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HETEROSIS AND HETROBELTIOSIS PERFORMANCE OF MORPHOLOGICAL TRAITS IN BREAD WHEAT CROSSES UNDER DROUGHT STRESS CONDITIONS

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ABSTRACT:- The study was designed to observe the heterotic and heterobeltiotic effects in F_1s of four different crosses having four drought tolerant cultivars and four susceptible lines as parents. The experiment was conducted at the Faculty of Agriculture, Gomal University, Dera Ismail Khan, Pakistan during 2012-13. The performance of crosses and their parents were evaluated with three replications. These crosses were evaluated for plant height, number of tillers plant^{-1}, days to 50% heading, spike length, number of spikelets spike^{-1}, number of grains spike^{-1} and 1000-grain weight. Maximum heterosis and heterobeltiosis interactions were noted in Pari-73 x Hashim-08 for 1000-grain weight (29% and 22%), grains per spike (19% and 11%) and spike length (33% and 22%). Promising results were obtained with respect to shorter plant height, maximum spike length, more spikelets and grains spike^{-1} and achieved all results important for drought resistant cultivars.

Key Words: Bread Wheat; Heterosis; Heterobeltiosis; Yield Components; Drought Tolerance; Morphological Parameters; Pakistan.

INTRODUCTION

The aim of crop breeding is to produce cultivars with high yield and other economically important traits. Exploiting heterosis for maximum yield and other qualitative traits has been utilized in cross pollinated crops while in self pollinated crops, heterosis results of heterosis is used (Haq and Laila, 1991) suggests the easiest way of commercial utilization of genetic potential of a crop. Heterosis was explored in wheat at first by Freeman (1919) who reported the increase in vigor of F_1 crosses over respective parent. Presence of heterosis in grain yield of wheat crosses was also reported by Briggle (1963).

Heterosis study can be utilized for obtaining knowledge about the increment or reduction in vigor of F_1s over their parents. It also helps in explaining the general and specific combining abilities in the selection process. However, genetic distance among parents is necessary to produce super hybrid (Fonseca and Patterson, 1968; Martin et al., 1995; Fabrizius et al., 1998; Morgan, 1998; Baric et al., 2004).

Heterosis and hetrobeltiosis has direct proportion to selection i.e., the more is heterosis more will be selection (Kalimullah, 2011). Hence to get effective yield of wheat for morphological, phenological and physiological traits. The objectives of

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study were to use generation means analysis for evaluation of the out-yielding effects of wheat F_1s for various morphological and physiological parameters and their utilization for mercantile use.

MATERIALS AND METHOD

The experimental material consisted of eight parents and their four cross combinations (SVP-74, Zam-04, SVP-83, Gomal-08, Pari-73, Hashim-08, May-1942, Dera-98, SVP-74 x Zam-04, SVP-83 x Gomal-08, Pari-73 x Hashim-08 and May-1942 x Dera-98). These were sown in RCBD with three replications in the experimental area of the Department of Plant Breeding and Genetics, Faculty of Agriculture, Gomal University, Dera Ismail Khan in 2012-13. The plant to plant distance was 10 cm while row to row distance was 30 cm. At the time of maturity data were recorded on plant height, number of tillers plant^{-1}, days to 50% heading, spike length, number of spikelets spike^{-1}, number of grains spike^{-1} and 1000-grain weight.

Equidistant parent and higher parent heterosis was computed with the protocol outlined by Matziner et al. (1962). Difference among the parents and their F_1 progenies for agronomical traits were evaluated by using analysis of variance (Steel and Torrie, 1980). Analysis were made of the traits having maximum differences regarding heterosis and heterobeltiosis.

Heterosis over mid parent (Ht%) = $[(F_1\text{-MP})/MP]*100$

where,

MP = Midparent

Heterosis over better parent heterobeltiosis (Hbt%) = $[(F_1\text{-BP})/BP]*100$

where,

BP = Better (higher) parent.

Significance of heterosis and heterobeltiosis were tested with t-test as proposed by Cochran and Cox (1950) and Wynne et al. (1970).

RESULTS AND DISCUSSION

Analysis of variance (Table 1) indicated highly significant differences among the parents and F_1 hybrids for all the parameters.

