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Studies on heterosis for yield and its components of bitter gourd (*Momordica charantia* L.)

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ABSTRACT : The present investigation entitled studies on heterosis for yield and its components of bitter gourd (*Momordica charantia* L.)” using 12 lines x 3 testers and their 36 crosses for 14 quantitative characters was carried out in summer and rainy seasons of 2010. The highest standard heterosis was observed for number of fruit per plant by crosses NDBT-10 x Kalyanpur Sona (Summer) and NDBT-19 x PDM (Rainy) and for fruit yield per plant the highest standard heterosis was observed in NDBT-13 x NDBT-12 during summer season and in NDBT-13 x Pusa Do Mousami during rainy season for days to anthesis of first pistillate flower, NDBT-7 x Kalyanpur Sona and NDBT-2 x PDM emerged as most promising crosses for summer and rainy season.

KEY WORDS : Heterosis, Yield, Bitter gourd

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Bitter gourd (*Momordica charantia* L.) is one of the most nutritive and commercially important vegetable grown throughout the country. In terms of nutritive value, bitter gourd ranks first among cucurbits due to high value of vitamins and minerals. There are about 60 species in the genus *Momordica*, among them *Momordica charantia* L. is widely cultivated. It is a monoecious and highly cross pollinated crop in which a large amount of variations are observed for most of the economically important traits. The breeding objectives can be addressed to satisfy the growers and the consumers and be considered in terms of crop and product improvement bitter gourd. In bitter gourd full exploitation of heterosis through development of hybrids has not been successfully commercialized due to one or the other reason. Variability found in shape, size and colour of fruits in most conspicuous which offers tremendous scope for heterosis breeding for yield enhancement. Crossing nature and heterosis in cross pollinated crops has long been known to offer good potentialities for increased yield.

RESEARCH METHODS

The present experiment was undertaken involving 12 lines *i.e.*, NDBT-1 (L_1), NDBT-2 (L_2), NDBT-3 (L_3), NDBT-4 (L_4), NDBT-5 (L_5), NDBT-6 (L_6), NDBT-7 (L_7), NDBT-8 (L_8), NDBT-10 (L_9), NDBT-13 (L_{10}), NDBT-15 (L_{11}) and NDBT-19 (L_{12}) and three

testers *i.e.* Kalyanpur Sona (T_1), NDBT-12 (T_2) and Pusa Do Mousami (T_3) and their 36 F_1 s₂₃ hybrids of bitter gourd. The material was evaluated in a Randomized Block Design with three replications for two seasons, namely summer season and rainy season of 2010 at Main Experimental Station, Department of Vegetable Science, N.D. University of Agriculture and Technology, Narendra Nagar (Kumarganj), Faizabad (U.P.). The material was sown in rows of 3m each. Row to row distance was 3 m and plant to plant spacing was 0.5m. The observations were recorded for nine quantitative characters namely, node number to anthesis of first pistillate flower, days to anthesis of first pistillate flower, days to first fruit harvest, fruit length (cm), fruit diameter (cm), average fruit weight (g), number of fruits per plant, fruit yield per plant (kg) and vine length (m). The estimation of nature and magnitude of heterosis for yield and its components was done as per the method of Fonseca and Patterson (1968).

RESEARCH FINDINGS AND DISCUSSION

Heterosis was computed as per cent increase or decrease in F_1 values over the better parent and over the best standard variety (SV). In the present investigation the relative magnitude of heterosis over the better parent and standard variety (Pusa Do Mousami) was studied for 9 characters (Table 1). Node number to anthesis of first pistillate flower revealed that high

Table 1 : Estimates of heterosis in 36 hybrids for 9 characters during summer and rainy seasons in bitter gourd

