Research Note

HETEROSIS STUDIES IN WHEAT CROSSES

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ABSTRACT

A study was undertaken to estimate the heterotic and heterobeltiotic effects in wheat during the year 2002-03 at Wheat Research Institute, AARI, Faisalabad, Pakistan to identify combinations expressing high hybrid vigour. Fifteen F_1 single crosses were developed and planted alongwith their 8 parents. Data were recorded on grain yield, tillers per plant, grains per spike, 1000-grain weight and plant height. Highly significant differences were found among genotypes for hybrid vigour for all traits. Out of 15 crosses, four crosses showed significantly positive heterosis and three crosses exhibited significant positive heterobeltiosis for grain yield. Heterotic and heterobeltiotic effects on grain yield ranged from 1.43 to 52.01 percent and 5.00 to 48.19 percent, respectively. Maximum heterosis (52.01%) and heterbeltiosis (48.19%) for grain yield were expressed by cross Iqbal-2000 x Chenab-2000. For tillers per plant, heterosis and heterobeltiotic effects ranged from 2.33 to 21.22 and 1.53 to 5.78 percent, respectively. Ranges for grains per spike were 1.61 to 13.12 and 1.48 to 6.86 percent, respectively. Heterotic and heterobeltiotic effects ranged from 1.62 to 20.97 and 4.65 to 15.33 percent, respectively for 1000-grain weight. The parents Iqbal-2000, Chenab-2000, MH-97, and Crow's' could be utilized in hybrid wheat programme.

KEYWORDS: *Triticum aestivum;* crossbreeding; hybrid vigour; agronomic characters; Pakistan.

INTRODUCTION

The importance of wheat is increasing day by day due to increased human population pressure in the country. Hence, it is need of the day to boost per acre wheat yield which is subjected to continuous genetic improvement of wheat plant. Successful hybrid maize production has created sense of considerable interest among wheat breeders for utilization in hybrid wheat production. The presence of sufficient hybrid vigour is an important prerequisite for successful production of hybrid varieties. Previously, exploitation of heterotic effects for grain yield was largely attributed to cross-pollinated crops but Briggle (2) reported presence of heterosis in considerable quantity for grain yield components in various F_1 wheat crosses. It was revealed that heterosis for grain yield reached 60 percent while fair degree of heterosis was noted for number of grains per spike (14). However, heterosis was calculated for grain weight per plant (112%), number of spikes

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per plant (109%), 1000 grain weight (106%) and plant height (103%) from a study of F_1 hybrids in spring wheat (6).

The conclusions were made that all hybrids exhibited an average increase of 6.78, 35.81, 2.22, 22.85 and 31.16 percent over better parent for plant height, number of tillers per plant, number of grains per spike, 100-grain weight and yield per plant, respectively (10). While, Krishna and Ahmad (8) found higher mean heterosis for 1000-grain weight (14.6%) and grain yield (12.52%).

It has earlier been reported (13) that most of the hybrids showed negative heterosis for plant height over the tallest parent and maximum heterosis over the better parent, 141.7 and 18.9 percent for tillers per plant and grain yield per plant, respectively. Fida *et al.* (5) measured positive heterotic effects as 11.61, 61.90, 30.67 and 51.89 percent for plant height, tillers per plant, grains per spike and grain weight, respectively. Another study (12) made on grain yield per plant from seven cultivars and their 42 F_1 hybrids revealed that 12 crosses showed significant positive heterosis for grain yield per plant (77.15 to 160.43%). Heterotic effects were measured as 62.32, 51.19 and 40.35 percent over the better parental values for grain yield per plant, 1000-grain weight and grains per spike, respectively (7). Sufficient work was earlier performed for the estimation of heterosis but recent findings (15) have been obtained to evaluate heterosis and assess the prediction of amplified fragment length polymorphism (AFLP) based and agronomic traits based genetic distances (GD) from 15 F_1 crosses of durum wheat under stress conditions. It was found that some cross combinations showed significant mid parent heterosis for grain yield components (15). El-Sayed (4) studied 15 F_1 and F_2 crosses of durum wheat alongwith parents and indicated that means square for parents versus crosses as an indication for heterosis was significant for all traits.

