Journal of Wheat Research 1(1&2) : 38-43 (2007)

Heterosis studies in wheat (*Triticum aestivum* L. em. Thell)

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ABSTRACT

Forty five treatments (Nine parents and their 36 F1S) were grown in Randomized Complete Block Design with three replications during rabi 2006-2007. In general, the nature and magnitude of heterosis differed from character to character depending upon the cross combinations. The results indicated that NW 1012 x Raj 3765 is only common cross which had high mean performance, heterobeltiosis and standard heterosis for grain yield per plant. In respect to common crosses having high heterobeltiosis and mean performance NW 1012 X HP 1731 and NW 1014 X Raj 3765 were also sorted out good for grain yield per plant. Crosses which showed significant desirable standard heterosis and mean performance were NW 1012 x KRL-19 and NW 1014 X PBW 154 for grain yield per plant. Harvest index and number of tillers per plant appeared as most important component associated with manifestation of heterosis for grain yield.

Key words: Bread wheat, heterobeltiosis, standard heterosis and segregates

Bread wheat, due to its versatile nature, is widely cultivated under different agro-climatic condition. In India, wheat is the second important food crop after rice. Among cereals, India ranks first in the world both in area (215.61 m. ha) and production of 628.1 m tones (Anonymous 2006). This crop offers sizable opportunities of a quantum jump by accelerating its yield potential through genetics manipulation. These gains can be realized by utililizing enormous magnitude of genetic variability available In the crop.

The present study on diallel analysis in bread wheat was undertaken with the objective of identification of parental lines and hybrids of superior genetic worth for further exploitation in breeding programme. Of course, heterosis is contraction of the frase "stimulus of heteriozygosis" and designates the increased growth or other augmented action resulting from crossing. The extent of heterosis manifested, gives an idea of genetic diversity of the parental lines. In bread wheat a number of workers have reported varying extent of heterosis for yield and its contributing traits. Though exploitation of heterosis in wheat has been limited due to its autogamous nature. In present study, the aims of breeder is to sort out better parents and their significant and superior F1s for commercial seed production.

MATERIALS AND METHODS

The experimental materials for present investigation consisted of 9 diverse strains of bread wheat, namely, NW 1012, NW 1014, UP 2338, UP 2475, HP 1731, HP 1744, PBW 154, Raj 3765 and KRL-19. These varieties strains were crossed in all possible combinations excluding reciprocals in diallel fashion during rabi 2005-2006. The resulting 36 F1s along with parents were grown in Randomized Complete Block Design with three replications during rabi 2006-2007 under reclaimed fertile soils at Main Experiment Station farm of Narendra Deva University of Agriculture and Technology, Kumjarganj, Faizabad, U. P. Each treatment (Parents as well as F1S) were planted in row length of 2.5 meter. The inter and intra row spacings were 23 cm and 5 cm, respectively. All the recommended package of practices were adopted for growing a good crop. The observations were recorded on plant height (cm), tillers per plant, days to maturity, spike length (cm), grain per spike, harvest index (%) and grain yield per plant (g) on five randomly selected plants from each plot. The heterosis was calculated (in per cent) as increase or decrease over the better parent and standard (check) variety.

RESULTS AND DISCUSSION

The estimates of heterosis were calculated as per cent of increase or decrease over better parent as well as standard variety for all the seven characters are presented in Table-1. In the present study, high manifestation of heterosis for grain yield was observed as evidenced by seventeen crosses over better parent and twenty one crosses over standard variety showed positive and significant heterosis. A perusal of Table 1 and 2, revealed that heterosis in grain yield was not proportional to the heterosis observed for yield components. In majority of cases, heterosis in one or two components registered heterosis in grain yield. The top fourteen crosses showing heterobeltiosis for grain yield, were also found to register significant positive heterobeltiosis for harvest index and number of tillers per plant. Obviously, harvest index, number of grains per spike and number of tillers per plant appear as most important components associated with manifestation of heterosis for grain yield. This confirms the view that heterosis for yield reflects through heterosis in individual components. These observations correlate with the findings of Mani *et al.* (1977). Abdel *et al.* (1996), Kumar *et al.* (1996), Jitendra and Sinha (2004), Kumar *et al.* (2005).

