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Research Article

HETEROSIS STUDIES IN BLACKGRAM (*Vigna mungo* (L.) Hepper)

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Abstract: Field experiment was conducted in twenty hybrids synthesized with the use of nine parents (four lines and five testers in 'Line x Tester mating design) along with a check variety 'MDU 1' to estimate the magnitude of economic heterosis for exploitation of hybrid vigour of crosses for higher yield. Three traits *viz*., plant height, days to 50 % to flowering to which negative heterosis is desirable for early maturation of crop. Based on experimental results of this investigation four crosses *viz*., ACM-16-017 x VBN8, ACM-16-017 x KKM1, ACM-16-014 x VBN8 and ACM-16-014 x KKM1 had exhibited higher positive significant standard heterosis for yield and yield attributing traits in positive direction and negative heterosis for two traits *viz*., days to 50 % flowering and pods per plant. The presence of magnitude of standard heterosis was higher in these crosses for yield and yield attributes. Hence, exploitation of hybrid vigour may be achievable in these crosses which might be helpful in the improvement of this crop.

Keywords: *Heterosis, Blackgram*

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Introduction

Urdbean (2n=22) also known as blackgram is an important short duration legume crop belonging to family Fabaceae, widely cultivated in Asia. The crop is utilized in several ways, as sources of protein as well as plant parts are used as fodder and green manure. It adapts well to various cropping systems owing to its ability to fix atmospheric nitrogen (N2) in symbiosis with soil bacteria, rapid growth, and early maturity [1]. Genetic improvement mainly depends upon the amount of genetic variability present in the base population [2]. Among the legumes urdbean is one of the narrow genetic base crops represents smaller variability in primary gene pool. Lack of newer varieties and genotypes adapted to local environment is among the factors affecting its production necessitating, the development of new varieties adapted to local condition. Heterosis has important implications for both in F1 and for adopting transgressive segregates in F2 generation [3]. Extent and magnitude of heterosis present in hybrids is important for any crop improvement programme. The presence of heterosis in food legumes has also been demonstrated by Rama Kant and Srivastava, (2012) [4] and Singh, (2000) [5]. However, highly heterotic crosses can be used for development of high yielding pure line varieties in a self-pollinated crop like urdbean. Therefore, objectives of the present study were to unravel the genetic information on heterosis and extent of heterosis for yield and its components in urdbean crosses for selection of promising genotypes in segregating generation.

Materials and Methods

Nine diverse black gram genotypes and varieties adapted to various agro-climatic condition were crossed in Line x Tester fashion which comprised of four lines (L1-L4) *viz*., ACM-16-014, ACM-16-017, ACM-16-023 and MDU1 and five testers (T1-T5) *viz*., VBN8, KKM1, ADT6, CO5 and VBN6 during Rabi, 2017 at Madurai research farm, Agricultural College and Research Institute, to obtain twenty inter-varietal crosses. Field experimentation on heterosis analysis comprised of twenty F1s along with nine parents grown in randomized block design with two replications during *kharif*, 2018. Each plot consisted of 4 meters row length with a spacing of 30 x 10 cm between row and plants, respectively. The parents and F1s were grown as single row each. The observations were recorded on ten randomly selected competent plants from each row for nine quantitative traits *viz*., plant height (cm), number of branches per plant, days to 50 per cent flowering, number of clusters per plant, number of pods per plant, number of seeds per pod, pod length (cm). 100 seed weight (g) and single plant yield (g) [6]. Variety 'MDU 1' was used as the standard parent as it is one of the best released variety in Tamil Nadu. The mean values of hybrids and their respective parents were used for estimation of different heterosis per cent under three categories based on the formula suggested by Fonseca and Patterson, (1968) [7] the test of significance for estimates of heterosis were tested for significance at error degrees of freedom as suggested by Turner (1953) [8].

