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Heterosis and genetic variability in F_1 generation of blackgram

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Abstract
The present investigation was done to study the variability, heritability and genetic advance as % mean, Heterosis, Heterobeltiosis and Economic Heterosis involving 14 parents and their 22 F_1 hybrids and 2 checks in Blackgram for *kharif* 2017. The experimental material was planted in randomized block design with three replications at the field experimentation center, Department of Genetics and Plant Breeding, SHUATS, Allahabad, U.P. Biological yield, harvest index, seed yield per plant, exhibited high GCV, PCV and genetic parameters revealed that heritability (broadsense) and genetic advance as % of mean values were high for seed yield per plant indicating that selection would be fruitful for improvement of these traits. Among 14 parents studied, KPU-63-189 recorded high performance for seed yield per plant followed by IU-02-1-3, PU-09-37 and PU-38 genotypes. The magnitude of percentage of heterosis expressed by the hybrids for 13 characters varied among themselves. Among 22 crosses, KPU-13-192 x LBG-648, KPU-13-192 x KU-13-01, KPU-13-192 x KU-96-7 exhibited positive significant heterosis in seed yield per plant.

Keywords: Blackgram, genetic variability, heterosis, heterobeltiosis, economic heterosis

Introduction
Pulses are indispensable source of protein for predominantly vegetarian population of our country and they constitute a major part in our daily diet. Pulses are also known to increase the soil fertility and productivity of succeeding crop. The domestication and cultivation of staple food crops received more attention than pulses. Pulses are being ceaselessly grown under marginal lands of low fertility and moisture stress conditions hence genotypes are more adoptable to poor management which registers limited yield, this does not reflect low genetic potential but they may have higher genetic potential than cereals. Blackgram (*Vigna mungo* L. Hepper) is commonly known as urad, mesh or kalai. India is primary center of origin of Blackgram and Central Asia is a secondary center of origin. It is one of the most important legumes of India which belongs to family leguminosae. To improve the productivity of such an important crop through Breeding requires the knowledge of genetic variability of important traits of seed yield, heritability along with the genetic advance as percent mean provides an opportunity for simple selection of the trait. Heterosis has important implications for both in F_1 and for adopting transgressive segregates in F_2 generation. Genetic information regarding heterosis provides a clue for selecting the most suitable parents for hybridization. The presence of heterosis in food legumes has been demonstrated by Singh *et al.* (1975). The presence of heterosis can only be utilized in pulse crops for the development of high yielding pure line varieties. Little information about heterosis and gene action is available in blackgram. The exploitation of the heterosis for the commercial purpose is very common in pollination crop. However, its scope in self-pollinated crops like urdbean seems to be limited in production of hybrid seed. Among the self-pollinated crops, the example of commercial exploitation of hybrid is scanty. However, the information collected on the basis of heterosis effects of the crosses which need to be carried for further selection in the segregation generation. Patil *et al.* (2014) [10]. Hence, the present research work was undertaken to assess the genetic variability, Heterosis, Heterobeltiosis, Economic Heterosis contributing to seed yield in blackgram.

Materials and Methods
The present investigation is carried out for 13 characters of Blackgram (*Vigna mungo* L. Hepper) on 38 genotypes (14 parents and their 22 F_1 hybrids including T_9, AZAD-1 checks). *kharif*-2017 in randomized block design with a spacing of 30x10 cm replicated thrice at field experimentation center, Department of Genetics and Plant Breeding, Sam Higginbottom

University of Agriculture, Technology and Sciences, Allahabad, U.P. Five were selected and quantitative characters Days to 50% flowering, days to 50% pod setting, days to maturity, plant height, number of primary branches per plant, number of clusters per plant, number of pods per plant, number of seeds per pod, pod length, 100 seed weight, biological yield, harvest index and seed yield per plant were recorded on plot bases. The analysis was done by using statistical package WINDOSTAT 9.3 version.

