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Exploitation of Heterosis in Inter-Varietal Crosses of Urdbean (*Vigna mungo* [L.] Hepper)

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A B S T R A C T

Field trial was conducted to assess the magnitude of heterosis for nine traits in 33 inter-varietal crosses (synthesized by crossing 11 lines and 3 testers in LxT fashion) of urdbean along with a check variety 'VBN (Bg) 4' towards exploitation of hybrid vigour for early maturity and higher yields. The ANOVA revealed that mean squares due to genotypes, parents, crosses, lines, testers (except for plant height) and lines x testers (except plant height) were highly significant for all the traits under evaluation connoting the existence of wider genetic diversity among them. In general, the inter-varietal crosses showed desired heterosis for days to 50 per cent flowering and plant height *i.e.*, negatively significant relative heterosis, heterobeltiosis and standard heterosis indicating their earliness in maturity. Based on experimental results of this investigation, two inter-varietal crosses *viz*., LBG 709 x PU 31, LBG 645 x VBN (Bg)6 and LBG 645 x PU 31 were found promising for most of the traits including seed yield. Therefore, exploitation of hybrid vigour may be rewarding in these crosses, paving way for genetic enhancement of this crop.

Introduction

Urdbean (2n=22), popularly known as blackgram or mash is a premier short duration legume crop belonging to family leguminosae. It is an excellent source of high quality easily digestible dietary protein (25-28%), oil (1.0-1.5%), fiber (3.5%-4.5%, ash (4.5-5.5%), carbohydrates (62-65%), low flatulence, fairly supplier of lysine, vitamins iron and phosphorus. Being a short duration legume and photo-thermo insensitive nature, it is considered as excellent for crop intensification and diversification. Besides like any other legume, this crop acts as an ameliorator of soil fertility through symbiotic nitrogen fixation as well as a green manure. However in recent years, lack of promising genotypes suited to local environments is a major constraint hindering its production, necessitating the development of new varieties adapted to local condition. Extent and magnitude of heterosis present in hybrids is vital aspect for any crop improvement programme. The presence of heterosis in food legumes has also been demonstrated by Kant and Srivastava (2012). Little information about heterosis and gene action is available in blackgram. The exploitation of heterosis in urdbean has not been commercialized due to limited extent of out crossing (Singh, 2000). However, highly heterotic crosses can be used for development of high yielding pure line varieties in a self-pollinated crop like urdbean. Hence, the present study was undertaken to assess the magnitude of heterosis in order to harness the hybrid vigour of inter-varietal crosses in urdbean.

Materials and Methods

Fourteen varieties / cultures of urdbean adapted to various agro-climatic condition were crossed in Line x Tester fashion which comprised of eleven lines *viz*., ACM 05007, MDU 1, ADT 3, Co 5, Co 6, LBG 623, LBG 645, LBG 685, LBG 709, TMV 1 and VBN (Bg) 5 and three testers *viz*., PU 31, VBN (Bg) 4 and VBN (Bg) 6 during October, 2013 at Agricultural College and Research Institute, Madurai to obtain 33 inter-varietal crosses. The resultant 33 hybrids were raised along with their respective parents in RBD, replicated twice with a spacing of 30 x 10 cm at National Pulses Research Centre, Vamban, during July, 2014. Each plot consisted of 4m row length with a spacing of 30 x 10 cm between row and plants, respectively. Data were recorded on 10 randomly selected in each replication for nine quantitative traits *viz.*, days to 50% flowering, plant height, number of branches / plant, number of clusters / plant, number of pods / plant, number of seeds / pod, hundred seed weight and seed yield / plant. The mean data on above traits were used to compute relative heterosis, heterobeltiosis, and standard heterosis (Hays *et al*., 1955). Variety 'VBN (Bg)4' 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) the test of significance for estimates of heterosis were tested for significance at error degrees of freedom as suggested by Turner (1953).

