Jinks (1971). Biometrical Genetics. Champman and Hill Let., London, P. 1-382.

Panse, V.G. and P.V. Sukhatme (1964). Statistical Methods for Agricultural Workers . Indian Council of Agricultural Research, New Delhi, p-359.

Petahni,K.V and R.L. Kapoor (1984).Combining ability and its interaction with environment for grain yield in pearl millet. *Indian J. Agric. Sci.,* **54:** 87-92.

Praduman Kumar *et al*., (2009). "demand projections for food grains in India", Agricultural Economic Research Review, **22:** 34-45.

Santha, S and P. Velusamy (1999). Combining ability studies for biometrical traits in urdbean (*Vigna mungo* (L) Hepper). *J. Ecobio.,* **11(1):** 29-30.

Shull, G.H. (1914). Duplicate genes for capsule form in *Bursa bursapastoris. Z. Ind . Abstr. Ver.,* **12:** 97-149.

Singh *et al*. (2003). Combining ability studies for yield and architectural traits in mungbean (*Vigna radiata* (L). Wilczek). *Indian J. Genet.,* **45(2):** 181-185.

Snedecor, G.W. 1961. Statistical Analysis 5th ed. Iowa State University Press, Ames.

Swaminathan *et al*. (1972). Outlook for hybrid rice in india. In: Rice Breeding. International Rice Research Institute, Los Banos Philippines, 609-613.

Thomas *et al*. 2008. Heterosis for biological nitrogen fixation traits and yield components in black gram (*Vigna mungo* (L) Hepper). *Legume Res.,* **31(4):** 259-263.