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## Estimation and Utilization of Heterosis and Heterobeltosis in Some Breadwheat Crosses Derived from Diverse Germplasm

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**Abstract:** Wheat is the staple food of the people of Pakistan grown on an area of about 8.4 million hectares annually (MINFAL 97-98). The wheat production is affected due to the varying degree of different biotic and abiotic stresses in the country. The success of a breeding programme aims at the development of high yielding wheat varieties which are developed by making recombinants for the traits of economic importance. Forty bread-wheat cross combinations were attempted during the year 1997-98 to determine the heterotic and heterobeltotic effects of the recombinants in F1 generation. The parental material also included local types from highland and dryland areas to utilize the useful diversity in the breeding programme. Maximum degree of heterosis (increase over mid parents) was manifested by the cross number 21 (C-273/WCB BO) for all the trials studied. The same cross showed the maximum heterobeltosis (increase over better parents) for plant height, spike length, # of spikelets per spike and grain weight. Another cross (Local white/sannine) also showed the same effects for all the trials. There was a varying degree of heterosis in different crosses showing that different combinations can be exploited for the manifestation of heterosis and suggest the choice of selection of desirable parents for the development of better recombinants.

**Key words:** Bread wheat, heterosis, heterobeltosis, mid parents, better parents, figeneration, local types

### Introduction

Wheat is the staple food of the people of Pakistan and grown on an area of about 8.4 million hectares annually. The wheat production in the country varies depending upon different biotic and abiotic stresses which drastically reduce the grain yield. The success of a plant breeding program really aims at the development of high yielding and stress resistant wheat varieties for the target environments. The choice of parental material used in the hybridization scheme does contribute significantly for the development of a suitable genotype. The parents chosen which are genetically superior and diverse in the traits of interest are utilized for varietal development or exploitation of the heterosis (Khan *et al.*, 1995a). There are certain reports available showing the heterotic effects of F1 hybrids over mid-parents or better parents. El-Haddad *et al.* (1996), Khan *et al.* (1995b) and Khaliq *et al.* (1985) observed significant heterosis and heterobeltosis in 1000 grain weight, plant height and other physiological traits in some of the F1 wheat hybrids made through simple and reciprocal crosses and suggested the utilization and potential of the crosses.

Deshpande and Nayeem (1999), Liu *et al.* (1999) and Khan and Khan (1996) estimated heterosis for yield and yield components in some wheat crosses involving different wheat cultivars. High percentage of heterosis for 1000 grain weight, number grains per spike and plant height was observed in the crosses studied. Parsad *et al.* (1998) and Vitkare and Atale (1991) studied the different F1 hybrids resulting from crosses made in diallel and half diallel fashion and investigated the extent of heterosis and heterobeltosis in traits of economic importance. Maximum better parent heterosis was in grain yield per plant and biological yield per plant.

### Materials and Methods

Forty bread wheat crosses were attempted in the field during the crop year 1996-97 at the National Agricultural Research Centre wheat experimental area. The FO seed of the crosses alongwith the parents were planted during the year 1997-98 (Anonymous, 1997). Diverse parental sources were used in the hybridization scheme keeping in view the main priority areas of wheat research in the country. Some of the parents involved, were local wheata/landraces grown in the high elevation areas of Pakistan while others included improved

types and different groups constituting the crossing block. One row of five meter length of each of the cross in the middle and parents on both sides of the cross were hand dibbled. All the other cultural practices were kept uniform on the experiment. Data were recorded on five random plants for plant height, number of spikelets per spike, spike length and 500 grain weight in each cross and parent. The average of 5 plants were used to estimate the heterosis (increase over mid parent) and heterobeltosis (increase over better parent) with the following equations.

$$\text{Heterosis (\%)} = \frac{F1 - MP}{MP} \times 100$$

$$\text{Heterobeltosis (\%)} = \frac{F1 - BP}{BP} \times 100$$

where:

MP = Mid parent

BP = Better parent

### Results and Discussion

The details of the crosses attempted and mid parental values are given in Table 1. The means of different traits of the better parents are presented in Table 2. The mean performance of the F1's regarding plant height, spike length, number of spikelets per spike and 500 grain weight is presented in Table 3. Plant height ranged from 59-122 cm (mid-parent) while range for better parent was from 95-136.4 cm. The range for hybrids was (78.5-137.8 cm) (Table 3) showing some heterosis and heterobeltosis effects respectively (Table 4, 5).

