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EVALUATION OF THE HETEROTIC AND HETEROBELTIOTIC POTENTIAL OF WHEAT GENOTYPES FOR IMPROVED YIELD

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Abstract

Heterotic and heterobeltiotic performance of 28 F1's obtained through crossing 8 commercial varieties, were evaluated for days to heading, days to maturity, tillers per plant, flag leaf area, plant height, spike length, grains per spike, 1000 grains weight, harvest index and yield per plant. The highest heterotic and heterobeltiotic interactions were recorded in GZ x Der (-5.35 and -4.98%) for days to heading, Tat X SQ (-2.16 and -1.21%) for days to maturity, GZ x Tat (14.92 and 7.46%) for tillers/ plant, SQ x ICP (17.14 and 14.01%) for flag leaf area, Tat x Sar (-3.29 and -2.89%) for plant height, SQ x Der (19.11 and 16.21%) for spike length, Sar x Der (23.14 and 17.60%) for grains per spike, Tkb x Der (28.42 and 28.0%) for 1000 grain weight, SQ x ICP (24.69 and 21.68%) for harvest index and Tat x SQ (56.25 and 26.87%) for yield per plant, respectively. The results revealed that the hybrid combinations Tat x SQ and SQ x ICP could be recommended for improved yield and enhanced biological production of wheat, respectively.

Introduction

To get maximum yield associated with best quality combinations are the aims of the breeding programs. The use of heterosis for getting high yield with improved quality has been largely used in cross-pollinated crops. In self-pollinated crops evidences are available to confirm the potential use of heterosis (Haq & Laila, 1991), suggesting the easiest ways of the possibility of commercial exploitation of genetic potential of wheat crops. A number of explanations could be placed in this regard; *the theory of dominant linked genes* appears to be the most acceptable, both in the concept and utilization of hybrid vigor in self-pollinated crops (Singh *et al*., 1989; Saleem & Hussain, 1988).

Heterotic studies can also be used for getting information about the increase or decrease of F1s over their mid parent and better parent (heterobeltiosis). Its use for elaborating the general and specific combining ability, in the selection process is also confirmed.

Keeping in view the general rule of breeding, the higher the heterosis and heritability, the simpler the selection process and greater the response to selection. A diallel of bread wheat was employed for determination of the out yielding effects of wheat hybrids for 10 agronomic traits and their possible exploitation for commercial use.

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Materials and Methods

Eight commercial varieties of Bread wheat (*Triticum aestivum*), viz. Ghaznavi-98 (GZ), Fakhre Sarhad (FS), Tatara (Tat), Takbeer (Tkb), SQ-92 (SQ), Sar-3 (Sar), ICP-3 (ICP) and Der-98 (Der) and 28 F1's got from crossing the parents were planted in a Randomized Complete Block Design, with three replication. Each entry was planted in two rows of 2.5-meter length, with a plant-to-plant and row-to-row distance of 15 and 30 cm, respectively. Standard agronomic practices were followed from sowing till harvest. Data were recorded on 10 agronomic parameters i.e., days to heading, days to maturity, flag leaf area, tillers per plant, plant height, spike length, grains per spike, 1000-grain weight, harvest index and yield per plant.

The values of mid parent heterosis and better parent heterosis (heterobeltiosis) were calculated according to the scheme outlined by Matzingar *et al*., (1962) as given in the formulae:

Heterosis % = F1- MP X100/ MP

Heterobeltiosis % = F1- BPx100/ BP

F1, MP and BP in the formulae denote the performance of hybrid, average performance of parents and performance of better parent, respectively.

The data recorded for different characters were analyzed for variance in accordance with the technique of Steel & Torrie (1984). The characters showing significant differences were subjected to heterosis calculation.

Results and Discussion

Analysis of variance, means for the parents and hybrids are given in Tables 1, 2 and 3, respectively. Table 1 indicates highly significant differences among the genotypes for all the traits studied. Character wise discussion of the results is summarized below.