Results and Discussion

The analysis of variance revealed highly significant to significant differences among the genotypes for all the thirteen characters studied (table 1). The analysis of variance for all the characters revealed that parents were found to be highly significant for all the characters except number of branches per plant, pod length. In the present study, variation among the characters is estimated by Genotypic Coefficient of Variation (GCV) and Phenotypic Coefficient of Variation (PCV). The PCV was slightly higher than the GCV for few characters indicates the interaction of genotypes with the environment (Table 2). Biological yield, harvest index, seed yield per plant, exhibited high GCV, PCV. Similar results are reported by Bakshi and Ghoshdastidar (2004) [21], Sarkar *et al.* (2006) [23], Sowmini and Jayamani (2013) [24], Hemalatha *et al*. (2017) [22]. Estimates of heritability is a good index for predicting the transmission of characters from parents to their offspring. That heritability (broadsense) and genetic advance as % of mean values were high for seed yield per plant indicating that selection would be fruitful for improvement of these traits. Similar results are reported by Loganathan *et al.* (2001) [20], Pradhan *et al.* (2005) [19].

Heterosis, a fundamental tool, used for the improvement of crops in the form of F_1 and F_2 populations by improving the various yield contributing characters. The magnitude of heterosis was reported among the crosses, demonstrating potential of hybrid combinations of fourteen diverse parents for various traits enhancement in the present research. Table 1 illustrated the analysis of variance (ANOVA) for yield and its thirteen component characters among twenty two F_1 hybrids and their fourteen parents.

Among three estimates of heterosis, in general heterosis over commercial check has been widely considered as important estimate of heterosis for commercial exploitation of hybrid vigour of crosses (Grakh and Chaudhury, 1985) [4]. The extent of heterosis depends on the magnitude of nonadditive gene action and wide genetic diversity among parents (Bhagirath Ram *et al*., 2013) [2]. The results exhibited that the significant heterosis occurred in the hybrids for characters Days to 50% flowering, days to 50% pod setting, days to maturity, plant height, number of primary branches per plant, number of clusters per plant, number of pods per plant, number of seeds per pod, pod length, 100 seed weight, biological yield, harvest index and seed yield per plant in consonance with Sharma and Sengupta *et al*. (2013) [15], Makani *et al*. (2013) [6], Singh *et al*. (2013) [17]. Days to 50% flowering exhibited negative significant heterosis, heterobeltiosis (-16.47**, -20.61**) in F_1 hybrid LBG-648 x NDUK-13-6 and negative significant economic heterosis (-21.37**) in F_1 hybrid KPU-13-192 x PU-31. Negative heterosis is desirable for days to 50 % flowering which attributed to early maturing of hybrids and is the deciding factor on selection of short duration genotypes in different cross combinations. The above result is similar to the findings of Gupta (2005) [5] Singh *et al.* (2003) [16], Sharma *et al.* (2003) [15], indicating significantly negative standard heterosis for flowering. Days to 50% pod setting exhibited negative significant heterosis, heterobeltiosis, economic heterosis (-22.64**, -22.64**, -25.90**) in F_1 hybrid LBG-648 x NDUK 13-6. Days to maturity is one of deciding factor in the crop improvement programme accompanied with objectives of development early maturing genotypes. Negative heterosis for this trait is useful in selection of early maturing heterotic combination. Days to maturity exhibited negative significant heterosis, heterobeltiosis, economic heterosis (-15.51**, -22.03**, -22.03**) in F_1 hybrid LBG-648 x KPU-13-192. The result is similar to findings of Singh *et al.* (2003) [16], Sharma *et al.* (2003) [15], Gupta, 2005 [5], indicating significantly negative standard heterosis for flowering and days to maturity duration. Plant height exhibited positive significant heterosis, heterobeltiosis (56.62**, 52.25**) in F_1 hybrid LBG-648 x PU-31 and negative significant economic heterosis (-37.35**) in F_1 hybrid LBG-648 x Vallabh urd. These results were in close agreement with report of Rama Kant and Srivastava, (2012) [12]. Number of primary branches per plant exhibited positive significant heterosis, heterobeltiosis (93.44**, 78.79**) in F_1 hybrid KPU-13-192 x PU-31 and positive significant economic heterosis (45.45**) in F_1 hybrid KPU-13-192 x KU-96-7. Hence, it shows that this trait shows higher magnitude of dominance which are in conformity with earlier reports of Pandiyan *et al*. (2010) [8] and Yashpal *et al*. (2015) [18]. Number of clusters per plant exhibited negative significant heterosis, heterobeltiosis, economic heterosis (-55.49**, -59.46**, -59.46**) in F_1 hybrid LBG-648 x PU-09-37. Number of pods per plant exhibited negative significant heterosis, heterobeltiosis, economic heterosis (-50.40**, -58.14**, -58.14**) in F_1 hybrid LBG-648 x PU-09-37. Number of seeds per pod exhibited negative significant heterosis, heterobeltiosis, economic heterosis (-15.94**, -17.14**, -17.92**) in F_1 hybrid KPU-63-189 x KU-13-192. The result is similar to findings of Yashpal *et al.* (2015) [18]. Pod length is one of the important yield attributing trait which decides the seed number and size. Pod length exhibited positive significant heterosis, heterobeltiosis (18.14, 17.75) in F_1 hybrid IU-02-1-3 x MU-06 and negative non-significant economic heterosis (-12.40). The result is similar to findings of Yashpal *et al.* (2015) [18]. 100 seed weight exhibited negative significant heterosis, heterobeltiosis, economic heterosis (-31.77**, -44.05**, -44.05**) in F_1 hybrid LBG-648 x PU-09-37. The result is similar to findings of Yashpal *et al.* (2015) [18]. Biological yield exhibited positive significant heterosis, heterobeltiosis, economic heterosis (138.80**, 118.02**, 70.68**) in F_1 hybrid LBG-648 x PU-31. Harvest index exhibited positive significant heterosis, heterobeltiosis (100.27**, 96.93**) in F_1 hybrid LBG-648 x KPU-13-192 and negative significant economic heterosis (-68.15**) in F_1 hybrid LBG-648 x PU-09-37. Seed yield per plant exhibited positive significant heterosis (103.92**) in F1 hybrid KPU-13-192 x LBG-648, positive significant heterobeltiosis (75.58**) in F_1 hybrid KPU-13-192 x KU-13-01 and negative significant economic heterosis (-45.02**) in F_1 hybrid LBG-648 x MU-06. Estimation of heterosis for yield per plant had also been conducted by Yashpal *et al.* (2015) [18], Elangaimannan *et al.* (2008) [3], Barad *et al.* (2008) [1], Reddy (1998) [14], Neog and Talukdar (1999) [7], Patel *et al.* (2009) [9], Reddy *et al.* (2011) [13] and Ram *et al.* (2013) [11] who reported significant positive heterosis for yield per plant.