Cross number 21 (C 2731VVCB 80) manifested the maximum heterosis (108.5%) and 4.03% of heterobeltosis for plant height. The same cross had the maximum degree of heterosis (135.9%) for spike length; 128.92% for number of spikelets per spike and 115.87% for 500 grain weight (Table 4). The maximum heterobeltotic effects were also manifested by the same cross number 21 which showed the positive effects for all the traits studied. Another cross number 7 (local white/sannine) also showed a reasonable degree of heterosis and heterobeltotic effects for plant height, spike length, number of spikelets per spike and 500 grain weight. This cross was made between the two local wheats, one from the northern high elevation areas of Pakistan and the other from the Baluchistan area reflecting the greater magnitude of genetic diversity present in the two different wheat growing areas. There was a varying degree

Mujahid *et al.*: Bread, Wheat, Heterosis, Heterobeltosis, Mid parents, Better parents, F1 generation, Local types

Table 1: Means of the parents for plant height, spike length, Number of spikelets per spike and 500 grain weight

S.No.	Cross	HT	SPLN	SPLTS	500 GWT
1	KAMEREST/LOCAL WHITE	118.00	10.50	20.20	18.83
2	LOCAL ALIABAD/KAMERESTI	119.80	9.20	19.80	17.04
3	LOCAL ALIABAD/LOCAL WHITE	118.00	9.30	16.80	17.12
4	SANNINE/LOCAL WHITE	105.10	11.90	19.20	18.32
5	SANNINE/KAMERESTI	111.90	11.70	23.00	16.30
6	LOCAL WHITE/LOCAL ALIABAD	117.90	8.70	16.80	13.37
7	LOCAL WHITE/SANNINE	105.30	9.90	17.20	17.08
8	KAMERESTI/SANNINE	112.10	11.50	21.80	17.09
9	LOCAL WHITEMC8/2196-97)	110.00	9.80	19.60	15.54
10	LOCAL ALIABAD/SANNINE	121.00	10.20	19.20	11.94
11	KAMERESTI/LOCAL ALIABAD	122.00	11.50	22.40	13.09
12	LOCAL WHITE/KAMERESTI	105.00	10.30	18.80	15.54
13	C2731WC1381	109.50	9.40	17.60	19.30
14	PAK81MCB82	97.40	9.30	18.00	10.17
15	WC811WC1360	98.40	9.70	18.40	15.76
16	PARWAVWC1353	94.90	8.80	16.20	20.20
17	INDALABMC850	102.00	10.00	16.60	17.20
18	WC829/WC850	97.20	8.70	17.20	16.75
19	C591/WC865	108.90	8.40	15.80	16.30
20	C273/WC865	115.10	9.00	17.60	19.53
21	C2731WC880	59.60	3.90	8.30	10.55
22	C2711WC1365	101.00	9.00	18.20	15.45
23	WC8291WCB51	93.20	9.50	18.80	16.98
24	LYP73/SARIA892	107.50	9.00	18.20	25.13
25	C591/WC881	109.90	7.40	16.20	17.55
26	PAVON/WC848	97.90	8.90	18.60	16.92
27	WB21/41WC854	98.80	9.60	19.80	19.72
28	SARIA892PNC1354	105.60	9.10	18.80	20.20
29	INDALAB/WC1351	86.20	10.40	18.20	18.02
30	C2731WC866	119.30	8.60	16.80	22.43
31	NR74/WC..829	105.40	9.70	19.60	18.01
32	NF151/WCB27	95.90	9.60	18.20	20.92
33	SLITLJ813/WC825	95.20	9.50	18.40	17.44
34	NR331WC1355	96.10	10.40	20.00	14.92
35	INOALABMCB113	119.10	10.10	18.20	21.93
36	NR100/WCB47	109.00	8.40	17.80	20.23
37	NR50/WC1353	100.80	9.40	18.00	19.91
38	NR37/WCB60	94.40	10.80	18.80	18.84
39	CHAKWAL861WC823	103.90	10.40	18.00	20.91
40	NR61/WCB65	105.40	9.90	18.20	21.01
	MAXIMUM	122.00	11.90	23.00	25.13
	MINIMUM	69.60	3.90	8.30	10.17
	STD	11.51	1.31	2.22	3.05
	AVG	104.84	9.54	18.25	17.60
	HT :	Plant height (cm)	SPLN :	Spike length	
	SPLTS :	Number spikelets per spike	S000WT :	500 gain weight (g)	