Results and Discussion

Analysis of variance (ANOVA) for LxT analysis in urdbean for yield and its attributes were computed (Table 1). The ANOVA revealed that mean squares due to genotypes, parents, crosses, lines, testers (except for plant height) and lines x testers (except plant height) were highly significant for all the traits under evaluation connoting the existence of wider genetic diversity among them This justified the selection of 14 genotypes as parents in the present L x T analysis. The results of heterosis over mid parent, better parent and check variety *i.e.*, VBN (Bg)4 were presented in Tables 2, 3 and 4. 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).

The extent of heterosis depends on the magnitude of nonadditive gene action and wide genetic diversity among parents (Ram *et al*., 2013). For the trait, days to 50% flowering, the relative heterosis ranged from -5.71 to 5.51 and 13 inter-varietal crosses displayed desired significant and negative standard heterosis.

Table.1 Analysis of variance for LxT analysis in urdbean for yield and its attributes

Source	df	Mean Squares								
		Days to 50 % flowering	Plant height	Number of branches/plant	Number of clusters/plant	Number of pods/plant	Pod length	Number of seeds/pod	100 seed weight	Seed yield/plant
Replication	1	0.89	0.05	0.03	0.04	0.01	0.01	0.09	0.03	0.01
Genotypes	46	5.03 *	57.58 *	0.15*	18.42*	36.80*	0.08*	0.26*	0.28*	6.52*
Parents	13	8.09*	128.93*	0.13*	26.31*	20.57*	0.13*	0.23*	0.52*	4.44*
Crosses	32	3.94*	15.28*	0.16*	13.65*	36.63*	0.07*	0.23*	0.17*	5.47*
Parents Vs Crosses	1	0.12*	483.69*	0.07*	68.55*	253.66*	0.03*	1.72*	0.75*	67.31*
Lines	10	6.63*	35.53*	0.15*	22.92*	86.58*	0.12*	0.42*	0.37*	12.38*
Testers	2	21.02*	2.47	0.50*	11.02*	47.72*	0.04*	0.22*	0.17*	2.67*
Lines x Testers	20	0.88*	6.44	0.13*	9.28*	10.54*	0.04*	0.13*	0.07*	2.29*
Error	46	0.12	3.23	0.01	0.40	2.60	0.01	0.02	0.04	0.23

* Significant at 5 % level

Table.2 Heterosis percent for Days to 50% flowering, Plant height and Number of branches/plant