Characters	Node number to anthesis of first pistillate flower				Days to anthesis of first pistillate flower				
	Summer		Rainy		Summer		Rainy		
	BP	SV	BP	SV	BP	SV	BP	SV	SV
NDBT-1 x K. SONA	-26.67 *	-3.39	-5.00	-15.87**	-2.75	-18.52	-15.38	-10.81	
NDBT-1 x NDBT-12	14.81	-3.39	-5.00	-16.67**	-3.67	14.81	-5.26	-2.70	
NDBT-1 x PDM	-14.81	0.83	0.83	-11.90**	1.83	-14.81	0.00	0.00	
NDBT-2 x K. SONA	-33.33 **	-15.65**	-19.17**	-6.78*	0.92	-25.93 *	-7.69	-2.70	
NDBT-2 x NDBT-12	-7.41	-5.31	-10.83**	-11.86**	-4.59	-7.41	-13.16	-10.81	
NDBT-2 x PDM	-29.63 *	-15.83**	-15.83**	-16.10**	-9.17**	-29.65 *	-16.22	-16.22	
NDBT-3 x K. SONA	0.00	-7.83 *	-11.67**	-2.50	7.34*	11.11	5.13	10.81	
NDBT-3 x NDBT-12	-3.57	-2.73	-10.83**	-9.17**	0.00	0.00	2.63	5.41	
NDBT-3 x PDM	21.43	2.50	2.50	-9.17**	0.00	25.93 *	-2.70	-2.70	
NDBT-4 x K. SONA	25.81 *	-8.20 *	-6.67	-7.63*	0.00	44.44 **	11.63	29.76**	
NDBT-4 x NDBT-12	-3.23	-14.75**	-13.33**	-6.84*	0.00	11.11	-16.28*	-2.70	
NDBT-4 x PDM	6.45	-6.56	-5.00	-7.69*	-0.92	22.22	0.00	16.22	
NDBT-5 x K. SONA	-18.42*	-8.40 *	-9.17 *	-0.85	7.34*	14.81	-26.53**	-2.70	
NDBT-5 x NDBT-12	-15.79	-9.24 *	-10.00**	-2.56	4.59	18.52	-32.65**	-10.81	
NDBT-5 x PDM	-13.16	-5.83	-5.83	-1.71	5.50	22.22	-20.41**	5.41	
NDBT-6 x K. SONA	10.00	-13.91**	-17.50**	6.78*	15.60**	22.22	7.14	21.62*	
NDBT-6 x NDBT-12	13.79	0.88	-5.00	0.00	8.26*	22.22	-16.67*	-5.41	
NDBT-6 x PDM	13.79	-5.00	-5.00	-7.63*	0.00	22.22	-14.29	-2.70	
NDBT-7 x K. SONA	-24.32 **	-23.77**	-22.50**	-4.24	3.67	3.70	-7.69	-2.70	
NDBT-7 x NDBT-12	-10.81	1.64	3.33	-2.56	4.59	22.22	13.16	16.22	
NDBT-7 x PDM	-10.81	0.82	2.50	14.53**	22.94**	22.22	0.00	0.00	
NDBT-8 x K. SONA	-18.18	-1.74	-5.83	-3.36	5.50	0.00	-14.29	-2.70	
NDBT-8 x NDBT-12	-6.06	-7.08	-12.50**	-7.56*	0.92	14.81	9.52	24.32**	
NDBT-8 x PDM	9.09	-0.83	-0.83	0.84	10.09**	33.33 **	7.14	21.62*	
NDBT-10 x K. SONA	-5.41	-9.02 **	0.83	3.82	24.77**	29.63 *	20.51*	27.03**	
NDBT-10 x NDBT-12	-10.84	-8.27 *	1.67	-3.82	15.60**	22.22	18.42*	21.62*	
NDBT-10 x PDM	-2.70	-11.28**	-1.67	1.53	22.02**	33.33 **	13.51	13.51	
NDBT-13 x K. SONA	-32.50 **	3.48	-0.83	5.76*	34.86**	0.00	-20.00**	-2.70	
NDBT-13 x NDBT-12	-7.50	5.31	-0.83	-12.95**	11.01**	37.04 **	0.00	21.62*	
NDBT-13 x PDM	-10.00	0.00	0.00	-20.86**	0.92	33.33 **	-17.78*	0.00	
NDBT-15 x K. SONA	3.13	-10.40**	-6.67	-6.25*	10.09**	22.22	-26.83**	-18.92*	
NDBT-15 x NDBT-12	18.75	-9.60 **	-5.83	0.78	18.35**	40.74 **	2.44	13.51	
NDBT-15 x PDM	15.63	0.80	5.00	3.13	21.10**	37.04 **	-12.20	-2.70	
NDBT-19 x K. SONA	-20.00 **	-4.76	0.00	5.00	15.60**	33.33 **	-25.00**	-2.70	
NDBT-19 x NDBT-12	-6.67	-1.59	3.33	9.17**	20.18**	55.56 **	0.00	29.73**	
NDBT-19 x PDM	-13.33	3.17	8.33 *	10.83**	22.02**	44.44 **	-10.42	16.22	
Significance +ve	1	00	1	5	16	12	2	8	
Significance-ve	7	14	11	15	1	2	9	1	
Range of heterosis	-33.33 to	-23.77 to	-22.50 to	-20.86 to	-9.17 to	-29.65 to	-35.65 to	-18.92 to	
	25.81	5.31	8.33	14.53	34.86	55.50	20.51	29.76	

