Pak. J. Bot., 7 (2): 119—126, 1975.

STUDY OF HETEROSIS IN SOME INTRASPECIFIC CROSSES OF WHEAT (*TRITICUM AESTIVUM* L.)

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Abstract

Wheat crosses of nine medium tall and dwarf varieties were evaluated for expression of heterosis in F_1 generation for plant height, grain yield and its components, viz., number of spikes per plant, number of grains per spike, number of spikelets per spike and 1000-grain weight. In almost all the crosses, the heterotic effects were apparent in F_1 generation to varying extent.

Introduction

Short statured wheats of Mexican origin have replaced tall varieties in Pakistan, but there is an ever increasing demand of replacing Mexipak and Chenab 70 wheat varieties with still high yielding and rust resistant ones. Wheat breeders are thus engaged in hybridizing exotic and local cultivars for further improvement of grain yield and quality of new wheats. The literature contains enough evidence for the existence of heterosis expressed in wheat crosses for various agronomic characteristics. Gandhi *et al* (1961) reported that 10 out of 11 hybrids in his crosses were taller than the tall parents, seven of these comparisons were significant. The maximum increase over the taller parent was 20.5%. Five hybrids produced significantly more tillers than the better parents. Briggle (1963) reported the existence of heterosis in F_1 population of 5 hard red winter wheats for quantitative characters like plant height, number of spikes per plant, kernel wt and grain yield. Brown (1966) studied crosses among three soft and four hard wheat varieties and reported that out of 16 F_1 combinations, five gave significantly higher grain yield than the high parent, and 12 were higher than the mid parent. Shebeski (1966) reported that 3 out of ten hybrids yielded significantly more than the higher parents. None of the yield components was transmitted from parents to hybrids in a consistent manner indicating that component values of the parents were not useful in predicting relative hybrids' performance. Briggle *et al* (1967) noticed marked heterosis for grain yield than for plant height, in the F_1 hybrids of the cross, Lemhi 53 x Henny. Akemine & Kumagai [1968) studied heterosis in yield and its components in 28 diallel crosses involving 8 parental varieties, widely different in origin and other characteristics. They observed that about 5% F_1 hybrids were superior to higher parents in yield by 20%.

Materials and Methods

The experimental material comprised of nine wheat varieties ..*e*., Green Valley, Sonora 64, BK, AU 44, AU 49, AU 43, Lerma Rojo, Mexipak and one local variety, C5661 which were crossed in different combinations during Feb.-March, 1970 as under:—

1. Green Valley x Sonora 64
2. ,, x BK
3. ,, x AU 44
4. ,, x 5661
5. ,, x Lerma Rojo
6. GV x MP
7. AU 44 x GV
8. x Lerma rojo
9. x MP
10. BK x AU 43
11. BK x AU 49
12. x 5661
13. x GV
14. x MP
15. x Lerma Rojo

The seed of Green Valley, Sonora 64, BK, Lerma Rojo, Mexipak and C5661 was received from Cereal Botanist, Punjab Agri. Research Institute, Lyallpur while the varieties AU 44, AU 49 and AU 43 were developed in the Department of Plant Breeding and Genetics, University of Agriculture, Lyallpur. Excepting C5661 which is a tall variety, a ' other varieties are medium tall.

The F_1 seeds along with their respective parents were grown in randomized complete block design with four replications in the field on 15ht Nov., 1970. In one block, 24 treatments (9 parents & 15 F_1) were randomized with one row for each treatment. Each row was 15ft long and in each row two seeds were dibbled per hill at one ft apart. After germination one plant per hill was kept to obtain a uniform stand.

Before recording the data, F_1 plants were carefully examined and their hybrid nature was confirmed. Data on different plant characteristics were recorded. Average height of the primary tiller of mature plant was taken in each replication. Tillers per plant for all the F_1 plants along with their parents were counted to calculate the mean number of spikes per plant. Average number of grains per spike were cal ulated from central spike of each plant and mean calculated. Similarly at maturity each plant was harvested individually and threshed to see average grain yield per plant. Analysis of variance was run on the average values and statistical comparison made by the L.S.D. test.

Results and Discussion

A highly significant F_1 value obtained for plant height showed that the F_1's and parents differed among themselves significantly. In 14 out of 15 crosses, an increase over the parental mean height was exhibited which ranged from 0.16% (GV x LR) to 11.88% (BK x AU 49). The crosses of AU 44 gave invariably taller hybrids than other parents as depicted in Table 1. However, a number of F_1's showed significant differences in height from mid-parent values, it was positive in all the crosses except cross GV x MP which was negative.

TABLE 1. Average Plant Height for Different Wheat Varieties and their F1 Hybrids.