The possible heterosis exploitation continues to be a critical question in hybrid wheat research. For this purpose, the present studies were undertaken to estimate the heterosis and heterobeltiosis effects in wheat.

MATERIALS AND METHODS

Fifteen F_1 single crosses were made at Wheat Research Institute, AARI, Faisalabad, Pakistan involving 18 bread wheat varieties during March. F_1 single crosses alongwith the parents were planted in the field during year 2002-03 in a randomized complete block design with three replications. Plots size of one row of 2 meters length while plant to plant and row to row distances were 10 and 30 cm, respectively. Recommended agronomic

practices were performed uniformly. At maturity ten guarded plants were selected at random from each plot and data were recorded for plant height, fertile tillers per plant, number of grains per spike, 1000-grain weight and grain yield per plant. The data were subjected to statistical analysis using the analysis of variance technique (16) to determine significant differences among genotypes for the traits.

The percent increase(+) or decrease (-) of F_1 over mid parent as well as over better parent was calculated to estimate possible heterotic effects for traits studied following Matzingar *et al.* (11). The 't' test was applied to determine significant difference of F_1 hybrid means from respective mid parent and better parent values using formulae as reported by Wynne *et al*. (17).

RESULTS AND DISCUSSION

Statistical analysis of variance revealed significant differences at 1 percent probability level among genotypes for all traits studied (Table-1).

Table 1. Analysis of variance for yield and other traits in wheat

		Means square values				
SOV	df	Grain yield/ plant	Tillers/ plant	Grains/ spike	1000-grain weight	Plant height
Genotypes	32	17.90**	3.43**	80.67**	36.86**	255.19**
Error	64	0.,485	0.278	2.614	0.681	0.892

*P = 0.05, ** P = 0.01

Four crosses exhibited significant positive heterosis and three crosses showed significant positive heterobeltiosis for grain yield (Table-2). Hence, 27 and 20 percent of total crosses gave significant positive heterosis and heterobeltiosis ranging from -11.14 to 52.01 and -15.48 to 48.19 percent, respectively. Higher values for heterotic and heterobeltiotic effect were estimated from the hybrids Iqbal-2000 x Chenab-2000 (52.01 and 48.19 %) and MH-97 x Crow'S' (46.51 and 45.28 %).

Six crosses gave considerable increase in number of tillers over mid and better parents (Table-2). Overall 67 percent of total crosses displayed positive heterosis and heterobeltiosis ranging from -21.94 to 21.22 and -25.13 to 5.78 percent, respectively. Only two crosses had significant negative heterosis and three crosses exhibited negative heterobeltiosis. Cross No. 6 (NR8624/C271/F3.71/TRM x V87094) gave maximum heterosis (21.22%) followed by cross Iqbal-2000 x Chenab-2000 (19.85%) while cross Pb-96 x Kohistan-97 showed 5.78 percent increase over better parents.

Table 2. Heterotic and heterobeltiotic effects on grain yield and tillers per plant