Contd.... Tabl 1

Table 1 contd..

Characters	Days to first fruit harvest				Fruit length (cm)			
	Summer		Rainy		Summer		Rainy	
Hybrids	BP	SV	BP	SV	BP	SV	BP	SV
NDBT-1 x K. SONA	-3.29	-7.11 *	-7.95**	0.72	2.33	0.36	-6.15	-1.83
NDBT-1 x NDBT-12	-3.38	-7.14 *	-13.28**	-5.08	-18.37**	-0.64	-5.23	6.65
NDBT-1 x PDM	-3.25	-3.25	-5.30	3.62	-3.57	-3.57	-0.97	3.58
NDBT-2 x K. SONA	-15.07**	-19.48 **	-10.60**	-2.17	2.45	0.47	3.96	7.80
NDBT-2 x NDBT-12	-2.10	-9.09 **	-10.60**	-2.17	-29.83**	-14.60 **	4.55	17.65**
NDBT-2 x PDM	-16.88**	-16.88 **	-13.25**	-5.07	-8.12	-8.12	2.14	5.91
NDBT-3 x K. SONA	-4.79	-9.74 **	-3.27	7.25*	-2.83	-1.20	-11.31**	4.51
NDBT-3 x NDBT-12	-2.13	-10.39 **	-11.11**	-1.45	-20.29**	-2.99	-14.79**	0.41
NDBT-3 x PDM	1.95	1.95	-9.80**	0.00	9.85 *	11.69 **	10.29*	29.96**
NDBT-4 x K. SONA	-9.09 **	-9.09 **	-5.33	2.90	-20.69**	-14.71 **	1.21	12.15*
NDBT-4 x NDBT-12	-14.29**	-14.29 **	-6.67*	1.45	-6.33	14.01 **	-13.20**	-2.33
NDBT-4 x PDM	-5.84	-5.84	-6.67*	1.45	0.88	8.48 *	-8.89*	0.96
NDBT-5 x K. SONA	-4.73	-8.44 **	1.34	9.42**	17.99 **	15.71 **	-11.94**	-0.36
NDBT-5 x NDBT-12	-5.41	-9.09 **	1.37	7.25*	-29.72**	-14.46 **	-11.51**	0.14
NDBT-5 x PDM	-8.44 **	-8.44 **	2.05	7.97**	0.08	0.08	-1.81	11.11*
NDBT-6 x K. SONA	-8.90 **	-13.64 **	7.38**	15.94**	-9.22 *	-10.97 **	-17.97**	-3.94
NDBT-6 x NDBT-12	1.38	-4.55	2.07	7.25*	-12.73 **	6.22	-10.96*	4.27
NDBT-6 x PDM	-5.19	-5.19	-2.76	2.17	-4.69	-4.69	-4.65	11.66*
NDBT-7 x K. SONA	-19.33**	-21.43**	-4.70	2.90	-10.75 *	-10.13 *	-4.91	4.92
NDBT-7 x NDBT-12	1.33	-1.30	-0.68	5.80	-10.53 **	8.90 *	2.87	15.76**
NDBT-7 x PDM	0.65	0.65	14.29**	21.74**	-17.41 **	-16.83 **	-2.53	7.55
NDBT-8 x K. SONA	-0.68	-5.84	0.66	10.14**	-7.80	-9.57 *	-3.26	13.79**
NDBT-8 x NDBT-12	-0.71	-9.09 **	-3.31	5.80	-27.10 **	-11.28 **	-5.07	11.66*
NDBT-8 x PDM	-5.84	-5.84	-4.64	4.35	7.79	7.79	-16.12**	-1.34
NDBT-10 x K. SONA	-3.75	0.00	5.03	21.01**	-28.93 **	-6.34	-8.93*	7.47
NDBT-10 x NDBT-12	-5.00	-1.30	-2.52	12.32**	-21.75 **	3.13	-0.56	17.35**
NDBT-10 x PDM	-4.38	-0.65	3.77	19.57**	-25.98 **	-2.46	-0.21	17.76**
NDBT-13 x K. SONA	3.42	-1.95	7.83**	29.71**	-2.72	6.89	17.40**	21.48**
NDBT-13 x NDBT-12	7.69 *	0.00	-9.04**	9.42**	-19.58 **	-2.12	1.39	14.09**
NDBT-13 x PDM	-2.60	-2.60	-15.06**	2.17	3.76	14.01 **	16.37**	20.41**
NDBT-15 x K. SONA	-11.04**	-5.84	-7.64**	5.07	-14.04 **	-7.03	-10.96*	-3.94
NDBT-15 x NDBT-12	-12.88**	-7.79 *	2.55	16.67**	-11.53 **	7.68	0.53	13.13**
NDBT-15 x PDM	-4.29	1.30	1.91	15.94**	-3.35	4.52	-8.06	-0.82
NDBT-19 x K. SONA	-3.73	0.65	4.61	15.22**	-14.74 **	-16.38 **	-6.76	-4.10
NDBT-19 x NDBT-12	-6.83 *	-2.60	2.63	13.04**	-17.70 **	0.17	6.37	19.70**
NDBT-19 x PDM	-1.24	3.25	5.92*	16.67**	15.13 **	15.13 **	17.13**	20.47**
Significance +ve	1	00	4	17	3	7	4	15
Significance-ve	10	16	12	00	19	9	11	00
Range of heterosis	-19.33 to	-21.43 to	-13.28 to	-5.08 to	-29.72 to	-16.63 to	-17.97 to	-3.94 to
	7.69	3.25	14.29	29.71	17.99	15.71	17.40	29.96