Plant Height

Short stem wheat plant is most wanted and negative heterosis is required because taller wheat plants are likely to lodge and also need more light energy for photosynthesis to transport solutes to the grains. Thus taller plants have lower grain weight and ultimately low grain yield (Mazurek and Sabat, 1984). Significant and useful negative better parent heterosis was noted for all the crosses whereas, the cross SVP-74 x

Table 1. ANOVA for yield and yield related traits in F_1 generation

Source	DF	Days to 50% heading	Plant height	No. of tillers plant^{-1}	Spike length	No. of spikelets spike^{-1}	No. of grains spike^{-1}	1000-grain weight
Rep	02	294.00**	152.51**	4.00**	4.08**	70.04**	12.76**	87.43**
Genotypes	11	150.50**	074.29**	2.157**	8.65**	35.056**	65.717**	53.19**
Error	22	2.81	7.98	0.14	0.08	1.09	0.63	2.41

*** Significant at 1% level of probability.*

Zam-04 showed positive heterosis over respective parent. Heterosis for mid parent and better parent ranged from -1.82 to 1.65 and -0.44 to -8.49, respectively (Table 2). Maximum negative mid parent heterosis (-1.82) and better parent heterosis (-8.49) was shown by Pari-73 x Hashim-08. In all the crosses -0.16% and 4.46% decrease was observed for plant height regarding mid parent and better parent heterosis, respectively. By crossing parents, having different genetic configuration, brings positive changes in the F_1 hybrid. The trait under study may be controlled by dominant, additive or over dominance type of genes. Heterosis is actually meant for changed progeny with respect to its parents. So it may be positive or negative. These results are in accordance with the previous findings (Inamullah et al., 2006; Sadeque et al., 1991) who also reported negative heterosis for plant height.

Number of Tillers per Plant

Positive heterosis is required because number of fertile tillers directly affects the grain yield. Heterotic study revealed that significant useful positive heterosis both over mid parent and better parents (Table 1). Maximum mid parent heterosis (27.3%) was exhibited by cross SVP-83x Gomal-08 whereas maximum better parent heterosis (13.06%) was found in cross SVP-74 x Zam-04. In the mean of all the crosses 15.95% and 7.27% increase was observed for tillers plant^{-1} regarding mid parent and better parent heterosis, respectively. Mid parent and better parent hetrosis was earlier

Table 2. Mean performance of the parents and their F_1 hybrids for the traits studied

Genotype/ Crosses	Days to 50% heading	Plant height (cm)	Number of tillers plant^{-1}	Spike length (cm)	Number of spike let spike^{-1}	Number of grain spike^{-1}	1000-grain weight (g)
SVP-74	102.50	79.20	9	12.15	21	42.25	39.36
Zam-04	89.50	90.50	8	11.60	17	53.50	41.84
SVP-83	98.50	75.55	9	9.20	19	37.75	53.45
Gomal-08	78.50	82.45	6	8.70	16	44.40	44.04
Pari-73	96.00	70.20	8	10.8	22	33.05	43.24
Hashim-08	75.50	81.25	8	9.10	13	37.90	38.25
May-1942	98.00	73.50	8	12.55	22	43.50	49.59
Dera-98	89.50	72.95	8	7.90	12	38.00	38.23
SVP-74x Zam-04	93.50	86.25	10	13.95	24	47.35	43.76
SVP-83x Gomal-08	96.76	78.95	9	10.80	21	46.55	46.00
Pari-73x Hashim-08	102.50	74.35	8	13.20	21	42.05	52.66
May-1942x Dera-98	96.50	72.90	9	13.90	25	49.20	46.58
$LSD_{(0.05)}$	2.84	4.78	0.63	0.478	1.768	1.344	2.629

observed regarding tiller plant^{-1} in wheat (Sadeque et al., 1991;Walia et al., 1993; Yu et al., 1997). So, these hybrids verify the earlier reviews.

Days to 50% Heading

Early heading is desirable in wheat. Thus negative heterosis is effective for days to heading. Regarding mid parent heterosis, all the crosses showed positive heterosis except the cross SVP-74 x Zam-04 which exhibited negative desirable heterosis (Table 3). The better parent heterosis was negative in all the crosses except cross Pari-73x Hashim. Mean values of all the crosses -1.32% were reduced as compared to better parent heterosis whereas mid parent heterosis increased by 7.29%. The instant results suggest that selection for early maturity from these combinations may not be effective. The outcome are in contrast with the results of Sadeque et al. (1991), Murai (1998) and Wu et al. (2001) who described that negative heterosis cause earliness in wheat. The contradiction in the results with previous findings may be due to changed genotype, varietal differences or the environmental differences. Positive and negative heterosis related to the linkage phenomena of genes which indicates epistasis.