Table 2: Range, mean and standard deviation of the 40 better Parents regarding plant height, spike length, number of spikelets per spike and 500 grain weight

S.No.	CROSS	HT	SPLN	SPLTS	500 GWT
1	KAMERESTI/LOCAL WHITE	122.40	10.60	20.60	18.89
2	LOCAL ALIABAD/KAMERESTI	127.00	10.60	23.80	19.53
3	LOCAL ALIABAD/LOCAL WHITE	133.20	10.60	17.40	19.23
4	SANNINE/LOCAL WHITE	107.40	12.00	19.40	21.20
5	SANNINE/KAMERESTI	118.40	12.20	23.00	17.11
6	LOCAL WHITE/LOCAL ALIABAD	131.80	8.80	17.80	14.77
7	LOCAL WHITE/SANNINE	105.60	10.20	17.40	20.53
8	KAMERESTI/SANNINE	115.80	11.60	24.60	19.41
9	LOCAL WHITE/WC1302(96-97)	117.20	10.60	21.00	17.41
10	LOCAL ALIABAD/SANNINE	130.80	11.60	19.40	13.41
11	KAMERESTI/LOCAL ALIABAD	127.40	13.20	25.40	17.80
12	LOCAL WHITE/KAMERESTI	105.80	10.40	19.00	17.31
13	C273/WCB81	124.00	10.20	18.20	19.79
14	PAK811WC1382	97.80	9.60	19.40	11.16
15	WCB1MC850	100.40	10.60	18.60	16.52
16	PARWA2/WC1353	96.40	9.60	17.00	20.59
17	INGALAB/WC1350	103.00	10.20	17.80	20.23
18	WC1329/WCB50	98.00	10.40	19.40	18.70
19	C591/WC1365	120.40	9.60	18.20	17.28
20	C273/WCB65	131.00	9.40	18.20	20.50
21	C273MCB80	119.20	7.80	16.80	21.31
22	C271/WCB65	114.40	9.00	18.20	15.57
23	WC1329/WC1351	99.40	9.80	19.00	17.35
24	LYP73/SARIA892	112.00	9.60	19.40	26.29
25	C591/WCB61	124.40	8.00	16.20	17.77
26	PAVON/WCB48	105.80	9.00	19.00	17.89
27	WB2#4/WCB54	100.00	9.80	20.20	20.95
28	SARIA892/WCB54	107.60	10.40	21.00	20.47
29	INCIALABANCB51	95.20	10.80	19.00	19.27
30	C273/WC666	123.20	9.00	17.80	22.88
31	NR74/WCB29	111.40	10.40	19.80	18.47
32	NR51fWC B27	96.80	9.80	18.20	21.02
33	SUTLE..186/WCB25	99.80	10.00	18.60	18.19
34	NR33MCB55	101.40	11.60	21.40	17.42
35	INOALAB/WCB113	136.40	10.80	19.00	25.77
36	NR100/WC1347	116.40	8.40	18.20	22.26
37	NR50/WC853	103.20	10.20	18.60	20.71
38	NR37/WC860	102.20	12.00	19.40	20.63
39	CHAKWAL8131WC823	104.80	12.60	19.40	22.52
40	NR61/WCB65	121.40	11.60	19.40	22.10
	MAXIMUM	138.40	13.20	25.40	26.29
	MINIMUM	95.20	7.80	16.20	11.16
	STD	12.00	1.19	1.98	2.87
	AVG	112.72	10.32	19.35	19.26
	HT :	Plant height (cm)	SPLN :	Spike length	
	SPLTS :	Number spikelets per spike	S000WT :	500 grain weight (g)	