Cross	Female parent	Male parent	Mean of the parents	F1 hybrids	Percentage increase (+) or decrease (—) of mean of F_1 over			
					Mid parent	Sig.	Better parent	Sig.
AU 44 x GV	108.63	97.70	103.16	107.78	+ 4.37	*	—0.78	ns
AU 44 x LR	108.63	101.52	105.07	107.27	+ 2.09	r s	—1.15	ns
BK x MP	99.55	101.75	100.65	105.55	+ 4.86	**	—3.73	ns
AU 44 x MP	108.63	101.75	105.19	105.41	— 0.20	ns	— 2.94	ns
GV x AU 44	97.70	108.63	103.16	103.70	+ 0.52	ns	—4.55	ns
BK x LR	99.55	101.52	100.53	103.56	+ 3.0	ns	+2.00	ns
BK x 5661	99.55	95.72	97.65	102.53	+ 5.07	**	+3.04	ns
BK x AU 43	99.55	97.36	98.45	102.43	+ 4.04	*	+3.04	ns
GV x BK	97.70	99.55	98.62	102.11	+ 3.53	*	+2.57	ns
BK x GV	99.5	97.70	98.62	101.83	+ 3.25	*	+2.29	ns
GV x 5661	97.70	95.72	96.71	101.45	+ 4.90	**	+3.83	*
GV x Sonora 64	97.73	102.31	100.25	100.28	+ 0.28	ns	—1.98	ns
GV x LR	97.70	101.90	99.61	99.77	+ 0.16	ns	—1.72	ns
BK x AU 49	99.55	78.61	89.08	99.67	+11.88	**	+0.12	ns
GV x MP	97.70	101.75	99.72	99.32	— 0.40	ns	—2.38	ns

	P+F1	MP+F1
L.S.D. at P = 0.05	3.68	3.19*
P = 0.01	4.19	4.84**

Number of grains per spike also depicted heterotic effects in F_1 generation over mid-parent value and better-parents. The maximum increase of 16.7% over mid parent value was observed in the cross, AU 44 x GV. Twelve out of 15 crosses showed heterotic effect over that of mid parents, while 8 crosses covered respective better parents for grains per spke, as shown in Table 2. The crosses involving AU 44 again showed higher general combining ability for this character than others.

A fair degree of heterosis was also apparent for the number of spikes per plants as shown in Table 3. Eleven out of 15 crosses showed considerable amount of vigour over both mid and better parents while only 8 gave significant results over better parents. The range of increase over the parental mean was from 3.49% (Bk x AU 49) to 31.15% (AU 44 x GV). Most of the crosses showing con-

TABLE 2. Average number of grains per spike for different wheat varieties and their F_1 hybrids.

Cross	Female parent	Male parent	Mean of the parents	F1 hybrids	Percentage increase (+) or decrease (—) of mean of F_1, over			
					Mid parent	Sig.	Better parent	Sig.
AU 44 x GV	68.56	60.58	64.57	75.42	+16.79	**	+ 10.01	**
AU 44 x MP	68.56	75.30	71.93	75.15	+ 4.48	*	— 0.20	ns
GV x MP	60.58	75.30	67.94	74.86	+10.18	**	— 0.58	ns
GV x AU 44	60.54	68.56	64.57	73.74	+14.20	**	+ 7.55	**
AU 44 x LR	68.56	61.06	64.81	73.03	+12.68	**	+ 6.52	**
GV x Sonora 64	60.58	70.07	65.32	72.86	+11.54	**	+ 3.98	ns
BK x 5661	38.48	64.52	61.50	69.57	+13.12	**	+ 7.82	**
JV x 5661	58.48	64.52	62.55	68.52	+ 9.54	**	+ 6.20	**
GV x LR	60.58	61.06	60.82	68.16	+12.39	**	+11.63	**
BK x LR	58.48	61.06	59.77	66.53	+11.31	**	+ 8.96	**
BK x MP	58.48	75.30	66.89	66.38	— 0.76	ns	—11.84	ns
BK x AU 43	58.48	61.86	60.17	63.60	+ 5.70	**	+ 2.81	ns
BK x AU 49	58.48	51.22	54.85	61.86	+12.78	**	+ 5.77	**
GV x BK	60.58	58.48	59.53	61.54	+ 3.37	ns	+ 1.58	ns
BK x GV	58.48	60.58	59.33	56.24	— 5.53	ns	— 7.16	ns

		P+F1	MP+F1
L.S.D. at	P = 0.05	4.21	3.63*
	P = 0.01	5.52	4.76**

siderable heterosis included AU 44 as one of the parents suggesting a greater general combining ability in this variety for number of spikes per plant.