Table 1: Analysis of variance for 13 characters in blackgram

S. No	Character	Replication d.f=2	Treatment d.f=37	Hybrids d.f=21	Parents d.f=13	Hybrids vs. Parents	Checks	Checks vs. Hybrids	Checks vs. Parents	Error	Total
1.	Days to 50% Flowering	7.19	30.86**	22.06**	9.94*	116.90**	20.17*	480.66**	273.24**	4.38	13.10
2.	Days to 50% Pods Setting	7.30	48.98**	43.90**	20.38**	315.19**	0.67	420.36**	144.05**	3.69	18.52
3.	Days to Maturity	18.17*	39.94**	55.51**	20.24**	22.76*	0.17	17.29	38.68**	5.47	16.76
4.	Plant Height	29.79*	257.83**	323.89**	60.15**	1113.30**	3.38	1190.49**	346.70**	8.63	90.23
5.	Number of Primary branches Per Plant	0.014	1.34**	0.79**	0.24	25.40**	0.01	1.33**	11.59**	0.16	0.55
6.	Number of Clusters Per Plant	7.39**	11.51**	9.97**	6.35**	50.34**	9.63*	95.07**	39.91**	1.66	4.89
7.	Number of Pods Per Plant	20.80*	85.20**	91.25**	55.28**	101.26**	26.46*	310.13**	473.34**	6.38	32.19
8.	Number of Seeds Per Pod	0.52*	0.32**	0.28*	0.34*	0.74*	0.17	0.27	0.80*	0.15	0.20
9.	Pod Length	0.20	0.26**	0.28**	0.12	1.37**	0.00	0.41	1.33**	0.12	0.17
10.	100 Seed Weight	0.15	0.47**	0.22*	0.83**	1.00**	0.34	0.17	0.73*	0.13	0.24
11.	Biological Yield	0.95	90.58**	129.00**	14.76**	447.73**	0.29	4.88	54.91**	3.31	31.88
12.	Harvest Index	24.43	280.33**	369.78**	150.15**	621.15**	4.25	97.02	2.72	27.46	110.26
13.	Seed Yield Per Plant	0.48	8.24**	7.91**	3.68**	90.54**	0.40	1.88*	8.79**	0.30	2.90