Result and Discussion

The mean sum of squares due to genotypes (parents and crosses) was highly significant for all the traits studied in this investigation represented in [Table-1]. It reveals the presence of significant variability in the material studied. Considering earliness, ACM-16-017 and ACM-16-023 was the best for days to 50 per cent flowering and ACM-16-023, ACM-16-017, VBN (Bg)8, ADT6 and KKM1 were the best for early maturity. With respect to mean performance, line ACM-16-017 recorded high mean performance for number of pods per plant and number of clusters per plant. Among the lines, ACM-16-017 showed the best for number of clusters per plant, pod length, 100 seed weight and single plant yield followed by ACM-16-023, ACM-16-014 and MDU (Bg)1.

Table-1 Analysis of variance for different quantitative traits in parents and crosses

Source	df	Mean square								
		DF	PH	NBR	NCP	NPP	PL	NSP	HSW	SPY
Parents										
Replications	1	0.89	0.05	0.03	0.04	0.01	0.01	0.09	0.03	0.01
Parents	8	6.21	95.54*	0.13*	26.31*	20.57*	0.13*	0.23*	0.60*	4.44*
Error	8	1.12	0.39	0.02	0.16	1.15	0.01	0.03	0.01	0.03
Crosses										
Replications	1	0.6	3.84	0.03	1.49	5.24	0.03	0.05	0.07	1.38
Crosses	19	3.94*	23.46*	0.16*	13.65*	36.63*	0.07*	0.23*	0.29*	5.47*
Error	19	0.69	4.44	0.01	0.5	3.23	0.01	0.01	0.01	2.29

**Significant at 5% level*

Table-2 Per se expression of different traits in parents

Parents	DF	PH	NBR	NCP	NPP	PL	NSP	HSW	SPY
Lines									
ACM-16-023	33.5	35.20*	2.57	17	33.2	4.64	6.50*	4.76*	7.87*
AM-16-014	34	36.10*	2.53	17.1	34.30*	4.79	6.1	4.74*	7.88*
ACM-16-017	34.5	40.3	3.30*	20.10*	36.50*	4.73*	6.50*	5.00*	9.18*
MDU1	33	32.30*	2.5	14.5	31.30*	4.71	6.15	4.32	7.04
Testers									
VBN6	33	51	2.9	13.1	31.7	4.26	6.3	4.79*	6.89
VBN8	33	19.10*	2.55	21.40*	34.00*	4.95*	5.7	4.98*	8.90*
CO5	35	37.2	2.55	18.1	26.65	4.93*	5.65	3.79	4.81
ADT6	30.50*	35.80*	2.3	13.4	31.1	4.63	5.7	4.49	6.69
KKM1	30.5	36.2	2.5	19.7	33.5	4.53	5.85	4.56	8.09
Mean	33.31	41.18	2.55	16.13	31.23	4.59	5.92	4.29	6.7
SEd±	0.45	2.26	0.06	0.83	0.92	0.06	0.09	0.12	0.4
CD	2.28	1.34	0.29	0.85	2.31	0.09	0.38	0.12	0.37