Crosses	Days to 50% flowering			Plant height			Number of branches/plant		
	d_i	d_{ii}	d_{iii}	d_i	d_{ii}	d_{iii}	d_i	d_{ii}	d_{iii}
ACM 05007 x PU 31	0.00	-3.08	-8.70**	-0.82	-13.85**	4.96	4.90	2.88	-18.94**
ACM 05007 x VBN (Bg)4	1.49	-1.45	-1.45	-12.53**	-20.37**	-2.98	-10.34**	-19.85**	-19.85**
ACM 05007 x VBN(Bg) 6	-3.82	-4.55	-8.70**	-3.37	-32.89**	-18.24**	-4.47	-5.38	-25.45**
MDU 1 x PU 31	5.51*	1.52	-2.90	-16.06**	-28.24**	-9.18*	7.41*	0.00	-12.12**
MDU 1x VBN (Bg)4	-2.22	-4.35	-4.35	-23.33**	-31.37**	-13.15**	-10.16**	-15.61**	-15.61**
MDU 1 x VBN (Bg)6	1.52	1.52	-2.90	-16.55**	-42.65**	-27.42**	-13.21**	-18.45**	-28.33**
ADT 3 x PU 31	-2.40	-4.69	-11.59**	-12.77**	-15.06**	-23.70**	5.00	5.00	-20.45**
ADT 3 x VBN (Bg)4	-3.76	-7.25**	-7.25**	-2.88	-10.11*	-10.11*	-7.76*	-18.94**	-18.94**
ADT 3 x VBN (Bg)6	-3.08	-4.55	-8.70**	17.98**	-8.16	-21.84**	-6.34	-7.25	-28.33**
CO 5 x PU 31	2.29	-4.29	-2.90	-18.85**	-33.24**	-7.07	2.41	-4.66	-16.21**
CO 5 x VBN (Bg)4	0.72	0.00	1.45	-17.84**	-29.41**	-1.74	-15.81**	-20.91**	-20.91**
CO 5 x VBN (Bg)6	4.41	1.43	2.90	-16.36**	-43.94**	-21.96**	-4.04	-9.83*	-20.76**
CO 6 x PU 31	-3.28	-3.28	-14.49**	-3.75	-4.28	-14.02**	-1.25	-5.20	-28.18**
CO 6 x VBN (Bg)4	0.00	-5.80*	-5.80*	-16.10**	-20.78**	-20.78**	-12.14**	-25.45**	-25.45**
CO 6 x VBN (Bg)6	0.79	-3.03	-7.25**	7.01	-17.95**	-27.11**	-4.12	-8.82*	-29.55**
LBG 623 x PU 31	-3.70	-12.16**	-5.80*	-22.76**	-35.64**	-13.28**	-2.78	-9.48*	-20.45**
LBG 623 x VBN (Bg)4	-3.50	-6.76**	0.00	-21.88**	-31.95**	-8.31	-15.16**	-20.30**	-20.30**
LBG 623 x VBN (Bg)6	-5.71*	-10.81**	-4.35	-23.16**	-48.07**	-30.02**	-3.49	-9.31*	-20.30**
LBG 645 x PU 31	0.78	-4.41	-5.80*	2.07	1.93	-8.44	-5.00	-5.00	-28.03**
LBG 645 x VBN (Bg)4	0.73	0.00	0.00	-1.57	-6.70	-6.70	-18.28**	-28.18**	-28.18**
LBG 645 x VBN (Bg)6	0.00	-1.47	-2.90	18.08**	-9.72	-19.13**	-6.53	-7.45	-28.48**
LBG 685 x PU 31	-3.82	-10.00**	-8.70**	-10.35*	-11.56*	-18.36**	34.40**	34.40**	1.82
LBG 685 x VBN (Bg)4	-2.16	-2.86	-1.45	-10.97**	-14.39**	-14.39**	-18.28**	-28.18**	-28.18**
LBG 685 x VBN (Bg)6	-1.47	-4.29	-2.90	4.53	-20.90**	-26.99**	3.76	2.75	-20.61**
LBG 709 x PU 31	4.69	0.00	-2.90	0.55	0.55	-9.68*	45.00**	45.00**	9.85**
LBG 709 x VBN (Bg)4	4.41	2.90	2.90	-3.20	-8.13	-8.13	-20.69**	-30.30**	-30.30**
LBG 709 x VBN (Bg)6	2.26	1.49	-1.45	8.50	-17.13**	-25.56**	5.94	4.90	-18.94**
TMV 1 x PU 31	3.17	0.00	-5.80*	-6.18	-7.69	-14.33**	5.20	5.20	-20.30**
TMV 1 x VBN (Bg)4	2.99	0.00	0.00	-13.45**	-16.56**	-16.56**	-19.83**	-29.55**	-29.55**
TMV 1 x VBN (Bg)6	-0.76	-1.52	-5.80*	3.19	-22.06**	-27.67**	4.16	3.14	-20.30**
VBN 5 x PU 31	-0.79	-4.55	-8.70**	-1.61	-6.91	-16.38**	-2.20	-2.20	-25.91**
VBN (Bg)5 x VBN (Bg)4	2.22	0.00	0.00	-2.62	-12.28**	-12.28**	-15.00**	-25.30**	-25.30**
VBN (Bg)5 x VBN (Bg)6	0.00	0.00	-4.35	22.96**	-2.17	-21.59**	-5.94	-6.86	-28.03**
SE	**0.7614**	**0.8791**	**0.8791**	**1.5365**	**1.7742**	**1.7742**	**0.0926**	**0.1070**	**0.1070**

d_i = Relative heterosis; d_{ii} = Heterobeltiosis; d_{iii} = Standard heterosis; ** Significant at 1% level, * Significant at 5% level