**, *Significant 1% and 5% level of significance respectively

Table 2: Genetic parameters for 13 characters of 38 blackgram genotypes

S. No	Character	Genotypic Coefficient of variation (%)	Phenotypic Coefficient of variation (%)	Heritability(h^2) (%) (broad sense)	Genetic advance	Genetic advance as percent of mean (5%)
1.	Days to 50% flowering	7.47	9.14	66.82	5.00	12.58
2.	Days to 50% Pods Setting	7.78	8.65	80.80	7.20	14.40
3.	Days to maturity	4.95	5.94	69.34	5.84	8.49
4.	Plant height	15.47	16.20	91.17	17.95	30.42
5.	Number of Primary branches per plant	20.37	24.36	69.89	1.08	35.08
6.	Number of Clusters per plant	20.35	24.51	68.94	3.12	34.81
7.	Number of Pods per plant	19.42	21.52	81.50	9.56	36.12
8.	Number of Seeds per pod	3.81	6.88	30.65	0.28	4.34
9.	Pod length	5.19	9.82	27.99	0.23	5.66
10.	100-seed weight	8.74	12.67	47.59	0.48	12.42
11.	Biological yield	29.37	31.03	89.61	10.51	57.27
12.	Harvest index	25.34	29.19	75.37	16.42	45.31
13.	Seed yield per plant	25.71	27.08	90.12	3.18	50.27

Table 3: Heterosis, Heterobeltiosis and Economic Heterosis for different characters

Genotypes	Days to 50% flowering			Days to 50% Pods Setting			Days to maturity		
	Ha	Hb	Hc	Ha	Hb	Hc	Ha	Hb	Hc
LBG-648 x MU-06	-15.32 **	-19.85**	-19.85**	-15.11 **	-16.98**	-20.48**	-12.09 **	-16.74**	-16.74**
LBG-648 x KPU-13-192	-14.17 **	-19.08 **	-19.08**	-16.61 **	-19.50**	-22.89**	-15.51 **	-22.03 **	-22.03**
LBG-648 x PU-38	-5.51	-8.40 *	-8.40*	-2.79	-4.27	-5.42	-0.93	-5.73 *	-5.73*
LBG-648 x PU-31	-9.65 **	-10.69 **	-10.69**	-9.66 **	-10.49 **	-12.65**	-9.17 **	-12.78**	-12.78**
LBG-648 xVallabh Urd	-6.35	-9.92 *	-9.92*	-9.84 **	-10.69**	-14.46**	2.78	-2.20	-2.20
LBG-648 x NDUK-13-6	-16.47**	-20.61**	-20.61**	-22.64 **	-22.64 **	-25.90**	-11.06 **	-13.22**	-13.22**
LBG-648 x PU-09-37	-11.29 **	-16.03**	-16.03**	-12.34 **	-15.09 **	-18.67**	-9.17 **	-12.78**	-12.78**
KPU-13-192 x PU-31	-15.57 **	-19.53 **	-21.37**	-18.06 **	-21.60 **	-23.49**	-3.24	-7.18 *	-14.54**
KPU-13-192 x KU-96-7	-13.36 **	-18.32 **	-18.32**	-10.83**	-15.66 **	-15.66**	-3.27	-6.34 *	-15.42**
KPU-13-192 xVallabh Urd	-1.27	-3.31	-10.69**	1.97	-0.64	-6.63*	11.34**	7.80 **	-2.64
KPU-13-192 x LBG-791	3.31	-0.79	-4.58	-1.60	-6.67 *	-7.23*	5.97 *	1.43	-6.17*
KPU-13-192 x LBG-648	-3.64	-9.16 *	-9.16*	1.63	-1.89	-6.02*	4.06	-3.96	-3.96
KPU-63-189 x LBG-648	-5.69	-11.45 **	-11.45**	-2.67	-8.18 **	-12.05**	-5.29 *	-9.25**	-9.25**
KPU-63-189 x KPU-13-192	4.76	4.31	-7.63	2.42	0.00	-10.84**	2.50	-1.44	-9.69**
KPU-63-189 x PU-38	0.00	-3.25	-9.16*	-0.33	-7.32 *	-8.43**	5.08 *	4.33	-4.41
KPU-63-189 x IU-02-1-3	-2.54	-4.96	-12.21**	2.70	-1.94	-8.43**	2.86	1.89	-4.85
KPU-63-189 x NDUK-13-4	-9.62 *	-12.90 **	-17.56**	-4.41	-8.44**	-15.06**	-1.90	-3.27	-8.81**
KPU-13-192 x KU-13-01	7.69 *	6.78	-3.82	6.16*	4.73	-6.63*	8.04 **	4.37	-5.29*
IU-02-1-3 x PU-09-37	8.40 *	6.61	-1.53	-0.66	-2.58	-9.04**	-0.24	-0.94	-7.49**
IU-02-1-3 x PU-38	-9.84 **	-10.57 *	-16.03**	-12.85**	-15.24 **	-16.27**	-10.31 **	-11.79**	-17.62**
IU-02-1-3 x PU-31	5.22	2.34	0.00	6.62 *	4.32	1.81	7.36**	6.60 *	-0.44
IU-02-1-3 x MU-06	-4.20	-5.79	-12.98**	-10.10 **	-10.97 **	-16.87**	-0.72	-2.83	-9.25**