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Table 3: Mean values of the Ft hybrids developed at NARC during 1997-98

S.No.	CROSS	HT	SPLN	SPLTS	500 GWT
1	KAMERESTI/LOCAL WHITE	127.60	10.60	20.20	15.05
2	LOCAL ALIABAD/KASAERESTI	96.40	9.60	17.80	21.05
3	LOCAL ALIABAD/LOCAL WHITE	111.00	11.80	19.80	18.05
4	SANNINE/LOCAL WHITE	78.50	7.00	14.00	18.67
5	SANNINE/KAMERESTI	111.80	10.00	18.60	20.00
6	LOCAL WHITE/LOCAL ALIADAD	137.80	10.60	19.00	24.00
7	LOCAL WHITE/SANNINE	121.80	13.20	20.20	22.00
13	KAMERESTI/SANNINE	105.20	11.00	20.20	21.05
9	LOCAL WHITE/WC9112(98-97)	128.00	8.50	18.00	18.00
10	LOCAL ALIMUID/SANNINE	106.00	11.00	19.00	21.00
11	KAMERESTI/LOCAL ALIABAD	105.00	12.00	23.00	14.05
12	LOCAL WHITE/KAMERESTI	92.67	10.00	17.67	17.05
13	C273/WC881	120.67	10.00	19.00	24.05
14	PAK61/141C882	97.60	10.40	19.80	20.05
15	WC81/WC850	93.20	9.00	18.60	21.00
16	PARWAZI/WCB53	96.80	10.40	18.60	24.00
17	I40ALAB/WC850	95.20	12.00	19.40	21.00
18	WC829/WC850	83.00	9.00	18.80	17.05
19	C591/WCB65	118.40	9.00	7.40	21.05
20	C273/WC965	124.80	9.40	18.60	21.05
21	C2731/WCE180	124.00	9.20	19.00	23.00
22	C271/WC865	111.40	8.20	17.80	23.00
23	Wa329/WC851	85.67	10.67	20.33	18.00
24	LYP73/SARIA892	111.40	9.60	19.40	23.05
25	0591/W0161	122.20	7.60	15.40	21.00
26	PAVONMC848	97.80	9.80	18.60	19.00
27	W02S4/WCE154	96.60	9.20	19.80	15.05
28	SARIA892/W0854	96.80	9.40	20.60	20.05
29	INOALARMC851 -	94.20	10.20	18.60	23.00
30	C273/WC866	133.50	11.00	18.00	21.00
31	1411741/WC829	104.60	9.00	17.40	18.00
32	NR51/WC927	96.60	10.20	18.20	21.00
33	SLITL.1861/WC1325	88.00	12.20	20.60	21.00
34	NR33/WC-1355	92.20	11.20	20.20	18.00
35	INOALABANC13113	125.40	9.00	16.20	25.00
36	NR1001/WCB47	111.40	10.40	21.00	20.05
37	NR50/WC853	105.00	10.00	19.00	13.00
38	NR37/WC960	91.60	10.00	19.00	20.05
39	CHAKWAL86/WC1323	97.00	10.33	16.33	20.05
40	NR61 MCE165	112.80	9.00	17.40	22.05
	MAXIMUM	137.80	13.20	23.00	25.00
	MINIMUM	78.50	7.00	14.00	13.00
	STD	14.61	1.24	1.59	2.75
	AVG	106.22	10.02	18.76	20.09