S. No	Crosses	Grain yield		Tillers/plant	
		Ht(%)	Hb(%)	Ht(%)	Hb(%)
1	Inqalab-91 x Milan	8.53	8.39	-3.5	-3.95
2	Auqab-2000 x Milan	13.11	8.53	8.21	5.76*
3	Auqab-2000 x CMH-76A..912/CIMH76A.769	20.38	16.32*	11.28*	4.15*
4	Ures/Bow's'//CMH75A. 142/CMH74A.487xINQ.91	-11.14*	-15.58*	-21.94*	-25.13*
5	Ures/Bow's'//CMH75A.142/CMH74A.487xV87094	-0.64	-4.31*	-15.6*	-17.28*
6	NR8624/C271//F3.71/TRMxV87094	22.87	5.54	21.22*	1.53
7	Alondra'S'xCrow'S'	16.52	11.75	2.33	-8.18
8	Alondra 'S' x Crow 'S'	16.88	5.00	-9.0	-11.69*
9	Pb-96 x Kohistan-97	24.06	12.12	11.11*	5.78*
10	Nasser x Inqalab-91	29.15*	12.98	9.51	5.14*
11	Iqbal-2000 x Chenab-2000	52.01*	48.19*	19.85*	-1.2
12	Aurora/2* Inarigal//4*Arona x V00183	31.49*	8.88	11.84*	4.91*
13	MH97 x Crow'S'	46.51*	45.28*	15.99*	5.73*
14	V87094 x Crow'S'	1.43	-12.80*	3.40	-0.54
15	PBW343xAuqab-2000	15.34	-3.56*	6.29	-9.69

Ht = Heterosis, Hb =Heterobeltiosis * P < 0.01

For number of grains per spike only two hybrids out of 15 crosses displayed significant positive heterosis and heterobeltiosis and three crosses showed negative heterosis (Table-3). Ranges of heterosis and heterobeltiosis were -5.79 to 13.12 and -9.61 to 6.86 percent. Higher heterosis (13.12%) was noted in cross No.12 (Aurora/2* Inarigal //4* Arona x V00183) followed by cross MH97 x Crow'S' (10.38).

Table 3. Heterotic and heterobeltiotic effects on grains/spike and 1000-grain weight

Sr. No	Cross	Grains/spike		1000-grain weight	
		Ht(%)	Hb(%)	Ht(%)	Hb(%)
1	Inqalab-91 x Milan	-2.52	-6.30	10.24	4.65
2	Auqab-2000 x Milan	4.04	2.85	3.18	-0.04
3	Auqab-2000xCMH76A.912/CMH76A.769	-4.14*	-9.39*	2.68	-1.32
4	Ures/Bow'S'//CHM75A.142/CMH74A.487xInq.91	1.61	-9.61*	15.43*	15.33*
5	Ures/Bow'S'//CMH75A.142/CMH74A.487xV87094	8.45	2.55	5.97	5.43
6	NR8624/C271//F3.71/TRMxV87094	4.87	2.16	-0.57	-5.57*
7	Alondra'S'xChenab-2000	4.07	-4.57	11.83	9.22
8	Alondra 'S' x Crow 'S'	7.80	5.41*	20.97*	13.83*
9	Pb-96 x Kohistan-97	-3.62*	-3.69	15.63	10.50*
10	Nasser x Inqalab-91	4.94	-5.87	16.31*	9.72*
11	Iqbal-2000 x Chenab-2000	8.29	-1.57	18.64*	9.02*
12	Aurora/2* Inarigal//4* Arona x V00183	13.12*	1.48	5.22	-7.19*
13	MH-97 x Crow 'S'	10.38*	6.86*	1.62	-1.69
14	V-87094 x Crow 'S"	-5.79*	-6.00	4.57	-13.36*
15	PBW343 x Auqab-2000	8.15	-6.17	14.94*	4.81

Ht = Heterosis, Hb = Heterobeltiosis *P < 0.05, **P < 0.01

Positive heterosis and heterobeltiosis for 1000-grain weight were significant in five crosses whereas negative significant heterobeltiosis was found in only three crosses (Table-3). Thus 33 percent of total crosses showed significant

positive heterosis and heterobeltiosis ranging from -0.57.42 to 20.97 and -3.36 to 15.33 percent, respectively. Better crosses both over mid and better parents that proved to be desirable for more 1000-grain weight were; Alondra'S' x Crow'S' and cross No.4 (Ures/Bow'S'//CMH75A142/ CMH74A.487 x Inqalab-91).