1. Days to heading: Early heading is desirable due to the fact that earlier heading provides sufficient time for grain formation and filling processes of the grain. The negative heterosis for days to heading is therefore useful. Negative heterosis was recorded for 23 out of the 28 crosses (Table 4). Maximum decrease over the mid parent was recorded by the cross GZ x Der (-5.35) followed by FS x Der (-4.46) and Sar x Der (-4.28), whereas maximum negative heterosis over better parent was recorded by GZ x Der (-4.98) followed by FS x Der (-4.46) and Tkb x Der (-3.19). The results are in conformity with the findings of Wu *et al*., (2001), Sadeque *et al*., (1991) and Murai (1998) that reveals the importance of heterotic studies for inducing earliness in wheat.

2. Days to maturity: Genotypes with early maturing habits are generally wanted; negative heterosis for days to maturity is therefore a useful parameter. 20 out of 28 crosses revealed negative heterosis (Table 4). Maximum negative mid parent heterosis was recorded for the cross Tat x SQ (-2.16) followed by GZ x Der (-1.61), whereas maximum negative better parent heterosis was shown by the same cross Tat x SQ (-1.21) followed by GZ x Der(-1.04). The cross SQ x Der (+2.29) recorded maximum positive mid parent and better parent heterosis. Mahajan & Nagarajan (2001) and Simon (1989) also observed that heterotic studies could be effectively used for incorporating early maturity in wheat.

Table 1. Analysis of variance for the characters studied.

S. No.	Characters	Mean squares		
		Replications df (2)	Genotypes df (63)	Error df (126)
1.	Days to heading	55.79	20.63**	3.28
2.	Days to maturity	128.92	7.30**	3.57
3.	Tillers per plant	17.07	6.31**	3.61
4.	Flag leaf area	115.38	22.23**	12.96
5.	Plant height	1545.17	67.21**	31.14
6.	Spike length	6.81	1.93**	0.72
7.	Grains per spike	219.64	110.85**	54.30
8.	1000 grain weight	105.59	41.90**	24.22
9.	Harvest index	200.38	35.51**	24.46
10.	Yield per plant	2.42	25.60**	15.57

** $P \leq 0.01$

3. Tillers per plant: Number of productive tillers directly contributes to plant yield; positive heterosis for tillers per plant is therefore desirable in wheat. Heterotic studies revealed that 13 out of 28 crosses were positive for heterotic effect over their respective mid parent (Table 4). Maximum positive mid parent heterosis was exhibited by the cross GZ x Tat (+14.92) followed by SQ x Sar (+10.89) and Sar x Der (+10.39). Maximum heterobeltiosis was shown by GZ x Tat (+7.46), followed by SQ x Sar (+6.96). Yu *et al.*, (1997), Walia *et al.*, (1993) and Sadique *et al.*, (1991) are also of the opinion that mid parent and better parent heterosis for tillers per plant could be obtained in wheat. Hence the crosses confirming the maximum heterosis GZ x Tat and SQ x Sar could further be employed for getting improved yield in bread wheat.

4. Flag leaf area: Flag leaf area is an effective yield related trait. A larger flag leaf helps to synthesize photosynthates in greater quantities, which are translocated to grains increasing their weight. Positive heterosis for flag leaf area is thus desirable (Kratochvil & Sammons 1990; Khan *et al.*, 1995; Mahmood & Chaudhry, 2000). Heterotic studies for flag leaf area revealed that 16 out of 28 crosses showed positive heterosis (Table 4). Maximum positive mid parent heterosis was recorded by SQ x ICP (+17.14) followed by Tat x ICP (+14.32) and FS x SQ (13.56), whereas maximum positive better parent heterosis was recorded for SQ x ICP (+14.03) followed by FS x Sar (+13.56).