**Significant at 5% level*

Table-3 Per se performance of different traits in F1's

F1's	DF	PH	NBR	NCP	NPP	PL	NSP	HSW	SPY
ACM-16-023 x VBN6	32	36.23	2.67	15.93	34.88	4.7	6.70*	3.84	9.82
ACM-16-023 x VBN8	31.5	32.95	2.46	18.40*	40.10*	4.68	6.55	4.72	8.8
ACM-16-023 x CO5	33.5	37.45	2.76*	17.84*	34.25	4.82*	6.21	4.7	8.39
ACM-16-023 x ADT6	34	34.5	2.37	12.7	32.1	4.69	6.56	4.09	7.96
ACM-16-023 x KKM1	33.5	36.6	2.9	16.85	39.25	4.56	6.35	4.71	9.24
ACM-16-014 x VBN6	34	39.1	2.64	16.20*	38	4.7	6.75*	4.6	8.64
ACM-16-014 x VBN8	32.5	36.9	2.38	16.00*	40.95*	4.77	6.37	4.83*	11.24
ACM-16-014 x CO5	33.5	32.59	2.36	16.90*	37.35	4.75	6.77*	5.21*	12.11*
ACM-16-014 x ADT6	34	30	2.67	12.67	32.63	4.69	6.69*	4.54	9.67
ACM-16-014 x KKM1	34.5	37.6	2.37	12.9	40.25*	5.07*	6.73*	4.77*	11.05
ACM-16-017 x VBN6	31.5	42.3	2.67	16.63	39.55*	4.6	6.51	4.7	8.98
ACM-16-017 x VBN8	33.5	36.4	3.63*	24.00*	44.50*	5.31*	6.92*	4.76*	13.98*
ACM-16-017 x CO5	30.50*	30.75*	2.63	14.7	36.4	4.64	6.38	3.6	8.45
ACM-16-017 x ADT6	29.50*	34.65	2.37	16.02*	39.27*	4.6	6.94*	5.00*	9.85
ACM-16-017 x KKM1	33.5	32.59	2.36	16.90*	37.35	4.75	6.77*	5.21*	12.11*
MDU1 x VBN6	34	30	2.67	12.6	32.63	4.69	6.69*	4.63	8.43
MDU1 x VBN8	32.5	31.92	2.46	12.6	37.48	4.59	6.45	5.11*	10.35*
MDU1 x CO5	34.5	35.5	2.47	11.63	34.1	4.36	6.13	4.49	8.44
MDU1 x ADT6	31.5	33.7	2.45	11.1	33.4	4.8	6.04	4.23	8.02
MDU1 x KKM1	32	29.38	2.33	13.1	35.10*	4.62	6.68*	4.90*	9.59
Mean	33.11	34.76	2.51	13.62	35.37	4.66	6.36	4.4	9.16
SEd±	0.24	0.75	0.04	0.43	0.53	0.02	0.04	0.08	0.22
CD (0.05)	1.28	2.49	0.16	1.03	2.66	0.13	0.21	0.16	3.08

**Significant at 5% level*

Among testers KKM1 and VBN (Bg)8 recorded high mean performance for single plant yield [Table-2]. Among crosses ACM-16-017 x VBN (Bg)8, ACM-16-017 x KKM1, ACM-16-014 x VBN (Bg)8 and ACM-16-014 x KKM1 recorded high mean performance of number of clusters per plant, number of pods per plant, 100 seed weight and single plant yield respectively [Table-3]. ACM-16-017 was the best for number of pods per plant (70-78 pods per plant), 100 seed weight and single plant yield. The negative heterosis was considered to be desirable for days to 50% flowering. In other words, earliness in hybrids was desirable. The crosses ACM-16-017 x VBN8, MDU1 x VBN8 and ACM-16-024 x VBN6 showed significant negative heterosis over mid parent and this cross was over standard check (MDU (Bg)1) for days to 50% flowering. Similarly result was reported by Natarajan and Rathnasamy (1999) [9] and Tyagi, *et al*., (2006) [10]. Highest negative significant heterosis among the twenty crosses were recorded by ACM-16-017 x VBN8, ACM-16-017 x KKM1, ACM-16-014 x VBN8 and ACM-16-014 x KKM1 over mid parent and better parent and it also recorded significant heterosis over standard check for number of pods per plant, pod length, number of seeds per pod and single plant yield. Maximum average heterosis, heterobeltiosis and standard heterosis were reported exhibited by the cross ACM-16-017 x KKM1 and ACM-16-017xVBN8. These results are similar with the findings of Santha and Velusamy (1999) [11], who reported the positive heterosis for plant height and number of branches per plant. The highest heterobeltiosis and standard heterosis were recorded by ACM-16-017xVBN88 and ACM-16-017xKKM1 for number of clusters per plant, number of pods per plant, 100 seed weight and single plant yield. With respect to pod length ACM-16-017xVBN8 recorded the highest average heterosis and heterobeltiosis. Ram, *et al*. (2013) [12] reported similar results in blackgram; Gadekar and Dodiya (2013) [13] in chickpea.

