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Heterosis Study of Certain Important Traits in Wheat

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ABSTRACT

Heterosis studies in ten crosses of bread wheat involving three varieties viz; Chakwal-86, Pak-81 and M.H-97 and two lines viz; 9068 and 243-1 were carried out in the experimental area of the Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad. Highly significant genetic variability was present in the experimental material for the traits under study except number of tillers per plant and spike length. Most of the crosses showed significant heterosis over mid and better parents for various characters. The crosses 9068 X 243-1,Chakwal-86 X 243-1 and Pak-81 X 243-1 may be considered for selection as hybrid or pure line wheat varieties after achieving desired homozygosity.

Key Words: Heterosis; Heterobeltiosis; Wheat; Grain yield; Yield components

INTRODUCTION

Being an agricultural country, economic stability and prosperity of Pakistan is primarily associated with surplus production of agricultural crops especially wheat which is staple food of our peoples. Our wheat production has reached to the level of self- sufficiency but still per acre yield is less than the other wheat growing countries.

Sharp increase in population is also a sign of caution towards our wheat breeding programs to increase per acre yield, which can be achieved by accelerating the pace of research on developing new wheat genotypes with high yielding potential and resistance against various stresses.

Exploitation of heterosis for more yield were largely attributed to cross-pollinated crops. Evidences are now available to confirm the presence of heterotic effects in self-pollinated crops like wheat (Freeman, 1919). The increase or decrease in the productivity and vigour of hybrids compared to those of their parents is generally attributed to heterotic effects expressed in F_1 's and following generations. The hybrids with high heterotic effects may offer better chances for identification of desirable pure lines in the following advanced generations as compared to hybrids with low heterosis (Sharif *et al*., 2001). This phenomenon could be commercially exploited in this crop which could increase per acre yield.

The present studies were, therefore, conducted to ascertain the extent of heterosis in crosses of three wheat varieties and two promising lines to generate valuable information which would be helpful in designing a meaningful breeding programme for the development of better quality and high yielding wheat varieties.

MATERIALS AND METHODS

The experimental material comprised of the crosses (9068 x Pak-81, 9068 x M. H-97, 9068 x Chakwal-86, 9068 x 243-1, Chakwal-86 x M. H-97, Chakwal-86 x 9068, Chakwal-86 x 243-1, 243-1 x 9068, 243-1 x Chakwal-86 and Pak-81 x 243-1) and their parents, which were planted in a triplicated randomized complete block design (RCBD) in the experimental area of the Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad. The sowing was done with the help of dibbler keeping plant to plant and row to row distance of 15 and 30 cm, respectively. At maturity, data were collected for plant height, number of tillers per plant, spike length, number of spikelets per spike, number of grains per spike and grain yield per plant, from ten guarded plants and subjected to statistical analysis of variance technique (Steel & Torrie, 1980). Significant differences where indicated were further subjected to Duncan's new multiple range test. The percent increase (+) or decrease (-) of F_1 over mid parent as well as better parent was calculated to observe possible heterotic effects for above mentioned traits following Fonseca and Patterson (1968):

$\%\ Ht = (F_1 - M.P) / M.P \times 100$
Ht = Heterosis, M.P = Mid parent

$\%\ Hbt = (F_1 - B.P) / B.P \times 100$
Hbt = Heterobeltiosis, B.P = Better parent

RESULTS AND DISCUSSION

Analysis of variance for all the traits under study indicated highly significant differences among the genotypes(i.e; parents and F_1 hybrids) except number of tillers per plant and spike length (Table I).

Plant height. The comparison of genotypic means (Table II) indicated that among parents 243-1 had maximum plant height (123.6 cm), While M.H-97 had minimum plant height (93.93 cm), where as among F_1 hybrids Chakwal-86 X 243-1 had maximum plant height (127.23 cm), while Pak-81 X 243-1 had minimum plant height (101.03 cm). Heterosis and Heterobeltiosis estimates (Table III) indicated that seven out of 10 hybrids were taller than their respective parents. Heterosis range was found from 0.92 (Chakwal-86

Table I. Analysis of variance for various quantitatively inherited traits in wheat (Mean squares)

S.O.V	Df	Plant Height	No of Tillers/Plant	Spike Length	No. of Spikelets/Spike	No. of Grains/ Spike	Grain Yield/plant Plant
Replications	2	136.70**	7.85NS	0.74NS	0.352NS	17.40NS	16.97NS
Genotypes	14	3528.46**	11.92NS	9.02NS	10.81**	1017.10**	136.62**
Error	28	289.51	44.27	9.40	5.83	117.88	77.83