Table.3 Heterosis percent for Number of clusters/plant, Number of pods/plant and Pod length

Crosses	Number of clusters/plant			Number of pods/plant			Pod length		
	d_i	d_{ii}	d_{iii}	d_i	d_{ii}	d_{iii}	d_i	d_{ii}	d_{iii}
ACM 05007 x PU 31	1.37	-15.61**	-17.29**	24.57**	18.06**	8.36	1.32	1.10	-2.65*
ACM 05007 x VBN (Bg)4	-2.41	-19.40**	-19.40**	14.29**	4.11	4.11	1.35	-0.53	-0.53
ACM 05007 x VBN(Bg) 6	6.67*	-14.02**	-8.46*	25.31**	17.94**	9.86*	-1.37	-5.35**	-0.85
MDU 1 x PU 31	2.74	-14.47**	-16.17**	26.53**	23.13**	13.01**	3.75**	0.66	-3.49**
MDU 1x VBN (Bg)4	0.00	-17.41**	-17.41**	11.29**	3.97	3.97	4.28**	-0.85	-0.85
MDU 1 x VBN (Bg)6	-9.57**	-27.10**	-22.39**	5.78	2.21	-4.79	-0.22	-7.17**	-2.75*
ADT 3 x PU 31	-11.98**	-25.38**	-26.87**	10.81*	8.66	-0.27	3.57**	2.54	-1.69
ADT 3 x VBN (Bg)4	-5.77	-20.77**	-20.77**	1.53	-4.45	-4.45	2.56*	-0.53	-0.53
ADT 3 x VBN (Bg)6	-2.76	-20.26**	-15.10**	-5.06	-7.57	-13.90**	-2.13	-7.17**	-2.75*
CO 5 x PU 31	-15.85**	-21.41**	-11.24**	14.93**	2.24	-6.16	-1.03	-7.49**	2.01
CO 5 x VBN (Bg)4	-22.78**	-27.20**	-17.79**	3.67	-11.10*	-11.10*	-6.19**	-10.56**	-1.38
CO 5 x VBN (Bg)6	-24.60**	-26.76**	-17.29**	-3.16	-14.41**	-20.27**	-9.35**	-11.61**	-2.54*
CO 6 x PU 31	-3.17	-18.65**	-20.27**	21.59**	17.24**	7.60	0.33	-0.76	-2.75*
CO 6 x VBN (Bg)4	-24.78**	-37.31**	-37.31**	10.87*	2.67	2.67	-1.98	-2.96*	-2.96*
CO 6 x VBN (Bg)6	-24.71**	-38.79**	-34.83**	7.83	3.24	-3.84	-3.65**	-6.77**	-2.33
LBG 623 x PU 31	-25.36**	-30.00**	-21.64**	3.96	-7.91	-15.48**	-1.45	-6.96**	0.42
LBG 623 x VBN (Bg)4	-10.09**	-14.89**	-4.73	-6.98	-20.55**	-20.55**	-4.43**	-7.94**	-0.63
LBG 623 x VBN (Bg)6	-27.56**	-29.33**	-20.90**	5.60	-7.06	-13.42**	-5.37**	-6.76**	0.63
LBG 645 x PU 31	-13.04**	-18.78**	-20.40**	20.80**	19.39**	12.19**	2.25*	-0.52	0.85
LBG 645 x VBN (Bg)4	-30.65**	-35.82**	-35.82**	13.70**	10.27*	10.27*	6.46**	5.74**	7.20**
LBG 645 x VBN (Bg)6	-12.21**	-21.03**	-15.92**	9.37*	8.89	2.33	-2.57*	-4.14**	0.42
LBG 685 x PU 31	-22.75**	-25.89**	-27.36**	-3.57	-13.43**	-20.55**	-1.59	-5.58**	-1.48
LBG 685 x VBN (Bg)4	-33.51**	-36.82**	-36.82**	1.66	-12.05**	-12.05**	-2.85*	-4.87**	-0.74
LBG 685 x VBN (Bg)6	-35.70**	-40.65**	-36.82**	-6.76	-16.84**	-22.53**	-5.47**	-5.66**	-1.16
LBG 709 x PU 31	30.79**	21.83**	19.40**	33.43**	32.84**	21.92**	15.81**	14.44**	12.38**
LBG 709 x VBN (Bg)4	-16.44**	-22.89**	-22.89**	7.25	2.40	2.40	7.10**	6.14**	6.14**
LBG 709 x VBN (Bg)6	-34.38**	-41.12**	-37.31**	-2.90	-4.04	-10.62*	-2.19*	-5.25**	-0.74
TMV 1 x PU 31	-19.35**	-31.22**	-32.59**	-9.56*	-13.88**	-20.96**	-1.30	-3.38**	-3.28*
TMV 1 x VBN (Bg)4	-23.38**	-35.20**	-35.20**	-9.81*	-17.47**	-17.47**	-7.77**	-7.82**	-7.72**
TMV 1 x VBN (Bg)6	-20.40**	-34.35**	-30.10**	-2.33	-7.65	-13.97**	-2.17*	-4.34**	0.21
VBN 5 x PU 31	-34.71**	-43.65**	-44.78**	3.09	-0.30	-8.49	3.84**	1.91	1.48
VBN (Bg)5 x VBN (Bg)4	-32.41**	-42.16**	-42.16**	0.59	-6.58	-6.58	-7.53**	-7.72**	-7.72**
VBN (Bg)5 x VBN (Bg)6	-35.01**	-45.79**	-42.29**	4.75	0.59	-6.30	-9.06**	-11.31**	-7.09**
SE	**0.5508**	**0.6360**	**0.6360**	**1.3976**	**1.6138**	**1.6138**	**0.0517**	**0.0597**	**0.0597**