Table-4 Expression of relative heterosis, heterobeltiosis and standard heterosis for days to 50% flowering, plant height and number of branches per plant

Crosses	Days to 50% flowering			Plant height			Number of branches per plant		
	di	dii	diii	di	dii	diii	di	dii	diii
L1 x T1	-3.82	-4.55	-8.70**	-0.82	-13.85**	4.96	4.9	2.88	-18.94**
L1 x T2	5.51*	1.52	-2.9	17.98**	-8.16	-21.84**	-6.34	-7.25	-28.33**
L1 x T3	-2.22	-4.35	-4.35	-18.85**	-33.24**	-7.07	2.41	-4.66	-16.21**
L1 x T4	1.52	1.52	-2.9	-3.75	-4.28	-14.02**	-1.25	-5.2	-28.18**
L1 x T5	-2.4	-4.69	-11.59**	18.08**	-9.72	-19.13**	-6.53	-7.45	-28.48**
L2 x T1	0.07	-5.80*	-5.80*	-12.53**	-20.37**	-2.98	-10.34**	-19.85**	-19.85**
L2 x T2	-3.28	-3.28	-14.49**	-3.37	-32.89**	-18.24**	-4.47	-5.38	-25.45**
L2 x T3	4.41	1.43	2.9	-16.06**	-28.24**	-9.18*	7.41*	0.08	-12.12**
L2 x T4	0.08	-1.47	-2.9	-2.88	-10.11*	-10.11*	-7.76*	-18.94**	-18.94**
L2 x T5	-0.79	-1.52	-5.80*	-16.55*	-42.65**	-27.42**	-13.21**	-18.45**	-28.33**
L3 x T1	-0.79	-4.55	-8.70**	-17.84**	-29.41**	-1.74	-15.81	-20.91**	-20.91**
L3 x T2	-5.71*	-10.81**	-4.35*	-23.33**	-31.37**	-13.15**	-10.61**	-15.61**	-15.61**
L3 x T3	-3.7	-12.16**	-5.80**	7.01	-17.95**	-27.11**	-4.12	-8.82*	-29.55**
L3 x T4	-3.5	-6.76**	0.08	-1.57	-6.7	-6.7	-18.28**	-28.18**	-28.18**
L3 x T5	-3.82	-10.00**	-8.70**	-16.10**	-20.78**	-20.78**	-12.14**	-25.45**	-25.45**
L4 x T1	3.17	0.03	-5.80*	4.53	40.90**	26.99**	3.76	2.75	-20.16**
L4 x T2	-3.76	-7.25**	-7.25**	10.97**	14.39**	14.39**	-18.28**	-28.18**	-28.18**
L4 x T3	-1.47	-4.29	-2.9	-3.2	-8.13	-8.13	-20.69**	-30.30**	-30.30**
L4 x T4	4.41	2.9	2.9	22.96**	-2.17	-21.59	-5.94	-6.86	-28.03**
L4 x T5	0.57	2.35	-4.35	-2.62	-12.28**	-12.28**	-15	-25.30**	-25.30**

**Significant at 5% level **Significant at 1% level*

Table-5 Expression of relative heterosis, heterobeltiosis and standard heterosis for number of clusters per plant, number of pods per plant and pod length