Besides yield, considerable heterosis has been observed for other characters also, but its degree varied considerable depending upon the characters. The three crosses viz., HP 1731 x PBW 154, Raj 3765 x KR L19 and HP 1744 x KRL 19 showed heterosis over standard variety in desirably direction for plant height whereas, HP 1731 x PBW 154, HP 1744 x Raj 3765 and HP 1731 x Raj 3765 showed negatively significant heterobeltiosis. The three crosses, namely, NW 1014 x UP 2338, NW 1014 x HP 1731 and UP 2338 x PBW 154 showed significant heterobeltiosis for number of tillers per plant. The three crosses, namely, UP 2338 x HP 1744, NW 1012 x UP 2425 and NW 1012 x KRL 19 showed significant negative heterobeltiosis for days to maturity. The three crosses viz., NW 1012 x HP 1744, UP 2425 x HP 1744 and UP 2338 x HP 1744 showed significant heterosis over better parent for spike length. The three crosses showed significant better parent for heterosis, number of grains per spike were, NW 1014 x UP 2338, NW 1012 x KRL 19 and UP 2338 x Raj 3765. The five best crosses, namely, NW 1014 x Raj 3765, NW 1012 x KRL 19, HP 1731 x KRL 19, UP 2338 x UP 2425 and NW 1012 x UP 2338 showed significant better parent for harvest index. The five best crosses viz., NW 1012 x Raj 3765, NW 1012 x HP 1731, NW 1014 x Raj 3765, NW 1012 x UP 2338 and NW 1014 x UP 2338 showed significant heterobeltiosis for grain yield per plant.

Liu and Li (1994) reported that the heterosis for grain weight was mainly determined by the nuclear genotypes. Although the seeds set on most A-lines were shriveled and those set on the F1 hybrids were not shriveled. Most hybrids displayed clear heterosis over the mid parental (MP) value for these characters. Grain weight heterosis was not significantly related to the MP value, indicating that grain weight heterosis will not decrease with an increase in the MP value.

Like wise Singh *et al.* (2004) observed that the crosses showing heterosis for grain yield were not heterotic for all the characters. Heterosis for grain yield per spike followed by tillers per plant and 1000-grain weight was independently associated with heterosis for grain yield in early and normal plantings. However, heterosis for grain yield per spike, dwarf plant height and tillers per plant contributed, maximum towards yield heterosis. The study reveals good scope for commercial exploitation of heterosis and isolation of pure lines among the progenies of heterotic F1s for improvement of yield levels in bread wheat.

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Table 1 Extent of heterosis over better parent and standard variety for 11 characters in 36 crosses in wheat

