

HETEROSIS IN BREAD WHEAT (*TRITICUM AESTIVUM* L.)

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ABSTRACT

*The performance of F_1 hybrids involving ten purelines of bread wheat (*Triticum aestivum* L. Em. Thell.) was studied to investigate heterobeltiosis and economic heterosis for grain yield and yield related characters. The heterobeltiosis and standard heterosis for grain yield per plant ranged from -29.99 to 39.60 and -23.92 to 20.05 per cent, respectively. The F_1 hybrid, RAJ-4136 x UAS-281 showed highest, significant and positive heterobeltiosis (39.60%) which was ranked second for both standard heterosis (16.69%) and high grain yield per plant (27.92g). The heterosis for grain yield appeared to be due to high manifestation of heterosis for number of effective tillers per plant, length of main spike, 100-grain weight and were main contributors towards increased grain yield per plant. Selection of crosses on the basis of per se performance would also be more desirable. Per se performance of hybrid was compared with heterobeltiosis revealed that there was significant and positive correlation between both parameters for all the traits. Similarly, there was also significant and positive association between heterobeltiosis and standard heterosis for all the traits.*

KEY WORDS: *Bread wheat, half-diallel analysis, heterobeltiosis, standard heterosis*

INTRODUCTION

Wheat (*Triticum* spp.) is usually accorded a premier place among the cereals because of the vast acreage devoted to its cultivation, its high nutritive value and its association with some of the earliest and most important civilizations of the world. Wheat is the second most important staple food crop next to rice, consumed by nearly 35 per cent of the world population and providing 20% of the total food calories. Wheat occupies about 32 per cent of the total acreage under cereals in the world. The commercial exploitation of heterosis in wheat has limited application because

of practical difficulties for hybrid seed production in sufficient quantity. Now-a-days, good progress has been achieved in the development of hybrid wheat varieties and several varieties are under testing. Hence, the knowledge of heterosis would help in determination of parents which produce the best cross combinations having maximum expression of heterosis and also produce desirable transgressive segregants in the advanced generations.

MATERIALS AND METHODS

The initial experimental material consisted of ten genotypes/varieties of bread wheat

(*Triticum aestivum* L. Em. Thell) viz., GW-496, GW-322, LOK-1, GW-173, KYZ-300, RAJ-4136, HW-5018, K-604, UAS-281, HI-1544, GW-366. These genotypes were crossed in all possible combinations using half-diallel mating design excluding reciprocal during *Rabi* 2010-11 at Wheat Research Station, Junagadh Agricultural University, Junagadh, Gujarat. A set of 56 entries, including 10 parents, their 45 crosses and one standard check (GW-366) were sown on randomized block design with three replications during *Rabi* 2011-12. Each entry was sown in a single row plot of 2.5 m long keeping row-to-row and plant-to-plant distance of 22.5 cm and 10 cm, respectively. Five plants of each parents and hybrids were selected randomly for recording observations for eight characters viz., number of effective tillers per plant, length of main spike (cm), number of spikelets per main spike, peduncle length of main spike (cm), number of grains per main spike, grain weight per main spike (g), 100-grain weight (g) and grain yield per plant (g). The heterosis over better parent and standard check was estimated as per the formula given by Fonseca and Patterson (1968).

RESULTS AND DISCUSSION

The analysis of variance revealed that mean square due to genotypes was highly significant for all the characters, indicating that experimental materials had sufficient genetic variability for all the characters studied. Mean square due to parents vs hybrids comparison was significant for all the characters except number of effective tillers per plant, number of spikelets per main spike, peduncle length of main spike and 100-grain weight indicating that the performance of hybrids as a group was different than that of parents for most of the characters. This revealed the presence

of substantial amount of heterosis in various cross combinations due to effect of directional dominance.