* = Significant ** = Highly significant NS = Non-significant

Table II. Statistical significance of various traits under study for crosses and their parents

Genotypes	Plant Height (cm)	No. of Tillers/Plant	Spike Length (cm)	No. of Spikelets/Spike	No. of Grains/ Spike	Grain Yield/ Plant (g)
9068	104.1efg	11.10	11.88	22.07 bcd	54.63 f	27.01ab
Chakwal-86	110.9 cd	9.30	11.93	23.20 a	64.47 b	24.33bc
243-1	123.6 ab	10.73	10.60	22.60 abc	62.00bcd	26.63ab
Pak-81	99.13 gh	10.40	11.50	23.20 a	60.77bcd	24.55bc
M.H-97	93.93 h	10.90	11.68	22.13 bcd	62.30 bc	27.03ab
9068 X Chakwal-86	110.3 cd	10.60	11.88	21.77 cd	55.87 ef	21.49 c
9068 X 243-1	104.1efg	10.00	11.66	22.90 ab	73.03 a	28.61 a
9068 X Pak-81	106.3def	10.56	11.30	21.53 d	59.10 de	24.00bc
9068 X M.H-97	105.7def	9.93	11.95	22.50 abc	64.07 bc	26.86ab
Chakwal-86 X 9068	114.0 c	10.70	11.50	21.93 cd	60.33 cd	26.69ab
Chakwal-86 X 243-1	127.2 a	11.16	10.60	22.40abcd	64.17 bc	27.21ab
Chakwal-86 X M.H-97	103.4efg	10.53	11.36	22.63 abc	59.13 de	26.28ab
243-1 X 9068	119.7 b	9.86	10.73	21.87 cd	58.97 de	26.71ab
243-1 X Chakwal-86	108.1 de	9.70	11.46	22.27 bcd	70.87a	24.42bc
Pak-81 X 243-1	101.0 fg	10.40	11.66	21.97 cd	61.50bcd	27.16ab
SE	1.857	NS	NS	0.2633	1.185	0.9626
LSD at α 0.05	5.378	NS	NS	0.7628	3.432	2.789

Table III: Expression of Heterosis (%) of F_1 generation over mid parents and better parents for various traits under study

Cross	Plant Height		No. of Spikelets /Spike		No. of Grains/ Spike		Grain Yield/Plant	
	Heterosis of F_1 over		Heterosis of F_1 over		Heterosis of F_1 over		Heterosis of F_1 over	
	M.P	B.P	M.P	B.P	M.P	B.P	M.P	B.P
9068 X Chakwal-86	2.58	-0.57	-3.82	-6.17	-6.18	13.34	-16.27	-20.43
9068 X 243-1	-8.53	-15.77	2.53	1.32	25.23	17.79	6.67	5.91
9068 X Pak-81	4.65	2.17	-4.86	-7.18	2.42	-2.74	-6.89	-11.14
9068 X M.H-97	6.76	1.56	1.80	1.65	8.64	1.21	-0.59	-0.61
Chakwal-86 X 9068	6.06	2.79	-3.09	-5.46	1.31	-6.41	3.97	-1.19
Chakwal-86 X 243-1	8.49	2.91	-2.18	-3.44	1.47	-0.46	6.79	2.17
Chakwal-86 X M.H-97	0.92	-6.79	-0.14	-2.44	-7.43	-8.27	2.33	-2.77
243-1 X 9068	5.10	-3.20	-2.08	-3.24	1.11	-4.89	-0.39	-1.11
243-1 X Chakwal-86	-7.81	-12.56	-2.76	-4.02	12.07	9.92	-4.16	-8.29
Pak-81 X 243-1	-9.29	-18.28	-4.07	-5.31	0.18	-0.80	6.15	2.01
S.E	0.8303	1.8565	0.1178	0.2634	0.5298	1.1846	0.4305	0.9626

M.P: Mid Parent, B.P: Better Parent

X M.H-97) to 8.49 (Chakwal-86 X 243-1). As far as heterobeltiosis is concerned, five out of 10 hybrids were highly significant and all estimates were negative. Crosses showing positive heterobeltiosis values ranged from 1.56 (9068 X M.H-97) to 2.91 (Chakwal-86 X 243-1). Negative values ranged from –0.57 (9068 X Chakwal-86) to –18.27 (Pak-81 X 243-1). The negative estimates of heterosis and heterobeltiosis for plant height are preferred over their mid and better parent in wheat breeding because dwarf ness is a desirable character (Budak & Yildirim, 1996). In some crosses where heterobeltiosis was observed over dominance might be involved and it may be concluded that effective selection of desirable recombinants from this material is possible.