All 15 crosses showed heterotic effects for number of spikelets per spike over the parental means. The range of increase over the parental mean was from 0.39% (AU 44 x MP) to 7.27% (GV x AU 44). The maximum number of spikelets (23.30) were recorded in the cross GV x AU 44, (Table 4). It is evident from the results that crosses involving AU 44 as one of the parent again showed significant heterosis.

TABLE 3. Average number of spikes per plant for different wehat varieties and their F1 hybrids.

Cross	Female parent	Male parent	Mean of the parents	F1 hybrids	Percentage increase (+) or decrease (—) of mean of F_1 over			
					Mid parent	Sig.	Better parent	Sig.
AU 44 x GV	19.21	18.79	19.00	24.92	+31.15	**	+29.72	**
AU 44 x LR	19.21	18.63	18.92	24.17	+27.75	**	+25.81	**
AU 44 x MP	19.21	20.28	20.01	23.34	+16.64	**	+12.10	**
GV x AU 44	18.79	19.21	19 00	23.03	+21.21	**	+19.88	**
GV x MP	18.79	20.82	19.80	21.13	+ 6.71	**	+ 1.49	ns
GV x LR	18.79	18.63	18.71	20.85	+11.44	**	+10.96	**
GV x Sonora 64	18.79	18.75	18.77	20.38	+ 8.52	**	+ 8.46	**
GV x 5661	18.79	18.63	18.71	20.00	+ 6.80	**	+ 6.43	**
BK x AU 43	17.41	18.53	17.97	19.46	+ 8.19	**	+ 5.09	**
BK x 5661	17.41	18.63	18.02	18.80	+ 4.32	**	+ 0.91	ns
BK x MP	17.41	20.82	19.11	18.23	— 4.70	ns	—12.44	ns
GV x BK	18.79	17.41	18.10	17.96	— 0.07	ns	— 4.42	ns
BK x AU 49	17.41	17.51	17.46	18.07	+ 3.49	*	+ 3.20	ns
BK x GV	17.41	18.79	18.10	17.62	— 2.65	ns	— 6.23	ns
BK x LR	17.41	18.63	18.02	16.93	— 6.04	ns	— 9.12	ns

		P+F1	MP+F1
L.S.D. at	P = 0.05	3.79	3.29*
	P 0.01	4.97	4.32**

Data reported for 1000 grain wt indicated that varieties and crosses had highly significant differences. The cross BK x 5661 topped the list by attaining 1000 grains wt. of 35.92 grams and was respectively followed by the cross BK x LR (34.99), GV x BK (33.19) and BK x GV (32.22). The differences between these crosses were non significant. All the 15 crosses recorded an increase over the mean of parents. The range of increase over the mid parents (Table 5) was from 0.24 (AU 44 x MP) to 25.42% (Bk x 5661). The crosses involving BK as one of the parents showed maximum heterosis than other. It has better general combining ability than others.

TABLE 4. Average number of spikelets per spike for different wheat varieties and their F1 hybrids.

Cross	Female parent	Male parent	Mean of the parents	F1 hybrids	Percentage increase (+) or decrease (—) of mean of F_1, over			
					Mid parent	Sig.	Better parent	Sig.
GV x AU 44	20.16	23.28	21.72	23.30	+7.25	**	+0.08	ns
AU 44 x GV	23.28	20.16	21.72	23.14	+6.53	**	—0.61	ns
AU 44 x LR	23.28	21.24	22.26	23.13	+3.90	**	—0.64	ns
AU 44 x MP	23.28	22.41	22.84	22.93	+0.39	ns	—1.50	ns
BK x 5661	19.96	22.29	21.12	22.53	+6.67	**	+1.08	*
GV x 5661	20.16	22.29	21.22	22.28	+4.99	**	—0.04	ns
BK x MP	19.96	22.41	21.18	22.19	+4.76	**	—0.98	ns
GV x MP	20.16	22.41	21.28	21.89	+2.86	**	—2.32	ns
BK x AU 43	19.96	21.62	20.79	21.81	+4.90	**	+0.88	ns
GV x LR	20.16	21.24	20.70	21.33	+3.04	**	+0.42	ns
GV x Sonora 64	20.16	21.40	20.78	21.18	+1.92	**	—1.03	ns
BK x LR	19.96	21.24	20.60	20.94	+1.65	**	—1.41	ns
BK x AU 49	19.96	20.92	20.44	20.77	+1.61	**	—0.72	ns
BK x GV	19.96	20.16	20.06	20.64	+2.89	**	+2.38	**
GV x BK	20.16	19.96	20.06	20.44	+1.89	**	+1.38	**

		P+F1	MP+F1
L.S.D. at	P = 0.05	.93	.83*
	P = 0.01	1.23	1.09**

A fair degree of heterosis was observed for grain yield (Table 6) in F_1 hybrids. The maximum heterosis over mid parents and better parents was 35.93% and 29.14% observed in cross, BK x 5661. Fourteen out of 15 crosses out-yielded their respective mid-parents.