Crosses	Number of clusters per plant			Number of pods per plant			Pod length		
	di	dii	diii	Di	dii	diii	di	dii	diii
L1 x T1	1.37	-15.61**	-17.29**	24.57**	18.06**	8.36	1.32	1.1	-2.65*
L1 x T2	-2.76	-20.26**	-15.10**	-5.06	-7.57	-13.90**	-2.13	-7.17**	-2.75*
L1 x T3	-15.85**	-21.41**	-11.24**	14.93**	2.24	-6.16	-1.03	-7.49**	2.01
L1 x T4	-3.17	-18.65**	-20.27**	21.59**	17.24**	7.6	0.33	-0.75	-2.75*
L1 x T5	-12.21**	-21.03**	-15.92**	9.37*	8.89	2.33	-2.57*	-4.14**	0.42
L2 x T1	-2.41	-19.40**	-19.40**	14.29**	4.11	4.11	1.35	-0.53	-0.53
L2 x T2	6.67*	-14.02**	-8.46**	25.31**	17.94**	9.86**	-1.37	-5.35*	-0.85
L2 x T3	2.74	-14.47**	-16.17**	26.53**	23.13**	13.01**	3.75*	0.66	-3.49**
L2 x T4	-5.77	-20.77**	-20.77**	1.53	-4.45	-4.45	2.56*	-0.53	-0.53
L2 x T5	-9.57**	-27.10**	-22.39**	5.78	2.21	-4.79	-0.22	-7.17**	-2.75*
L3 x T1	-22.78**	-27.20**	-17.79**	3.67	-11.10**	-11.10**	-6.19**	-10.56**	-1.38
L3 x T2	0.09	-17.41**	-17.41**	11.29*	3.97	3.97	4.28**	-0.85	-0.85
L3 x T3	-24.71**	-38.79**	-34.83**	7.83	3.24	-3.84	-3.65**	-6.77	-2.33
L3 x T4	-30.65**	-35.82**	-35.82**	10.87*	2.67	2.67	6.46**	5.74**	7.20**
L3 x T5	-24.78**	-37.31**	-37.31	13.70**	10.27**	10.27**	-1.98	-2.96*	-2.96*
L4 x T1	-35.70**	-40.65**	-36.82**	-6.76	-16.84**	-22.53**	-5.47*	-5.66**	-1.16
L4 x T2	-33.51**	-36.82**	-36.82**	1.66	-12.05**	-12.05**	-2.85*	-4.87**	-0.74
L4 x T3	-16.44**	-22.89**	-22.89**	7.25	2.4	2.4	7.10**	6.14**	6.14**
L4 x T4	-35.01**	-45.79**	-42.29**	4.75	0.59	-6.3	-9.06**	-11.31**	-7.09**
L4 x T5	-32.41**	-42.16**	-42.16**	0.59	-6.58	-6.58	-7.53**	-7.72**	-7.72**

**Significant at 5% level **Significant at 1% level*

Table-6 Expression of relative heterosis, heterobeltiosis and standard heterosis for number of seeds per pod, hundred seed weight and single plant yield