Contd.... Table 1

Table 1 contd...

Characters	Fruit diameter (cm)				Average fruit weight (g)			
	Summer		Rainy		Summer		Rainy	
Hybrids	BP	SV	BP	SV	BP	SV	BP	SV
NDBT-1 x K. SONA	6.48	29.03 **	-7.35	-8.98	-5.36	-8.23 **	-6.39 *	-13.50 **
NDBT-1 x NDBT-12	5.50	27.85 **	-0.57	-2.31	-16.67 **	-15.60 **	-17.83 **	-20.25 **
NDBT-1 x PDM	-9.85 *	9.25	-9.07	-9.07	-15.58 **	-15.58 **	-20.25 **	-20.25 **
NDBT-2 x K. SONA	2.19	5.48	-0.54	-15.09*	-1.67	2.16	-0.84	0.00
NDBT-2 x NDBT-12	3.64	10.22 *	8.29	-5.65	-2.50	1.30	-2.93	-2.11
NDBT-2 x PDM	-12.40**	-9.57 *	-22.87**	-22.87**	2.50	6.49 *	4.18	5.06
NDBT-3 x K. SONA	13.99 **	18.28 **	7.39	-5.83	9.38 **	6.06 *	12.79 **	4.22
NDBT-3 x NDBT-12	9.10 *	16.02 **	9.08	-4.35	2.56	3.90	5.65	2.53
NDBT-3 x PDM	41.04 **	46.34 **	19.72**	19.72**	0.43	0.43	0.00	0.00
NDBT-4 x K. SONA	-3.96	22.69 **	-8.76	-1.67	3.57	0.43	4.57	-3.38
NDBT-4 x NDBT-12	-12.71**	11.51 *	-8.25	-1.11	-2.56	-1.30	-3.04	-5.91 *
NDBT-4 x PDM	-3.62	23.12 **	-11.25*	-4.35	-9.09 **	-9.29 **	-13.50 **	-13.50 **
NDBT-5 x K. SONA	40.88 **	37.10 **	49.13**	19.44**	8.48 **	5.19	10.05 **	1.69
NDBT-5 x NDBT-12	-18.10**	-12.90 **	-18.70**	-29.17**	0.00	1.30	-0.87	-3.80
NDBT-5 x PDM	11.29 *	11.29 *	-7.87	-7.87	-3.90	-3.90	-8.86 **	-8.86 **
NDBT-6 x K. SONA	-21.90**	-6.45	-8.94	-16.11**	-9.38 **	-12.12 **	-4.98	-11.39 **
NDBT-6 x NDBT-12	0.09	19.89 **	11.56	2.78	5.13	6.49 *	2.61	-0.42
NDBT-6 x PDM	-11.13 **	6.45	4.44	4.44	-9.09 **	-9.09 **	-9.70 **	-9.70 **
NDBT-7 x K. SONA	-3.13	26.45 **	-14.46**	-4.72	-16.48 **	-5.63 *	-16.67 **	-9.28 **
NDBT-7 x NDBT-12	1.07	31.94 **	-5.74	5.00	-8.05 **	3.90	-7.36 **	0.84