S. N.	Cross combination	Plant height (cm)		No. of tillers / plant		Days to maturity		Spike length (cm)		No. of grains/ spike		H.I. (%)		Grain yield/ plant (g)	
		S.V.	B.P.	S.V.	B.P.	S.V.	B.P.	S.V.	B.P.	S.V.	B.P.	S.V.	B.P.	S.V.	B.P.
1.	NW 1012 x NW 1014	15.05**	0.39	50.80**	48.35**	-4.73**	0.62	-6.93**	8.61**	24.80**	12.87**	0.54*	-2.12*	4.97	10.60
2.	NW 1012 x UP 2338	13.08**	12.03**	76.01**	57.40**	-1.04*	4.29**	-14.98**	-5.53**	26.62**	18.36**	0.82**	0.54*	9.45*	10.73**
3.	NW 1012 xUP 2425	12.39**	17.65**	63.41**	54.22**	-10.74**	-16.34**	-21.04**	-3.32*	17.99**	13.08**	-0.54	-3.43**	16.79**	21.65*
4.	NW 1012 x HP 1744	6.15**	7.39**	58.41**	11.95	-5.60*	-13.87**	-14.02	3.06	27.58**	10.84**	0.54	-2.89*	14.12**	40.00**
5.	NW 1012 x HP 1731	4.36*	1.65	85.44**	89.14**	-1.51*	0.14	-10.94**	-4.02*	-0.20	-18.56**	2.17**	-0.27	12.67**	9.42
6.	NW 1012 x PBW 154	9.40**	3.44*	70.36**	64.98**	4.81**	2.05*	-14.84**	8.13**	13.30**	-8.04*	0.27	11.82**	17.58**	11.82**
7.	NW 1012 x Raj 3765	5.76**	-0.27	76.23**	75.01**	-3.21**	-5.88**	-5.84*	35.83**	30.32**	30.34**	1.09*	-2.11*	5.58*	-0.80
8.	NW 1012 x KRL 19	-4.21**	7.30**	45.46**	29.13**	8.00**	10.66**	-11.50**	-2.37*	33.23**	16.77**	-0.27	-2.91**	9.42*	-1.71
9.	NW 1014 x UP 2328	1.11*	14.87**	94.66**	76.95**	11.51**	11.27**	-3.08*	-7.71	13.77**	17.59**	0.79	3.25**	21.26**	16.43**
10	NW 1014 x UP 2425	-5.01**	13.95**	98.80**	90.73**	-4.05**	-14.85**	9.77**	15.18**	8.30*	14.76**	0.00	0.26	14.69**	13.38**
11.	NW 1014 x HP 1744	-4.65**	10.55**	120.91**	58.69**	2.29	-11.64**	11.29**	14.31**	0.48	-3.48	-0.26	-1.05*	13.15**	31.75**
12.	NW 1014 x HP 1731	-4.26**	6.88**	93.67**	100.80**	-2.71*	-6.35**	-0.69	-8.28**	15.75**	4.45*	-2.12**	-1.86	14.75**	5.77**
13.	NW 1014 x PBW 154	-4.64**	-3.34*	108.64**	105.39**	7.38**	-1.02	4.56*	13.77**	28.14**	15.00**	-2.91**	11.21**	17.82**	6.34

14.	NW 1014 x Raj 3765	-5.45**	2.17**	41.56**	42.90**	-0.45	-8.35**	10.84**	37.03**	7.19**	18.54**	-1.59*	-2.11*	8.88*	-2.90
15.	NW 1014 x KRL 19	-10.36**	15.09**	40.57**	26.85**	10.51**	7.21*	1.44	-4.10*	3.01*	-0.17	-1.59*	-1.59*	17.82**	0.44
16.	UP 2338 x UP 2425	0.21	5.88**	40.42**	48.20**	9..98**	-2.19	3.47*	14.01**	9.10**	11.85**	0.00	-2.64**	16.49**	19.95**
17.	UP 2338 x HP 1744	-2.21	-0.15	58.96**	25.61**	-0.25	-13.64**	6.22**	14.58**	20.46**	11.96**	-0.54*	-3.67**	11.16*	34.80**
						10.47**	6.57*	-1.16*	-4.13*	1.93	-11.01*				
18.	UP 2338 x HP 1731	-1.03	-2.70	47.03**	67.69**	0.54*	-1.59*	7.30*	3.0	0.00	-7.61*	-2.43*	11.49**	-8.14*	-20.24**
19.	UP 2338 x PBW 154	2.20*	-2.46*	76.64**	91.29**	1.08*	13.03**	20.11**	12.91**	10.43**	9.27**	-13.98**	11.68**	-7.11*	-0.61
20.	UP 2338 x Raj 3765	5.35**	0.27	48.04**	64.29**	2.98*	0.00	20.91**	12.30**	4.80*	1.92	-10.72**	-11.37*	-0.56	-6.76*
21.	UP 2338 x KRL 19	-0.93	12.03**	40.54**	39.51**	1.36*	-1.06*	8.46*	-3.70	-8.33**	-10.76**	-1.63	-3.70*	9.34**	0.88
22.	UP 2425 x HP 1744	8.07*	4.45*	84.82**	38.39**	-0.53	-1.05	14.96**	35.39**	-12.67**	-5.26*	7.21*	-5.63**	21.32**	3.31
23.	UP 2425 x HP 1731	0.75*	-6.25**	71.78**	85.64**	-1.06*	-0.53	19.57**	11.48*	-0.12	3.76	-6.30**	-2.83*	21.32**	2.75
24.	UP 2425 x PBW 154	5.43	4.77*	85.73**	90.57**	-1.32	13.33**	15.47*	5.42	-9.97*	-6.59*	8.50**	27.83**	7.05*	11.72**
25.	UP 2425 x Raj 3765	4.60	-5.77**	33.22**	40.18**	-1.58*	-1.84*	24.18**	12.02*	-13.85**	-5.82**	9.74**	-1.13*	16.99**	6.99**
26.	UP 2425 x KRL 19	3.17*	10.41**	51.44**	42.44**	-1.58*	-1.32*	22.85**	5.93*	-9.29**	1.09	-0.04	-10.12**	12.99**	6.13**