Crosses	Number of seeds per pod			Hundred seed weight			Single plant yield		
	di	dii	diii	di	dii	diii	di	dii	diii
L1 x T1	9.87**	8.50**	0.15	2.23	1.29	-5.9	20.55**	10.94	-2.23
L1 x T2	2.1	-2.09	0.92	-9.95**	-22.21**	-22.90**	5.17	-8.03	-10.84*
L1 x T3	5.34*	4.45	-4.38*	16.55**	3.07*	-6.00*	33.02**	3.71	-8.61
L1 x T4	5.82**	-0.69	-0.69	10.45**	9.54**	-0.1	33.29**	21.76**	7.3
L1 x T5	5.78**	1.04	4.15	7.36**	4.82**	4.30**	12.17*	-1.07	-4.08
L2 x T1	8.00**	3.85	3.85	-4.72**	-8.10**	-8.10**	8.14	-5.88	-5.88
L2 x T2	3.15	-2.24	0.77	-1.87	-5.13**	-5.60**	30.50**	12.80*	12.80*
L2 x T3	4.53*	0.79	-2.31	0.75	-1.67	-5.80**	23.34**	14.15	0.6
L2 x T4	6.01**	3.15	3.15	-6.13**	-8.10**	-8.10**	23.95*	6.97	6.97
L2 x T5	0.69	-2.31	0.69	1.79	-0.1	-0.6	40.76**	38.94**	22.44**
L3 x T1	6.02**	1.54	1.54	2.41	-12.90**	-12.90**	21.56**	-9.26	-9.26
L3 x T2	7.69**	14.69**	12.31**	-11.02**	-23.30**	-23.30**	44.34**	36.07**	31.92**
L3 x T3	7.82**	-0.22	2.85	3.59**	-1.51	-2	20.53**	5.56	2.34
L3 x T4	6.75**	3.46	3.46	-2.05	-4.60**	-4.60**	29.54**	20.37**	20.37**
L3 x T5	20.17**	118.63**	6.77**	7.64**	2.1	2.1	75.24**	72.81**	52.29**
L4 x T1	2.81	1.23	1.23	-1.08	-12.86**	-13.30**	-9.26	-30.11**	-32.24**
L4 x T2	7.98**	0.92	0.92	-6.94**	-18.20**	-18.20**	13.58*	-13.45*	-13.45*
L4 x T3	2.69	2.69	2.69	-7.07*	-9.30**	-9.30**	13.46**	5.34	5.34
L4 x T4	-2.02	-6.04**	-3.15	-8.40**	-14.47**	-14.90**	3.89	-6.97	-9.8
L4 x T5	-3.16	-5.77**	-5.77**	-3.60**	-10.20**	-10.20**	4.07	-8.06	-8.06

**Significant at 5% level **Significant at 1% level*

Among the twenty crosses, the maximum standard heterosis was exhibited by ACM-16-014 x CO5 followed by ACM-16-017 x KKM1 for number of pods per plant and by ACM-16-017 x KKM1 for pod length. ACM-16-017 x VBN8 and ACM-16-017 x KKM1 recorded the highest relative heterosis, average heterosis and heterobeltiosis for single plant yield, while ACM-16-017 x KKM1 and ACM-023 x CO5 recorded maximum standard heterosis with respect to 100 seed weight. Andhale *et al.,* (1997) [14] and Reddy (1998) [15] reported that heterosis for grain yield was due to clusters per plant, number of pods per plant and number of seeds per pod in blackgram. The estimation of heterosis for yield per plant had also been done by Reddy (1998). Neog and Talukdar (1999) [16], Patel *et.al*., (2009) [17], Reddy *et al*, (2011) [18] and Ram *et al*., (2013) who reported significant positive heterosis for yield per plant.

Conclusion

The top four crosses based on mean per se performance and heterosis were ACM-16-017xVBN8, ACM-16-017xKKM1, ACM-16-014xVBN8 and ACM-16-014xKKM1 had high seed and yield attributing characters. These crosses recorded high mean per se performance of 25.78g, 23.68g, 19.54g and 20.88g respectively.

Application of research: The exploitation of hybrid vigour could be done in these crosses and it might be helpful in the improvement of this blackgram as they showed significant heterosis as well as significant sca for seed yield and yield attributes.

Research Category: Plant Breeding and Genetics

Abbreviations:

DF – Days to 50% flowering
PL – Pod length
PH – Plant height
NSP – number of seeds per pod
NBR – Number of branches per plant
HSW – hundred seed weight
NCP – Number of clusters per plant
SPY – Single plant yield
NPP – Number of pods per plant

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University: Tamil Nadu Agricultural University, Coimbatore, 641003, Tamil Nadu
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Author statement: All authors read, reviewed, agreed and approved the final manuscript. Note-All authors agreed that- Written informed consent was obtained from all participants prior to publish / enrolment

Study area / Sample Collection: Research farm, Agricultural College and Research Institute, Coimbatore, 641003

Cultivar / Variety / Breed name: Blackgram (*Vigna mungo* (L.) Hepper)

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

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