HT = Plant height icrrd SPLN: Spike length SPLTS: Number spikelets per spike 500 GWT: 500 grain weight (g)

Table 4: Manifestation of Heterosis (%) in 40 crosses of breed wheats for different traits developed during the year 1997-98

S.No.	CROSS	HT	SPLN	SPLTS	500 GWT
1	KAMERESTI/LOCAL WHITE	8.14	0.85	0.00	-20.27
2	LOCAL ALIABAD/KAMERESTI	-19.53	4.35	-10.10	23.52
3	LOCAL ALIABAD/LOCAL WHITE	-5.93	26.88	17.86	5.46
4	SANNINE/LOCAL WHITE	-25.31	-41.18	-27.08	1.92
5	SANNINE/KAMERESTI	-0.09	-14.53	-19.13	21.19
6	LOCAL WHITE/LOCAL ALIABAD	18.88	21.84	13.10	74.30
7	LOCAL WHITE/SANNINE	15.67	33.33	17.44	29.19
a	KAMERESTI/SANNINE	-6.16	-4.35	-7.34	23.16
9	LOCAL WHITE/WCBS2196-97)	16.36	-13.27	-8.16	18.03
10	LOCAL ALIABAD/SANNINE	-12.40	7.84	-1.04	75.91
11	KAMERESTI/LOCAL ALIABAD	-13.93	4.35	2.68	7.37
12	LOCAL WHITE/KAMERESTI	-11.75	-2.91	-6.03	10.37
13	C273I/WCB81	10.20	6.38	7.95	24.60
14	PAK81/WC8132	0.21	11.83	6.46	97.16
11	WC81/WC850	-5.28	-7.22	1.09	33.25
18	PARWAZI/WCBS3	2.00	18.18	14.81	18.80
17	INGALABANC850	-6.67	20.00	16.87	22.10
16	WC829/WCE150	-14.61	3.45	8.14	1.81
19	C591/WCI365	8.72	7.14	10.13	29.11
20	C273/WC1365	8.43	4.44	5.68	7.25
21	C273/WCB80	108.06	135.90	128.92	115.87
22	C271 /WCB66	10.30	-8.89	-2.20	48.58
23	WCB291/WC1351	-8.08	12.28	8.16	6.31
24	LYP73/SARIA892	3.63	6.67	6.59	-8.28
25	C591ANC13151	11.19	2.70	-4.94	19.65
26	PAVON/WC848	-0.10	10.11	0.00	12.32
27	W12.4/WC1354	-2.23	-4.17	0.00	-23.69
29	SARIA921/WC854	-9.28	3.30	9.57	-0.73
29	INCIALAB/WC1351	9.28	-1.92	2.20	27.63
30	C2731/WC8118	11.90	27.91	7.14	-6.57
31	NR74/WC1129	-0.76	-7.22	-11.22	-0.06
32	NR51ANCB27	0.73	6.25	0.00	0.39
33	SUTLEJ86/WC825	-7.56	28.42	11.96	20.38
34	NR33I/WCBSB	-4.06	7.69	1.00	20.63
35	INCIALAB/WC8113	5.29	-10.89	-10.99	15.27
36	NR100/WCB47	2.20	23.81	17.98	-0.91
37	NR501/WC1353	4.17	6.38	5.56	-34.89
30	NR37/WC1360	-2.97	-7.41	1.06	6.42
39	CHAKWAL801/WCE123	-8.84	-0.84	-9.26	-4.13
40	NR61/WC865	7.02	-9.09	-4.40	4.94
	MAXIMUM	108.05	135.90	128.92	115.87
	MINIMUM	-25.31	-41.18	-27.08	-34.69
	STD	19.55	24.83	22.21	29.40
	AVG	2.43	7.72	5.01	18.04

HT: Plant height (cm) SPLN: Spike length SPLTS: Number spikelets per spike 500 GWT: 500 grain weight (g)