5. Plant height: Plants with greater height are likely to lodge quite often. Tall plants require more energy to translocate solutes to the grain and have lower grain weight. Short stature wheat is therefore preferred and negative heterosis is desirable. Maximum negative heterosis was shown by Tat x Sar (-3.29) followed by FS x Tat (-0.38) and GZ x Tat (-0.37) whereas maximum negative heterobeltiosis was revealed by the hybrid Tat x Sar (-2.89). Sadeque *et al.*, (1991) reported negative heterosis for plant height, whereas positive heterosis for plant height has been recorded by Mahajan *et al.*, (1999), Khan & Bajwa (1989). The result showed that heterotic interaction improves genetic diversity and provides ample chances to select the desired combinations.

6. Spike length: In case of spike length 22 and 19 out of the 28 crosses showed positive heterosis over mid parent and better parent respectively (Table 5). Maximum mid parent and better parent heterosis values were +19.11 and +16.21 respectively, for the hybrid SQ x Der which was followed by FS x Der (+15.40) and (+13.81), respectively. The difference in response of genotypes towards heterosis is a studied phenomena e.g., Moiscu *et al*., (1984) and Thakur *et al*., (1991) have reported positive mid parent heterosis, while Sadeque *et al*., (1991) have recorded negative heterosis for spike length in wheat genotypes.

7. Grains per spike: Grains per spike directly determine the yield potential of a genotype. Analysis of the data revealed that 17 out of 28 crosses were positive mid parent heterotic and 8 out of 28 crosses were positive better parent heterotic in interaction. Maximum positive mid parent heterosis was recorded for Sar x Der (+23.14) followed by Tat x ICP (+22.92) and Sar x ICP (+12.85), whereas positive better parent heterosis was showed by Sar x Der (+17.60) followed by Sar x ICP (+12.67) and Tat x ICP (+11.80). These results could be verified from the findings of Saleem & Hussain (1988), Khan & Bajwa (1989) and Tiwari & Chakraborty (1992) who observed mid and better parent heterosis for grains per spike in wheat.

8. 1000 grain weight: Data on means for 1000-grain weight revealed that it was highest for the hybrid Tat x Tkb (49.20 g) and Sar x ICP (47.78 g), as shown in Table 3. For the 1000-grain weight 27 out of 28 crosses displayed positive heterosis (Table 5). Maximum positive mid parent heterosis revealed by the hybrid Tkb x Der (+28.42) followed by Sar x ICP (+26.0) and Tat x Tkb (+25.72) whereas maximum positive better parent heterosis was observed for the cross Tkb x Der (+28.0) followed by Sar x ICP (+25.27) and GZ x Tkb (+16.56). Positive heterosis for 1000-grain weight have also been reported by Pickett (1993), Saleem & Hussain (1988). The predominant heterotic interaction with respect to 1000-grain weight, in all the hybrids showed the effectiveness of heterosis for increased grain yield.

9. Harvest index: The highest mean value for harvest index was recorded (Table 3) for Tkb x Sar (38.6) and FS x Tkb (37.3). Heterotic studies revealed that 8 out of 28 crosses were positive by heterotic over mid parent value for harvest index (Table 5). Maximum positive heterosis for harvest index over mid parent was displayed by SQ x ICP (+24.7%), Tkb x Der (+19.3%) and Tkb x ICP (+18.4%). The maximum positive heterosis over better parent displayed by the cross SQ x ICP (+21.6%) was however followed by Tkb x Sar (+16.01%) and FS x Tkb (+12.0%). Wu *et al*., (2001) and Murai (1998) have also reported positive heterosis for harvest index.

10. Yield per plant: The highest mean value was recorded for the cross Tat x SQ (22.9g) followed by GZ x FS (20.8g) per plant (Table 3). Heterotic studies revealed that 18 out of 28 crosses were positive by heterotic interaction for yield per plant (Table 5). Maximum positive heterosis for yield per plant over mid parent was displayed by Tat x SQ (+56.25) followed by SQ x Der (+37.68) and SQ x Sar (+32.04). The maximum positive heterosis over better parent was displayed by Tat x SQ (+26.87) followed by GZ x FS (+20.39) and SQ x Der (+11.76). Singh *et al*., (2004), Afia *et al*., (2000) and Prasad *et al*., (1988) have reported mid parent and better parent heterosis for yield per plant.

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