Genotypes	Pods per plant			Pod length			Seeds per pod		
	Ha	Hb	Hc	Ha	Hb	Hc	Ha	Hb	Hc
LBG-648 x MU-06	-37.20**	-49.61 **	-49.61**	-3.42	-5.04	-12.40	-2.62	-7.92	-12.26**
LBG-648 x KPU-13-192	-22.53 **	-34.69 **	-34.69**	-3.23	-6.98	-6.98	-10.34*	-10.78*	-14.15**
LBG-648 x PU-38	-22.17 **	-29.26 **	-29.26**	1.87	0.59	-7.21	-2.04	-4.95	-9.43*
LBG-648 x PU-31	-12.09	-30.23 **	-30.23**	13.04*	9.24	0.78	-3.59	-6.93	-11.32*

LBG-648 xVallabh Urd	-5.62	-25.19 **	-25.19**	13.22*	11.38	6.20	-5.00	-5.94	-10.38*
LBG-648 x NDUK-13-6	-15.18 *	-23.64 **	-23.64**	-3.64	-7.03	-7.75	-2.42	-4.72	-4.72
LBG-648 x PU-09-37	-50.40 **	-58.14 **	-58.14**	16.53**	14.63*	9.30	-1.96	-2.91	-5.66
KPU-13-192 x PU-31	29.98 **	20.62 *	-17.25**	5.83	-1.55	-1.55	-7.14	-10.78*	-14.15**
KPU-13-192 x KU-96-7	17.92 *	8.76	-25.39**	15.92*	10.08	10.08	2.02	-0.98	-4.72
KPU-13-192 xVallabh Urd	-10.37	-16.95	-43.02**	-3.17	-5.43	-5.43	-5.47	-6.86	-10.38*
KPU-13-192 x LBG-791	16.67 *	10.73	-24.03**	-5.79	-11.63	-11.63	-6.74	-11.76*	-15.09**
KPU-13-192 x LBG-648	21.84 **	2.71	2.71	-0.81	-4.65	-4.65	-10.34*	-10.78*	-14.15**
KPU-63-189 x LBG-648	-0.10	-7.75	-7.75	-4.49	-7.14	-9.30	-9.71*	-11.43*	-12.26**
KPU-63-189 x KPU-13-192	4.93	-5.03	-19.57**	-1.96	-3.10	-3.10	-15.94**	-17.14**	-17.92**
KPU-63-189 x PU-38	14.32 *	12.36	-4.84	7.44	3.17	0.78	4.00	-0.95	-1.89
KPU-63-189 x IU-02-1-3	7.24	5.03	-11.05	-7.26	-8.73	-10.85	-3.52	-8.57	-9.43*
KPU-63-189 x NDUK-13-4	24.73 **	18.31 *	0.19	1.69	-4.76	-6.98	-0.49	-2.86	-3.77
KPU-13-192 x KU-13-01	33.70 **	31.34 **	-6.59	11.20	7.75	7.75	-4.43	-4.90	-8.49
IU-02-1-3 x PU-09-37	-17.83 *	-24.11 **	-38.37**	6.94	6.50	1.55	0.51	-3.88	-6.60
IU-02-1-3 x PU-38	-0.59	-0.95	-18.99**	5.04	2.46	-3.10	-2.65	-3.16	-13.21**
IU-02-1-3 x PU-31	18.84 *	2.39	-16.86**	11.59	6.56	0.78	7.45	7.45	-4.72
IU-02-1-3 x MU-06	34.06 **	16.95 *	-5.04	18.14**	14.75*	8.53	7.61	5.32	-6.60