27.	HP 1744 x HP 1731	5.82**	1.89	11.92*	61.52**	-2.36**	-1.33**	31.23**	3.88	-32.57**	-28.04**	-1.97*	3.85*	-27.10**	-31.89**
28.	HP 1744 x PBW 154	-0.40	-6.91**	23.34**	69.02**	-0.26	15.15**	34.83**	4.52*	-19.89**	-14.63**	-2.12*	17.80**	-16.71**	-4.11*
29.	HP 1744 x Raj 3765	-7.98**	-14.23**	11.30*	56.41**	-3.15**	-2.89*	29.70**	-0.65	-16.56**	-6.30**	2.51**	-5.65**	-9.95**	-9.15**
30.	HP 1744 x KRL 19	-12.35**	-2.95	16.52**	46.37**	-1.05*	-0.26	41.49**	3.59	-16.68**	-20.21**	-12.18**	3.46	-20.04**	-20.47**
31.	HP 1731 x PBW 154	-14.95**	-17.44**	76.06**	67.17**	-2.65*	11.21**	14.33**	11.96**	-2.07	-6.34**	2.37	37.02**	1.63	24.55**
32.	HP 1731 x Raj 3765	-8.79**	-11.70**	70.92**	66.42**	-0.53	-1.32*	8.89**	5.35*	-2.36*	-1.60*	-20.05**	-18.17**	-32.28**	-27.27**
33	HP 1731 x KRL 19	-11.85**	1.38	69.15**	47.22**	-1.33**	-1.59*	10.65**	2.34	-22.54**	-22.64**	12.87**	28.24**	-31.79**	-15.95**
34.	PBW 154 x Raj 3765	-4.36*	-4.62*	50.59**	54.42**	12.42**	-2.37**	13.60**	12.24**	-8.26*	3.46*	-4.98*	-17.45**	-35.89*	-30.77**
35.	PBW 154 x KRL 19	-7.26*	9.88**	74.03**	59.53**	10.91**	-3.17**	10.43**	4.30	-14.32**	-9.72**	8.53**	-17.00**	-1.09	-13.32*
36.	Raj 3765 x KRL 19	-12.77**	3.63*	85.71**	66.01**	-3.42**	-2.91*	4.10	-0.49						

Table 2 The best parents, best general combiners, best specific combiners and F_1 with highest heterosis for each characters

Characters	Best parent based on *per se* performance	Best general combiner	Best specific combiner	F_1s showing high heterosis	
				B.P.	S.V.
Plant height (cm)	KRL 19 HP 1744 NW 1012	KRL 19 (-6.48) HP 1731 (-2.42) HP 1744 (-2.07)	HP 1731 x PBW 154 HP 1744 x Raj 3765 HP 1744 x KRL 19	HP 1731 x PBW 154 HP 1744 x Raj 3765 HP 1731 x Raj 3765	HP 1731 x PBW 154 Raj 3765 x KRL 19 HP 1744 x KRL 19
No of tillers/plant	HP 1744 KRL 19 UP 2338	HP 1744 (0.66) NW 1014 (0.52) KRL 19 (0.50)	NW 1014 x HP 1744 Raj 3765 x KRL 19 NW 1012 x PBW 154	NW 1014 x UP 2338 NW 1014 x HP 1731 UP 2338 x PBW 154	NW 1014 x HP 1744 NW 1014 x PBW 154 NW 1014 x UP 2425