d_i = Relative heterosis; d_{ii} = Heterobeltiosis; d_{iii} = Standard heterosis; ** Significant at 1% level, * Significant at 5% level

Table.4 Heterosis percent for Number of seeds/pod, Hundred seed weight and Seed yield/plant

Crosses	Number of seeds/pod			Hundred seed weight			Seed yield/plant		
	d_i	d_{ii}	d_{iii}	d_i	d_{ii}	d_{iii}	d_i	d_{ii}	d_{iii}
ACM 05007 x PU 31	9.87**	8.50**	0.15	2.23	1.29	-5.90**	20.55**	10.94	-2.23
ACM 05007 x VBN (Bg)4	8.00**	3.85	3.85	-4.72**	-8.10**	-8.10**	8.14	-5.88	-5.88
ACM 05007 x VBN(Bg) 6	3.15	-2.24	0.77	-1.87	-5.13**	-5.60**	12.17*	-1.07	-4.08
MDU 1 x PU 31	4.53*	0.79	-2.31	0.75	-1.67	-5.80**	23.34**	14.15*	0.60
MDU 1x VBN (Bg)4	2.81	1.23	1.23	-6.13**	-8.10**	-8.10**	5.32	-7.84	-7.84
MDU 1 x VBN (Bg)6	0.69	-2.31	0.69	1.79	-0.10	-0.60	7.38	-4.78	-7.68
ADT 3 x PU 31	6.25**	3.66	-1.92	-11.98**	-21.05**	-28.00**	14.54*	4.45	-7.95
ADT 3 x VBN (Bg)4	6.01**	3.15	3.15	-11.02**	-23.30**	-23.30**	23.95**	6.97	6.97
ADT 3 x VBN (Bg)6	2.10	-2.09	0.92	-9.95**	-22.21**	-22.60**	5.17	-8.03	-10.84*
CO 5 x PU 31	5.34*	4.45	-4.38*	16.55**	3.07*	-6.00**	33.02**	3.71	-8.61
CO 5 x VBN (Bg)4	6.02**	1.54	1.54	2.41	-12.90**	-12.90**	21.56**	-9.26	-9.26
CO 5 x VBN (Bg)6	-10.12**	-15.15**	-12.54**	15.45**	-1.61	-2.10	9.27	-17.58**	-20.10**
CO 6 x PU 31	20.17**	18.63**	6.77**	10.45**	9.54**	-0.10	33.29**	21.76**	7.30
CO 6 x VBN (Bg)4	5.82**	-0.69	-0.69	7.64**	2.10	2.10	30.50**	12.80*	12.80*
CO 6 x VBN (Bg)6	7.82**	-0.22	2.85	3.59**	-1.51	-2.00	20.53**	5.56	2.34
LBG 623 x PU 31	11.35**	8.97**	-1.92	7.77**	-5.70**	-14.00**	20.40**	-6.98	-18.03**