NDBT-7 x PDM	-31.47 **	-10.54 *	-34.41 **	-26.94**	-17.24 **	-6.49 *	-13.95 **	-6.33 *
NDBT-8 x K. SONA	-33.62 **	-8.06	-38.15**	-27.04**	-10.74 **	-6.49 *	-9.80 **	-6.75 *
NDBT-8 x NDBT-12	-36.57 **	-12.15 *	-45.53**	-35.74**	-18.60 **	-14.72 **	-21.63 **	-18.99 **
NDBT-8 x PDM	-20.89 **	9.57 *	-4.16	13.06*	0.83	5.63 *	1.63	5.06
NDBT-10 x K. SONA	-16.51**	3.33	-25.06**	-17.78**	-4.46	-7.36 **	-4.98	-11.39 **
NDBT-10 x NDBT-12	-8.51 *	13.23 **	-15.53**	-7.31	7.26 **	8.66 **	9.57 **	6.33 *
NDBT-10 x PDM	3.91	28.60 **	-3.63	5.74	1.30	1.30	3.80	3.80
NDBT-13 x K. SONA	20.72 **	47.85 **	34.94**	24.44**	0.00	16.88 **	4.92	16.88 **
NDBT-13 x NDBT-12	5.36	29.03 **	16.37*	7.31	-7.04 **	8.66 **	-4.17	6.75 *
NDBT-13 x PDM	-0.61	21.72 **	5.00	5.00	0.00	16.88 **	5.30 *	17.30 **
NDBT-15 x K. SONA	-24.27 **	-5.38	-8.39	-8.98	6.45 *	14.29 **	10.59 **	10.13 **
NDBT-15 x NDBT-12	-12.05 **	9.89 *	-9.04	-9.63	3.23	10.82 **	8.47 **	8.02 **
NDBT-15 x PDM	7.49	34.30 **	8.52	8.52	3.23	10.82 **	8.02 **	8.02 **
NDBT-19 x K. SONA	-21.30 **	-3.87	-16.25*	-25.09**	-12.24 **	-6.93 *	-8.82 **	-8.44 **
NDBT-19 x NDBT-12	0.88	23.23 **	6.21	-5.00	-11.84 **	-6.49 *	-6.30 *	-5.91 *
NDBT-19 x PDM	-0.26	21.83 **	1.67	1.67	-9.80 **	-4.37	-8.40 **	-8.02 **
Significance +ve	5	24	4	4	4	11	7	7
Significance-ve	15	4	10	9	14	13	14	15
Range of heterosis	-36.57 to	-12.90 to	-45.53 to	-35.74 to	-18.60 to	-15.60 to	-21.63	-20.25 to
	41.08	47.85	49.13	24.44	9.38	16.88	to12.79	17.30

Table 1 contd...

STUDIES ON HETEROSIS FOR YIELD & ITS COMPONENTS OF BITTER GOURD

Table 1 contd...