Days to heading	KRL 19 UP 2338 NW 1012	NW 1014 (-1.38) KRL 19 (-0.77) HP 1731 (-0.56)	HP 1744 x Raj 3765 HP 1731 x Raj 3765 UP 2338 x HP 1744	NW 1014 x PBW 154 HP 1731 x Raj 3765 UP 2338 x HP 1744	HP 1744 x Raj 3765 HP 1731 x Raj 3765 HP 1731 x PBW 154
Days to maturity	HP 1744 NW 1012 UP 2338	PBW 154 (-2.82) NW 1012 (-0.70) UP 2338 (-0.12)	UP 2425 x PBW 154 UP 2338 x HP 1744 HP 1744 x Raj 3765	UP 2338 x HP 1744 NW 1012 x UP 2425 NW 1012 x KRL 19	Raj 3765 x KRL 19 HP 1744 x Raj 3765 NW 1014 x PBW 154
Spike length (cm)	KRL 19 RAJ 3765 PBW 154	PBW 154 (0.36) KRL 19 (0.29) Raj 3765 (0.12)	NW 1012 x HP 1744 UP 2338 x Raj 3765 NW 10144 x UP 2338	NW 1012 x HP 1744 UP 2425 x HP 1744 UP 2338 x HP 1744	HP 1744 x KRL 19 HP 1744 x PBW 154 HP 1744 x HP 1731
No of spikelets/ spike	HP 1744 UP 2425 RAJ 3765	UP 2338 (0.52) UP 2425 (0.38) HP 1744 (0.09)	NW 1012 x PBW 154 UP 2338 x Raj 3765 NW 1014 x KRL 19	NW 1014 x KRL 19 UP 2338 x KRL 19 NW 1012 KRL 19	UP 2338 x Raj 3765 UP 2338 x UP 2425 UP 2338 x KRL 19
No of grains/spike	HP 1744 UP 2425 RAJ 3765	UP 2338 (2.04) NW 1012 (0.94) UP 2425 (0.79)	UP 2338 x Raj 3765 UP 2425 x PBW 154 NW 1012 x KRL 19	NW 1014 x UP 2338 NW 1012 x KRL 19 UP 2338 x Raj 3765	NW 1014 x UP 2338 NW 1014 x KRL 19 UP 2338 x HP 1731
Biological yield/plant (g)	HP 1744 UP 2338 KRL 19	NW 1014 (4.25) NW 1012 (2.03) UP 2425 (1.75)	NW 1014 x PBW 154 HP 1744 x HP 1731 HP 1731 x Raj 3765	NW 1014 x PBW 154 NW 1014 x Raj 3765 HP 1731 x Raj 3765	NW 1014 x PBW 154 NW 1014 x Raj 3765 NW 1014 x KRL 19
1000 grain weight (g)	NW 1012 HP 1731 KRL 19	NW 1012 (1.69) NW 1014 (1.43) UP 2338 (0.48)	HP 1731 x Raj 3765 UP 2338 x HP 1744 PBW 154 x Raj 3765	NW 1014 x Raj 3765 HP 1731 x Raj 3765 NW 1012 x Raj 3765	PBW 154 x Raj 3765 NW 1014 x HP 1744 NW 1014 x Raj 3765
Harvest index (%)	HP 1731 PBW 154 RAJ 3765	HP 1731 (1.45) PBW 154 (0.60) UP 2425 (0.15)	UP 2425 x PBW 154 NW 1014 x UP 2338 NW 1012 x Raj 3765	NW 1012 x Raj 3765 NW 1012 x KRL 19 HP 1731 x KRL 19	UP 2425 x PBW 154 NW 1012 x KRL 19 NW 1012 x Raj 3765
Grain yield/plant (g)	PBW 154 HP 1731 HP 1744	NW 1014 (1.78) Raj 3765 (1.44) NW 1012 (1.07)	NW 1014 x PBW 154 NW 1012 x KRL 19 NW 1012 x Raj 3765	NW 1012 x Raj 3765 NW 1012 x HP 1731 NW 1014 x Raj 3765	NW 1012 x KRL 19 NW 1012 x Raj 3765 NW 1014 x PBW 154