LBG 623 x VBN (Bg)4	-2.48	-9.23**	-9.23**	0.01	-15.80**	-15.80**	-5.52	-30.07**	-30.07**
LBG 623 x VBN (Bg)6	-6.67**	-14.33**	-11.69**	-0.18	-15.78**	-16.20**	0.75	-24.66**	-26.96**
LBG 645 x PU 31	6.61**	4.43	-2.00	3.87**	1.90	-3.40*	40.76**	38.94**	22.44**
LBG 645 x VBN (Bg)4	6.75**	3.46	3.46	-2.05	-4.60**	-4.60**	29.54**	20.37**	20.37**
LBG 645 x VBN (Bg)6	5.78**	1.04	4.15	7.36**	4.82**	4.30**	44.34**	36.07**	31.92**
LBG 685 x PU 31	10.78**	8.89**	-2.00	11.26**	1.86	-7.10**	23.41**	-1.61	-13.29*
LBG 685 x VBN (Bg)4	7.98**	0.92	0.92	-6.94**	-18.20**	-18.20**	13.58*	-13.45*	-13.45*
LBG 685 x VBN (Bg)6	-7.69**	-14.93**	-12.31**	-1.08	-12.86**	-13.30**	-9.26	-30.11**	-32.24**
LBG 709 x PU 31	12.15**	6.54**	6.54**	2.25	0.11	-4.70**	75.24**	72.81**	52.29**
LBG 709 x VBN (Bg)4	2.69	2.69	2.69	-7.07**	-9.30**	-9.30**	13.46**	5.34	5.34
LBG 709 x VBN (Bg)6	1.44	-0.07	3.00	-4.98**	-7.04**	-7.50**	0.57	-5.28	-8.17
TMV 1 x PU 31	4.75*	0.63	-1.69	-6.10**	-8.00**	-16.10**	-16.04**	-22.68**	-31.86**
TMV 1 x VBN (Bg)4	-3.74	-4.85*	-4.85*	-6.03**	-11.90**	-11.90**	-7.44	-19.39**	-19.39**
TMV 1 x VBN (Bg)6	-8.97**	-11.34**	-8.62**	5.03**	-1.31	-1.80	5.60	-6.80	-9.64
VBN 5 x PU 31	0.67	-1.79	-7.08**	-4.79**	-7.35**	-15.50**	6.01	-0.87	-12.64*
VBN (Bg)5 x VBN (Bg)4	-3.16	-5.77**	-5.77**	-3.60**	-10.20**	-10.20**	4.07	-8.06	-8.06
VBN (Bg)5 x VBN (Bg)6	-2.02	-6.04**	-3.15	-8.40**	-14.47**	-14.90**	3.89	-6.97	-9.80
SE	**0.1210**	**0.1397**	**0.1397**	**0.0596**	**0.0688**	**0.0688**	**0.4184**	**0.4831**	**0.4831**

d_i = Relative heterosis; d_{ii} = Heterobeltiosis; d_{iii} = Standard heterosis; ** Significant at 1% level, * Significant at 5% level