Characters	Number of fruits per plant				Fruit yield per plant (kg)			
	Summer		Rainy		Summer		Rainy	
Hybrids	BP	SV	BP	SV	BP	SV	BP	SV
NDBT-1 x K. SONA	9.63 *	18.07**	9.79	-5.22	9.66 *	7.91	-4.72	-22.90 **
NDBT-1 x NDBT-12	-28.74 **	-23.26**	-41.51 **	-31.83 **	-31.30**	-32.38**	-52.71**	-45.03 **
NDBT-1 x PDM	-26.91 **	-21.29 **	-17.27 **	-17.27 **	-33.08**	-33.08**	-24.55**	-24.55 **
NDBT-2 x K. SONA	-4.01	-5.72	-4.85	-18.88 **	-4.32	-5.85	-3.63	-19.01 **
NDBT-2 x NDBT-12	-0.72	-1.97	-23.92 **	-11.33	1.15	-0.45	-25.33**	-13.20 *
NDBT-2 x PDM	-11.63 *	-11.63 *	8.99	8.99	-5.85	-5.85	14.66 *	14.66 *
NDBT-3 x K. SONA	-21.13 **	-22.54 **	-26.07 **	-37.77 **	-22.21**	-23.46**	-20.79**	-35.91 **
NDBT-3 x NDBT-12	-39.86 **	-40.61 **	-22.38 **	-9.53	-39.41**	-40.36**	-23.06 **	-10.57
NDBT-3 x PDM	3.40	3.40	6.12	6.12	3.31	3.31	7.59	7.59
NDBT-4 x K. SONA	7.83	5.90	-0.64	-16.37 **	10.24 *	8.48	-0.20	-19.25 **
NDBT-4 x NDBT-12	15.04 **	13.60 *	-11.73 *	2.88	13.31 **	11.53 *	-12.11 *	2.16
NDBT-4 x PDM	-11.00 *	-10.55 *	12.59 *	12.59 *	-15.94**	-16.12**	-1.61	-1.61
NDBT-5 x K. SONA	3.64	1.79	-16.90 **	-23.92 **	9.52 *	7.77	5.00	-15.03 *
NDBT-5 x NDBT-12	-5.80	-6.98	-21.60 **	-8.63	0.43	-1.15	-22.72 **	-10.17
NDBT-5 x PDM	-3.40	-3.40	-10.79	-10.79	-5.85	-5.85	-17.90 **	-17.90 **
NDBT-6 x K. SONA	12.86 **	23.08 **	-1.28	-16.55 **	3.83	8.24	-7.74	-25.34 **
NDBT-6 x NDBT-12	-13.22 **	-5.37	-37.35 **	-26.98 **	-2.70	1.43	-37.74 **	-27.62 **
NDBT-6 x PDM	2.53	11.81 *	1.08	1.08	-3.60	0.49	-7.40	-7.40
NDBT-7 x K. SONA	23.50 **	21.29 **	15.85 *	2.52	9.69 *	16.93 **	-4.05	-5.24
NDBT-7 x NDBT-12	-0.36	-1.61	-29.63 **	-17.99 **	-5.07	1.20	-28.21 **	-16.55 **
NDBT-7 x PDM	-16.82 **	-16.82 **	-4.86	-4.86	-27.53**	-22.75**	-11.73 *	-11.73 *
NDBT-8 x K. SONA	0.63	14.49 **	-2.24	1.98	-11.28**	8.95 *	-11.77 *	-5.31
NDBT-8 x NDBT-12	-11.95 *	0.18	-19.14 **	-5.76	-29.45**	-13.36**	-34.37 **	-23.71 **
NDBT-8 x PDM	-16.98 **	-5.55	11.21 *	16.01 **	-17.40**	1.43	14.59 **	22.99 **
NDBT-10 x K. SONA	-0.67	32.20 **	-9.13	1.98	-2.16	27.73 **	-16.54 **	-11.31
NDBT-10 x NDBT-12	-21.51 **	4.47	-32.25 **	-21.04 **	-11.33**	15.75 **	-26.41 **	-14.45 *
NDBT-10 x PDM	-23.79 **	1.43	12.66 *	26.44 **	-21.40**	2.61	24.20 **	31.98 **
NDBT-13 x K. SONA	7.10	5.19	-24.03 **	-8.45	14.51 **	22.33 **	-23.54 **	6.03
NDBT-13 x NDBT-12	32.43 **	30.77 **	-5.07	14.39 *	35.23 **	44.47 **	-11.60 **	22.60 **
NDBT-13 x PDM	-3.40	-3.40	-0.60	19.78 **	7.54	14.89 **	1.75	41.10 **
NDBT-15 x K. SONA	-8.80	1.97	-20.57 **	-4.86	-0.39	19.75**	-13.01 **	5.17
NDBT-15 x NDBT-12	-11.36 *	-0.89	6.91	28.06 **	-13.67**	3.78	13.99 **	37.82 **
NDBT-15 x PDM	-21.92 **	-12.70 *	-17.12 **	-0.72	-19.22**	-2.89	-8.95	10.08
NDBT-19 x K. SONA	17.86 **	23.97 **	-1.91	20.32 **	4.35	18.34 **	-8.41	12.03 *
NDBT-19 x NDBT-12	9.69	15.38 **	2.05	25.18 **	-2.69	10.35 *	0.15	22.50 **
NDBT-19 x PDM	23.47 **	29.87 **	11.88 *	37.23 **	9.32 *	23.97 **	3.01	25.99 **
Significance +ve	7	11	5	9	7	12	4	9
Significance-ve	14	8	14	10	11	7	18	15
Range of heterosis	-39.86 to 32.43	-40.61 to 32.20	-41.51 to 15.85	-37.77 to 37.23	-39.41 to 35.23	-40.36 to 44.47	-52.71 to 24.20	45.03 to 41.10