Genotypes	Plant height			Primary branches per plant			Clusters per plant		
	Ha	Hb	Hc	Ha	Hb	Hc	Ha	Hb	Hc
LBG-648 x MU-06	30.27 **	27.62**	10.46**	27.50 *	15.91	15.91	-12.70	-27.57 **	-27.57**
LBG-648 x KPU-13-192	-8.63*	-14.95 **	-18.04**	11.69	-2.27	-2.27	-16.17	-24.32 **	-24.32**
LBG-648 x PU-38	46.11**	40.10 **	16.33**	22.50 *	11.36	11.36	-24.92 **	-32.43 **	-32.43**
LBG-648 x PU-31	56.62 **	52.25**	33.88**	52.78 **	25.00 *	25.00*	-37.58 **	-47.03 **	-47.03**
LBG-648 xVallabh Urd	-25.32**	-26.07 **	-37.35**	-14.63	-20.45	-20.45	-32.44 **	-45.41 **	-45.41**
LBG-648 x NDUK-13-6	-23.14 **	-29.39 **	-29.99**	34.94 **	27.27 *	27.27*	-26.38 **	-31.35 **	-31.35**
LBG-648 x PU-09-37	27.26 **	25.71 **	4.38	68.00 **	43.18 **	43.18**	-55.49 **	-59.46 **	-59.46**
KPU-13-192 x PU-31	-16.21 **	-19.88 **	-22.79**	93.44 **	78.79 **	34.09**	-17.27	-22.82 *	-37.84**
KPU-13-192 x KU-96-7	29.30 **	25.36 **	20.81**	82.86 **	72.97 **	45.45**	20.00	8.72	-12.43
KPU-13-192 xVallabh Urd	7.78 *	1.27	-2.40	43.66 **	34.21 *	15.91	-13.31	-23.49*	-38.38**
KPU-13-192 x LBG-791	1.27	-2.66	-6.19	26.32 *	11.63	9.09	-37.32 **	-40.27 **	-51.89**
KPU-13-192 x LBG-648	9.16*	1.61	-2.08	1.30	-11.36	-11.36	-40.12 **	-45.95 **	-45.95**
KPU-63-189 x LBG-648	22.32 **	22.24**	1.49	12.82	0.00	0.00	-23.12 **	-25.41 **	-25.41**
KPU-63-189 x KPU-13-192	8.21 *	0.66	-2.99	61.19 **	58.82 **	22.73*	-24.46**	-29.89 **	-34.05**
KPU-63-189 x PU-38	12.14 **	7.59	-10.78**	62.86 **	58.33 **	29.55*	14.91	6.32	0.00
KPU-63-189 x IU-02-1-3	5.75	-1.12	-5.76	65.71 **	61.11**	31.82**	-4.29	-10.34	-15.68
KPU-63-189 x NDUK-13-4	7.23	-1.92	-1.92	27.78 *	21.05	4.55	-37.87**	-39.66 **	-43.24**
KPU-13-192 x KU-13-01	18.25 **	16.61 **	12.38**	61.19 **	58.82 **	22.73*	-34.57 **	-40.94 **	-52.43**
IU-02-1-3 x PU-09-37	13.32 **	4.82	-0.11	64.18 **	52.78 **	25.00*	-26.32 **	-26.32 *	-39.46**
IU-02-1-3 x PU-38	26.70 **	14.00 **	8.64*	13.89	13.89	-6.82	3.33	1.97	-16.22
IU-02-1-3 x PU-31	19.51 **	14.89 **	9.50*	43.75 **	27.78 *	4.55	4.63	-3.29	-20.54*
IU-02-1-3 x MU-06	24.24 **	18.53 **	12.97**	58.33 **	58.33 **	29.55*	-3.65	-13.16	-28.65**