TABLE 5. Average grain weight (1000-grains weight) in grams for different wheat varieties and their F1 hybrids.

Cross	Female parent	Male parent	Mean of the parents	F1 hybrids	Percentage increase (+) or decrease (—) of mean of F_1 over			
					Mid parent	Sig.	Better parent	Sig.
BK x 5661	31.82	25.47	28.64	35.92	+25.42	**	+12.88	**
BK x LR	31.82	31.16	31.49	34.99	+11.11	**	+ 9.96	**
GV x BK	29.29	31.82	30.55	33.19	+ 8.64	**	+ 4.30	ns
BK x GV	31.82	29.29	30.55	32.22	+ 5.47	**	+ 1.26	ns
AU 44 x GV	23.24	29.29	26.66	32.00	+21.85	**	+ 9.25	**
BK x AU 43	31.82	24.60	28.21	31.97	+13.97	**	+ 0.47	ns
GV x LR	29.29	31.16	30.22	31.89	+ 5.53	**	+ 2.34	ns
BK x MP	31.82	26.06	28.94	31.04	+ 7.04	**	— 2.45	ns
GV x MP	29.29	26.06	27.67	29.98	+ 8.37	**	+ 2.35	ns
GV x 5661	29.29	25.47	27.38	29.94	+ 9.35	**	+ 2.22	ns
AU 44 x LR	23.24	31.16	27.20	29.70	+ 9.19	**	— 4.16	ns
BK x AU 49	31.82	25.43	28.62	29.50	+30.07	**	— 7.29	ns
GV x Sonora 64	29.29	27.32	28.30	29.30	+ 3.53	ns	+ 1.16	ns
GV x AU 44	29.29	23.24	26.26	28.85	+ 9.86	**	— 2.39	ns
AU 44 x MP	23.24	26.06	24.65	24.71	+ 0.2	ns	— 5.18	ns

		P+F1	MP+F1
L.S.D. at P	= 0.05	4.49	3.89*
P	= 0.01	5.89	5.10**

Considering all the results together, the cross GV x AU 44 and its reciprocal was the best combination of all. The other cross which consistently showed highest amount of heterosis for grain yield per plant as well as for other components was, AU 44 x MP. These two crosses gave indications of close association of grain yield with number of grains per spike and number of spikes per plant, number of spikelets per spike and 100 grain wt. (Table 6).

TABLE 6. Average grain yield per plant in grams for different wheat varieties and their F1 hybrids.

Cross	Female parent	Male parent	Mean of the parents	F1 hybrids	Percentage increase (+) or decrease (—) of mean of F_1 over			
					Mid parent	Sig.	Better parent	Sig.
GV x AU 44	34.19	36.19	35.19	43.58	+23.84	**	+20.42	**
AU 44 x MP	36.19	38.49	37.34	43.38	+16.17	**	+12.70	**
BK x 5661	32.08	29.30	30.69	41.47	+35.93	**	+29.14	**
GV x Sonora 64	34.19	40.46	37.32	41.03	+ 9.94	**	+ 1.14	ns
AU 44 x GV	36.19	34.19	35.19	40.83	+16.03	**	+1.57	ns
GV x 5661	34.19	29.30	31.74	39.93	+25.80	**	+16.79	**
GV x MP	34.19	38.49	36.34	39.20	+ 7.87	**	+ 1.84	ns
BK x AU 43	32.08	38.60	35.34	38.35	+ 8.23	**	— 0.91	ns
AU 44 x LR	36.19	34.83	35.51	37.82	+ 6.50	**	+ 4.50	**
BK s LR	32.08	34.83	33.45	36.48	+ 9.06	**	+ 4.74	**
GV x LR	34.19	34.83	31.51	35.26	+ 2.17	ns	+ 1.23	ns
BK x AU 49	32.08	34.60	33.34	34.52	+ 3.54	**	— 0.23	ns
GV x BK	34.19	32.08	33.13	34.31	+ 3.56	**	+ 0.35	ns
BK x GV	32.08	34.19	33.13	33.91	+ 2.35	*	— 0.82	ns
BK x MP	32.08	38.49	35.28	32.28	— 8.50	ns	—16.13	ns

		P+F1	MP+F1
L.S.D. at P	= 0.05	2.55	2.21*
P	= 0.01	3.35	2.9***

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