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Characters	Vine length(m)			
	Summer		Rainy	
Hybrids	BP	SV	BP	SV
NDBT-1 x K. SONA	-0.18	-9.00	-7.09 *	-0.91
NDBT-1 x NDBT-12	-9.01	-12.44*	-9.99**	-3.65
NDBT-1 x PDM	-24.55**	-24.55**	-13.30 **	-13.30**
NDBT-2 x K. SONA	-7.31	-10.80	-11.37**	-5.48
NDBT-2 x NDBT-12	-17.01**	-20.13**	3.78	11.08**
NDBT-2 x PDM	3.93	3.93	17.53**	21.51**
NDBT-3 x K. SONA	-32.57**	-13.26*	-21.01**	7.82*
NDBT-3 x NDBT-12	-19.85**	3.11	-11.46**	20.86**
NDBT-3 x PDM	-10.81*	14.73*	-10.12**	22.69**
NDBT-4 x K. SONA	-0.90	-9.66	-3.18	3.26
NDBT-4 x NDBT-12	19.22**	14.73*	14.62**	22.69**
NDBT-4 x PDM	-1.80	-2.00	3.11	7.95*
NDBT-5 x K. SONA	5.82	-1.80	0.00	7.17
NDBT-5 x NDBT-12	-2.04	-5.73	-3.77	3.13
NDBT-5 x PDM	9.66	9.66	5.96	13.56**
NDBT-6 x K. SONA	3.95	-5.24	-4.65	1.69
NDBT-6 x NDBT-12	-0.68	-4.42	-4.38	2.35
NDBT-6 x PDM	-19.15**	-19.15**	-15.08**	-10.43**
NDBT-7 x K. SONA	12.27*	27.33**	8.56**	27.38**
NDBT-7 x NDBT-12	1.73	15.38**	-0.67	16.56**
NDBT-7 x PDM	-24.96**	-14.89*	-18.78**	-4.69
NDBT-8 x K. SONA	-8.98	-17.02**	-10.88**	-4.95
NDBT-8 x NDBT-12	-4.93	-8.51	-3.41	3.39
NDBT-8 x PDM	51.39**	51.39**	50.20**	50.20**
NDBT-10 x K. SONA	57.48**	51.55**	16.32**	51.50**
NDBT-10 x NDBT-12	38.44**	33.22**	7.31*	39.77**
NDBT-10 x PDM	44.03**	44.03**	5.51	37.42**
NDBT-13 x K. SONA	3.37	45.66**	8.21**	40.94**
NDBT-13 x NDBT-12	-2.90	36.82**	6.01*	38.07**
NDBT-13 x PDM	12.66**	58.76**	17.92**	53.59**
NDBT-15 x K. SONA	-1.20	-6.06	-5.99	0.26
NDBT-15 x NDBT-12	-11.90	-15.22*	-7.67*	-1.17
NDBT-15 x PDM	12.60*	12.60*	28.42**	28.42**
NDBT-19 x K. SONA	10.36*	60.39**	26.23**	64.41**
NDBT-19 x NDBT-12	10.92**	61.21**	23.52**	60.89**
NDBT-19 x PDM	-1.01	43.86**	6.91*	39.24**
Significance +ve	10	15	13	21
Significance-ve	7	8	11	2
Range of heterosis	-32.57 to	-24.55 to	-21.01 to	-13.30 to
	57.48	61.21	50.20	64.41