Spike Length

The mean heterosis values of the entire cross combinations regarding mid and higher parents were 26.68% and 16.29% (Table 3) which were highly significant. Hybrid vigor ranged from 17.47 to 35.94 with respect to heterosis and from 10.75 to 22.22 for heterobeltiosis. These significant outcomes are in agreement with those of Jan et al. (2005) and Ilker et al. (2010).

Table 3. Mid parent and better parent heterosis for important traits of wheat in various hybrids (%)

Crosses	Plant height (cm)		Number of tillers plant^{-1}		Days to 50% heading		Spike length (cm)		Number of spikelets spike^{-1}		Number of grains spike^{-1}		1000 grain weight (g)	
	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP
SVP-74 x Zam 04	1.65	-4.69*	18.80**	13.06**	-2.60	-8.78**	17.47**	14.81**	27.84**	16.42**	-01.09	-11.49**	7.78*	4.60
SVP-83 x Gomal 08	-0.06	-4.25*	27.33**	05.74*	9.33*	-1.76	20.67**	17.39**	21.38**	10.63**	13.32**	04.84*	-5.63*	-13.93**
Pari-73 x Hashim	-1.82	-8.49**	02.75	00.59	19.53**	6.77*	32.66**	22.22**	19.14**	-05.86	18.53**	10.94**	29.24**	21.78**
May-1942 x Dera 98	-0.44	-0.44	14.92**	09.69**	2.93	-1.53	35.94**	10.75**	47.03**	14.03**	20.73**	13.10**	6.06*	-6.07*
Mean	-0.16	-4.46	15.95	07.27	7.29	-1.32	26.68	16.29	28.84	08.80	12.87	04.34	9.36	1.59

*MP= Mid Parent, BP= Better Parent, * and ** = Significant at 5% and 1% level of probability.*

Number of Spikelets per Spike

Hybrid vigor values ranged from 19.14% to 47.03% and -5.46% to 16.82% for mid parent and better parents, respectively (Table 3). In the mean values of all the crosses 28.84% increase was observed over mid parent whereas 8.80% increase over better parent was found. These effects are in contrast to Abdullah et al. (2002) who reported negative heterosis for spikelets spike^{-1}. This difference might arise from genetic diversity among the parents used in the present study. Similar positive increased vigor was also reported by Ilker et al. (2010).

Number of Grains per Spike

Number of grains spike^{-1} increased in all the crosses both over equidistant parent and higher parent except the cross SVP-74 x Zam-04 which showed decreased response regarding heterosis and heterobeltiosis (Table 3). Mean values of this trait over all the crosses increased by12.87% and 4.34% in comparison with mid parent and better parent, respectively. Heterosis values ranged from -1.09% to 20.73% and heterobeltiosis values varied between -11.49% and 13.10%. There is agreement in earlier studies (Çifci and Yağdi, 2007) but less than that of Fonseca and Patterson (1968) who found 100% heterobeltiosis in the crosses obtained from genetically different parents. On the other hand, Baric et al. (2004) found negative heterosis values in terms of number of grains spike^{-1} in bread wheat crosses.

1000-grain Weight

In 1000-grain weight positive heterosis was obtained over equidistant parent and higher parent in all the crosses excluding the cross SVP-83 x Gomal-08 which exhibited negative heterosis (Table 3). Heterosis and heterobeltiosis values ranged from -5.63% to 29.24% and -13.93% to 21.78%, respectively. In the mean of all crosses 9.36% and 1.59% increase was observed regarding mid parent and higher parent heterosis, respectively. Similar observations have been reported by Saleem and Hussain (1988). The paramount heterotic interaction of 1000-grain weight, in all the hybrids revealed efficiency of heterosis for maximum grain yield. The predominant heterotic interaction with respect to 1000-grain weight, in all the F_1 hybrids expressed the effectiveness of heterosis for maximized grain yield.

It is concluded that heterobeltiosis values in these crosses have lower vigor for broad use but have significant heterosis values for all characters except days to heading. Thus these parents can be used to develop high yielding and drought tolerant cultivars. Above all the nub of the whole study exposes that significant heterosis was observed. This is clue for the transference of desired genes in the hybrid. As present dissertation has great concern with drought it can be expressed as nut shell for drought tolerant character in these cultivars can be observed in the obtained hybrid. Consequently this is a landmark for producing high yielding lines/ cultivars.

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AUTHORSHIP AND CONTRIBUTION DECLARATION

S. No	Author Name	Contribution to the paper
1.	Mr. Said Salman	Data collection, Data entry in SPSS and analysis, Result and Discussion, Introduction, References
2.	Mr. Shah Jehan Khan	Conceived the idea
3.	Mr. Javed Khan	Overall management of article

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