Genotypes	100 seed weight			Biological Yield			Harvest Index		
	Ha	Hb	Hc	Ha	Hb	Hc	Ha	Hb	Hc
LBG-648 x MU-06	-23.15 **	-35.30**	-35.30**	-5.85	-20.07	-25.96 **	6.05	1.55	-39.17**
LBG-648 x KPU-13-192	-28.40 **	-39.26**	-39.26**	-36.60 **	-47.36 **	-48.48 **	100.27**	96.93**	7.95
LBG-648 x PU-38	-24.96 **	-38.86**	-38.86**	-9.81	-22.72 *	-29.99 **	38.61**	18.25	-8.22
LBG-648 x PU-31	-20.32 **	-33.43 **	-33.43**	138.80 **	118.02 **	70.68 **	-43.23**	-50.63**	-63.40**
LBG-648 xVallabh Urd	-26.41 **	-38.21 **	-38.21**	14.28	0.54	-14.40	16.67	6.23	-29.07**
LBG-648 x NDUK-13-6	-19.80 **	-34.19 **	-34.19**	-1.98	-17.21 *	-22.33 **	47.94**	42.38**	-15.61
LBG-648 x PU-09-37	-31.77 **	-44.05 **	-44.05**	108.35 **	81.13 **	58.55 **	-53.44**	-61.15**	-68.15**
KPU-13-192 x PU-31	-5.63	-7.37	-35.47**	-7.88	-17.09 *	-18.86 *	51.13**	29.58*	-3.93
KPU-13-192 x KU-96-7	3.11	1.51	-29.29**	111.09 **	86.70 **	82.73 **	-16.52	-28.45*	-46.91**
KPU-13-192 x Vallabh Urd	8.14	6.78	-25.61**	12.77	5.43	3.19	39.16**	24.80	-16.68
KPU-13-192 x LBG-791	4.77	2.01	-28.94**	51.39 **	49.78 **	49.78 **	-6.02	-12.01	-46.56**
KPU-13-192 x LBG-648	-17.88 **	-30.34 **	-30.34**	10.42	-8.31	-10.27	83.30**	80.25**	-1.19
KPU-63-189 x LBG-648	-23.17 **	-32.50 **	-32.50**	44.80 **	28.31 **	7.43	-0.04	-22.21	-23.37*
KPU-63-189 x KPU-13-192	-13.64 *	-17.10 *	-37.22**	27.61 **	18.39 *	15.87 *	8.48	-16.59	-17.83
KPU-63-189 x PU-38	5.43	-3.47	-26.90**	67.78 **	61.42 **	46.24 **	-22.82*	-31.01**	-32.03**
KPU-63-189 x IU-02-1-3	-5.72	-9.17	-31.21**	9.95	5.15	-11.96	-0.62	-1.36	-1.36
KPU-63-189 x NDUK-13-4	-10.63	-15.79*	-36.23**	18.19 *	15.48	-3.31	49.55**	19.68*	17.90
KPU-13-192 x KU-13-01	-11.22	-12.81	-39.26	33.80 **	8.19	5.88	30.67*	7.96	-12.30
IU-02-1-3 x PU-09-37	-4.09	-8.31	-35.65**	11.29	4.22	-8.77	6.16	-3.40	-3.40
IU-02-1-3 x PU-38	5.43	0.00	-29.81**	10.13	1.52	-8.03	-4.48	-15.17	-15.17
IU-02-1-3 x PU-31	4.89	2.58	-28.00**	13.02	11.67	-12.57	29.33**	12.61	12.61
IU-02-1-3 x MU-06	1.39	0.08	-29.75**	9.59	0.00	-7.36	39.55**	11.57	11.57

Conclusion

Based on overall observation of the results of this investigation it is concluded that among 22 crosses of Blackgram on the basis of mean performance and heterosis KPU-63-189 x NDUK-13-4, KPU-13-192 x LBG-648, KPU-13-192 x KU-13-01, KPU-13-192 x KU-96-7 had exhibited high positive significant standard heterosis for seed yield per plant and its yield attributing traits. Hence exploitation of hybrid vigour could be achieved in these crosses and it might be helpful in the improvement of the crop yield.

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