* and ** indicate significance of values at P=0.05 and 0.01, respectively

degree of standard heterosis for in cross combinations NDBT-7 x Kalyanpur Sona during summer and for rainy season NDBT-13 x PDM. The heterosis over better parent and standard variety for days to anthesis of first pistillate flower among the crosses revealed that fourteen crosses over better parent and eleven crosses over standard variety in summer season and fifteen crosses over better parent and one cross over standard variety showed negative and significant heterosis, high degree of standard heterosis was observed in NDBT-7 x Kalyanpur Sona during summer season and NDBT-2 x Pusa Do Mousami during rainy season for days to anthesis of first pistillate flower. For days to first fruit harvest heterosis over better parent and standard variety ten crosses over better parent and sixteen crosses over standard variety in summer season and twelve crosses over better parent and none of the crosses over standard variety in rainy season showed negative and significant heterosis. The highest standard heterosis was observed in NDBT-7 x Kalyanpur Sona showed in summer season. Similar findings were reported by Ram *et al.* (1997), Sundaram (2007) and Jadhav *et al.* (2009). For fruit length heterosis three crosses over better parent and seven crosses over standard variety in summer season and four crosses over better parent and fifteen crosses over standard variety in rainy season showed positive and significant heterosis and high at degree of standard heterosis was observed in NDBT-5 x Kalyanpur Sona during summer season while as NDBT-3 x Pusa Do Mousami showed it during rainy season. For fruit diameter five crosses over better parent and twenty-four crosses over standard variety during summer season and four crosses over better parent and standard variety showed positive and significant heterosis and the highest degrees of standard heterosis was observed for NDBT-13 x Kalyanpur Sona in both seasons. Present investigations are in close agreement with the finding of several workers (Sundaram, 2007 and Dey *et al.*, 2008). For average fruit weight four and eleven crosses in summer season and seven crosses in rainy season showed positive and significant heterosis over better parent and standard variety and the highest degree of standard heterosis was observed in NDBT-13 x Kalyanpur Sona in summer season, whereas NDBT-13 x Pusa Do Mousami showed highest heterosis in both the seasons. Heterosis for this trait has been reported by Singh *et al.* (2001) and Sundaram (2007). For number of fruits per plant heterosis was shown by seven and eleven crosses in summer season and five and nine crosses in rainy season. The highest standard heterosis for number of fruits per plant was recorded in NDBT-10 x K. Sona and NDBT-19 x PDM during summer and rainy seasons, respectively. For fruit yield per plant and 7 and 12 crosses in summer season and four and nine crosses-in rainy season showed positive and significant heterosis over better parent and standard variety (Pusa Do Mousami), respectively. Considering standard heterosis for fruit yield per plant, most promising hybrids were NDBT-13 x NDBT-12 (44.47), NDBT-

10 x Kalyanpur Sona (27.73), NDBT-19 x Pusa Do Mousami (23.97), NDBT-13 x Kalyanpur Sona (22.33) and NDBT-15 x Kalyanpur Sona (19.75) in summer season and NDBT-13 x Pusa Do Mousami (41.10), NDBT-15 x NDBT-12 (37.82), NDBT-10 x Pusa Do Mousami (31.98), NDBT-19 x PDM (25.99), NDBT-8 x Pusa Do Mousami (22.99), NDBT-13 x NDBT-12 and NDBT-19 x NDBT-12 in rainy season. Increased yield due to increased number of fruits per plant and fruit yield per plant in heterotic hybrids in bitter gourd observed in the present investigation is in conformity with the findings of Sundaram (2008), Maurya *et al.* (2009) and Jadhav *et al.* (2009). For vine length ten and fifteen crosses showed positive and significant heterosis over better parent and standard parent, respectively in summer season, whereas thirteen and twenty one crosses showed positive and significant heterosis over better parent and standard variety, respectively in rainy season. The highest standard heterosis was recorded in cross NDBT-19 x NDBT-12 (61.21) in summer and NDBT-1 x Kalyanpur Sona (64.41) in rainy season. Present investigations are in close agreement with the findings of several workers *viz.*, Dey *et al.* (2008), Yadav *et al.* (2009) and Hedau and Sirohi (2004) in ridge gourd.

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