Number of tillers per plant and spike length. The analysis of variance revealed that the differences among the parents and hybrids were non-significant. It means the hybrids and their parents were similar with regard to these characters. Their means are given in Table II.

Number of spikelets per spike. Individual comparison of average number of spikelets per spike (Table II) showed that among hybrids cross (9068 X 243-1) was at the top with an average of 22.90 spikelets per spike. Positive heterosis ranged from1.80 (9068 X M.H-97) to 2.53 (9068 X 243-1) whereas the magnitude of heterosis over better parents

ranged from 1.32 (9068 X 243-1) to 1.65 (9068 X M.H-97). Most of crosses showed negative heterosis and heterobeltiosis (Table III). The results indicated that the heterosis in F_1 is mainly due to additive genetic factors accompanied by over dominance type of gene action in some crosses. Similar findings had been reported by researchers like, Walia *et al*. (1993), and Li Youchun *et al*. (1997).

Number of grains per spike. A marked variation is evident (Table II) for average number of grains per spike among parents and hybrids which varied from 54.63 (9068) to 73.03 (9068 X 243-1). Impressive positive heterosis (Table III) was observed in most of the crosses which surpassed mid parental value ranging from 0.18 (Pak-81 X 243-1) to 25.23 (9068 X 243-1). The hybrid 9068 X 243-1 had maximum heterobeltiosis estimate where as 9068 X M.H-97 had minimum value i.e; 1.21. Tiwari and Chakraborty (1992), and Larik *et al*. (1995) observed similar results.

Grain yield per plant. Only single hybrid 9068 X Chakwal-86 had highly significant but negative value for heterosis i.e; 16.27. All other hybrids showed non-significant heterotic effects. The maximum heterosis was observed in hybrid Chakwal-86 X 243-1 (6.79) and minimum in Chakwal-86 X M.H-97 (2.34). Positive but non-significant heterobeltiosis estimate was recorded for 9068 X 243-1, Chakwal-86 X 243-1 and Pak-81 X 243-1. The chances of having good segregants from these hybrids are higher. The same three hybrids may be advanced and utilized for single plant selection. All the other hybrids were having negative and non-significant values. The differences in the results of present and previous studies may be attributed to different genotypes studied in different environments.

REFERENCES

Budak, N. and M.B.Yildirim, 1996. Heterosis in bread wheat (*Triticum aestivum L.*). *Turkish J. Agri. Forest.,* 20: 345–7.

Fonseca, S. and F.L. Patterson, 1968. Hybrid vigour in seven parent diallel cross in common wheat (*Triticum aestivum* L.). *Crop Sci*., 8: 85–8.

Freeman, G.F., 1919. Heredity of quantitative characters in bread wheat. *Genetics,* 4:1–93.

Larik, A.S., A.R. Mahar and H.M.I. Hafiz, 1995. Heterosis and combining ability estimates in diallel crosses of six cultivars of spring wheat. *Wheat Information Service,* 80: 12–9.

Larik, A.S., A.R. Mahar, A.A. Kakar, and M.A. Sheikh, 1999. Heterosis, inbreeding depression and combining ability in *Triticum aestivum* L. *Pakistan J. Agri. Sci*., 36: 39–44.

Li Youchun, P. Junhua and L. Zhongqi, 1997. Heterosis and combining ability for plant height and its components in hybrid wheat with *Triticum timopheevi* cytoplasm. *Euphytica,* 95: 337–45.

Sharif, A., A. Bakhsh, M. Arshad, A.M. Haqqani and S. Najma, 2001. Identification of genetically superior hybrids in chickpea (*Cicer arietinum* L.*). Pakistan J. Bot.,* 33: 403–9.

Steel, R.G.D. and J.H. Torrie, 1980. *Principles and Procedures of Statistics.* 2nd ed., McGraw Hill Book Co, New York, U.S.A.

Tiwari, V. and S.K. Chakraborty, 1992. Heterosis studies in bread wheat (*Triticum aestivum* L. em. Thell.). *Environmental Ecology,* 10: 197–202.

Walia, D.P., D. Tashi, P. Plaha and H.K. Chaudhary, 1993. Gene action and heterosis in bread wheat. *Ludhiana Symp.,* 2: 23–4.

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