In case of plant height trait, 24 inter-varietal crosses showed significant negative standard heterosis whereas none of the hybrids reported for significant positive standard heterosis In general, negative and significant heterosis over standard parent was noted in the inter-varietal crosses for days to 50 % flowering and plant height implying earliness in maturity is the deciding factor in selection of short duration genotypes in different heterotic cross combinations. Similar findings were reported by Gupta (2005) and Kant and Srivastava (2012). Number of branches/plant shows significant positive values in all three format of heterosis. However, only one cross combination alone LBG 709 x PU 31 recorded standard heterosis in significantly positive direction. This result is in conformity with earlier reports of Pandiyan *et al.,* (2010) and Yashpal *et al.,* (2015). Only one heterotic cross combination LBG 709 x PU 31 showed desired higher magnitude of heterosis for cluster/ plant over commercial check indicating the preponderance of dominance for heterotic expression of this trait. Because increase in number of cluster/plant will contribute to increase in number of pods and then on yield. A similar finding on cluster/ plant was reported by Barad *et al.,* (2008), Thomas *et al.,* (2008) and Kant and Srivastava (2012). For the trait number of pods/plant, 12, seven and five crosses registered significant positive relative heterosis, heterobeltiosis and standard heterosis respectively. The cross LBG 709 x PU 31registered the maximum values of 33.43, 32.84 and 21.92 per cent for relative heterosis, heterobeltiosis and standard heterosis respectively for this trait. Positive significant heterosis for pods/plant is desirable for selection of high yielding genotypes from crosses. The result was akin with the findings of Bagade *et al.,* (2002); Patil *et al.,* (2012) in Indian bean. Pod length is one of the important yield attributing trait which decides the seed number and size. For this trait, nine crosses expressed significant and positive relative heterosis while three crosses displayed significantly positive heterobeltiosis and standard heterosis. Similar observation was made by Bagade *et al.,* (2002) and Kant and Srivastava (2012).

For the trait, number of seeds/pod, 17 crosses exhibited significant and positive relative heterosis while five crosses displayed significantly positive heterobeltiosis and two crosses for standard heterosis. Similar result was also reported by Patil *et al.,* (2012) in lab lab bean and Kant and Srivastava (2012) in urdbean. Out of 33 inter-varietal crosses, 10, three and one crosses registered significant positive relative heterosis, heterobeltiosis and standard heterosis respectively for hundred seed weight. With regard to seed yield/plant, positive and significant values were recorded in18, seven and five crosses for relative heterosis, heterobeltiosis and standard heterosis respectively. Estimation of heterosis for yield per plant had also been conducted by Patel *et al.,* (2009), Reddy *et al.,* (2011) and Ram *et al.,* (2013) who reported significant positive heterosis for seed yield/ plant.

It is concluded, based on the results of this investigation, the inter-varietal crosses *viz.,* LBG 709 x PU 31, LBG 645 x VBN (Bg)6 and LBG 645 x PU 31 exhibited high positive significant standard heterosis for seed yield / plant and its yield attributing traits in positive direction and negative heterosis for two traits *viz.,* days to 50% flowering and plant height. Besides, these crosses registered high standard heterosis of 52.29%, 31.92%, and 22.44% respectively for seed yield /plant.

The existence of magnitude of heterosis was higher in these crosses for yield and its attributes. Therefore, exploitation of hybrid vigour could be achieved in these crosses and might aid in the genetic enhancement of this crop.

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