For plant height, out of 15 crosses, only one cross exhibited significant positive heterosis and heterobeltiosis as well, while one cross indicated significant negative heterosis and three crosses showed significant negative heterobeltiosis ranging from -7.12 to 8.78 and -18.60 to 3.88 percent, respectively (Table-4). Overall four crosses over mid parent and 10 crosses over better parent showing negative heterosis were classified for dwarfism.

Table 4. Heterotic and heterobeltiotic effects on plant height in wheat

S.No.	Cross	Plant height	
		Ht (%)	Hb (%)
1	Inqalab-91 x Milan	2.31	1.34
2	Auqab-2000 x Milan	1.16	-5.74
3	Auqab-2000 x CMH76A.912/CMH76A.769	3.64	-1.12
4	Ures/Bow'S'//CMH75A.142/CMH74A.487 x Inq.91	-0.05	-18.60*
5	Ures/Bow'S'//CMH75A.142/CMH74A..487 x V87094	-3.91	-14.33*
6	NR8624/C271//F2.71/TRM x V87094	0.74	-4.55
7	Alondra 'S' x Chenab-2000	5.46	-2.26
8	Alondra "s' x Crow 'S'	8.05	0.30
9	Pb-96 x Kohistan-97	5.65	3.88*
10	Naseer x Inqalab-91	8.78*	2.42
11	Iqbal-2000 x Chenab-2000	1.93	0.03
12	Aurora/2* Inarigal//4* Arona x V00183	7.68	-2.89
13	MH-97 x Crow 'S'	0.17	-1.75
14	V87094 x Crow 'S'	-1.45	-2.79
15	PBW343 x Auqab-2000	-7.12*	-11.18*

It is obvious from the results that possibility of exploiting hybrid vigour for the improvement in grain yield and economic traits exists in wheat. Hybrids Iqbal-2000 x Chenab-2000 and MH-97 x Crow's" gave maximum vigour over mid parent and better parent for yield and tillers per plant. Cross Pb-96 x Kohistan-97 showed vigour over better parent for tillers and 1000-grain weight. The cross No. 12(Aurora/2*Inarigal//4*Arona x V00183) and MH-97 x Crow'S' were considered to produce more grains per spike. Several researchers reported that extent of heterosis was appreciably influenced by the genotypes involved in hybrids, the direction the cross and traits concerned. Eight F_1 crosses displayed heterotic values >60 percent for yield per plant as revealed by Larik *et al* (9). In earlier studies (3), range of heterosis over mid-parent and better parent was reported from -70.82 to

72.75 and -79.24 to 61.34 percent, respectively. Grain weight is an essential component contributing for yield production, so positive heterosis is desirable for this trait. Higher grain weight was synthesized by the crosses; Alodra x Crow's' and Iqbal-2000 x Chenab-2000. Overall heterosis was emphasized (1) while, estimation of heterosis for grain yield per plant showed that out of 28 F_1 hybrids 19 hybrids significantly surpassed their mid-parental values with range of 13.12 to 57.11 percent and 14 crosses exhibited values ranging from 12.88 to 43.89 percent for significant positive heterobeltiosis. In wheat crop, dwarfism is a desirable trait. Hence, negative heterosis is favoured to avoid lodging. The reduced plant height was expressed in the combinations where PBW343 and V87094 were involved as parents.

The choice of parental material used in hybridization scheme is of prime importance for the development of suitable genotype. The parents which are genetically superior and diverse in traits if selected and utilized for designing a meaningful breeding programm can contribute to develop better quality and high yielding wheat varieties. Hence, for future hybridization the parents would be exploited for obtaining maximum vigour for certain trait on the basis of information obtained from present project. It is concluded that parents Iqbal-2000, Chenab-2000, MH-97 and Crow 's' should be utilized to improve certain traits in hybridization programme. Potential of diverse genotypes may also be exploited for further improving the breeding and selection strategies.

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