For number of effective tillers per plant, the heterosis over better parent ranged from -35.50 per cent (LOK-1 x GW-173) to 23.42 per cent (RAJ-4136 x UAS-281) and standard heterosis ranged from -23.01 per cent (LOK-1 x GW-173) to 29.51 per cent (LOK-1 x UAS-281) (Table 1). The estimates of heterobeltoiotic effect for length of main spike ranged from -17.45 per cent (LOK-1 x HW-5018) to 25.93 per cent (GW-173 x HI-1544) and that of standard heterosis from -5.38 per cent (LOK-1 x HW-5018) to 45.00 per cent (GW-173 x RAJ-4136). The estimates of heterobeltiosis for number of spikelets per main spike varied from -29.25 per cent (GW-496 x K-604) to 19.50 per cent (Lok-1 x GW-173), while the standard heterosis ranged from -17.99 per cent (KYZ-300 x HW-5018) to 20.29 per cent (GW-496 x KYZ-300). The estimates of heterobeltiosis for peduncle length of main spike ranged from -14.05 per cent (GW-173 x RAJ-4136) to 39.83 per cent (GW-322 x KYZ-300) and over standard check ranged from -21.86 per cent (GW-496 x GW-322) to 15.27 per cent (GW-322 x KYZ-300). The estimates of heterobeltiosis for number of grains per main spike varied from -35.05 per cent (GW-173 x K-604) to 24.58 per cent (GW-173 x HI-1544) and the cross GW-496 x HW-5018 exhibited the highest magnitude of standard heterosis (34.07%). The spectrum of variation for grain weight per main spike for heterobeltiosis was from -35.26 per cent (GW-173 x HW-5018) to 10.82 per cent (GW-322 x RAJ-4136), while that of standard heterosis was from 10.42 per cent (GW-173 x HI-1544) to 81.15 per cent (HW-5018 x K-604). The estimates of

heterobeltiosis for 100-grain weight varied from -41.53 per cent (Lok-1 x KYZ-300) to 28.94 per cent (HW-5018 x UAS-281) and that of standard heterosis varied from -14.08 per cent (GW-173 x HW-5018) to 56.84 per cent (HW-5018 x UAS-281). The spectrum of variation in heterobeltiosis for grain yield per plant varied from -29.99 per cent (Lok-1 x GW-173) to 39.60 per cent (RAJ-4136 x UAS-281). Overall, magnitude of heterotic effect was high for peduncle length of main spike, 100-grain weight and grain yield per plant, and it was low to moderate for number of effective tillers per plant, length of main spike, number of spikelets per main spike, number of grains per spike and grain weight per main spike.

The degree of heterosis varied from cross to cross for all the characters studied. In the present study, grain yield per plant was found to be most heterotic trait as out of 45 crosses studied, seven and three crosses manifested significant and positive heterosis over respective better parent and standard check (GW-366), respectively. The cross RAJ-4136 x UAS-281 showed highest, significant and positive heterobeltiosis (39.60%) which was ranked second for both standard heterosis (16.69%) and high grain yield per plant (27.92 g). On the other hand, the cross HW-5018 x K-604 showed highest, significant and positive standard heterosis (20.05%) and ranked second for heterobeltiosis (Table 1) along with maximum *per se* performance (28.72 g) followed by cross RAJ-4136 x UAS-281 (16.69 %) and HW-5018 x HI-1544 (16.18 %). These two hybrids had also recorded high grain yield of 27.92 g and 27.47 g, respectively. In such cases, expression of heterotic response over standard parent indicated the real superiority of hybrids from the

commercial point of view. High heterosis for grain yield in wheat has been reported by several earlier workers (Chakraborty and Tewari, 1995; Sharma and Menon; 1996; Nehvi *et al.*; 2000, Vanparia *et al.*, 2006; Singh *et al.*, 2007).

It will be of considerable interest to know the cause of heterosis for grain yield per plant. A comparison of seven most heterobeltiosis heterotic crosses for other yield-related characters along with average grain yield (Table 2) revealed that high and positive heterobeltiosis for grain yield in cross RAJ-4136 x UAS-281 was accompanied by positive and significant heterosis for number of effective tillers per plant; HW-5018 x UAS-281 and KYZ-300 x RAJ-4136 were accompanied by positive and significant heterosis for number of effective tillers per plant and 100-grain weight; GW-173 x RAJ-4136 and HW-5018 x HI-1544 were accompanied by positive and significant heterosis for length of main spike and 100-grain weight, respectively. It indicated that in different crosses, pathways for releasing heterotic effects varied from cross to cross. Thus, results revealed that number of number of effective tillers per plant, length of main spike and 100-grain weight were the main contributors towards increased grain yield. Grafius (1959) also indicated that heterosis in yield is reflected through heterosis in individual yield components or alternatively due to the multiplicative effects of partial dominance of component characters which further substantiated the present finding. Williams and Gilbert (1960) reported that even simple dominance in respect of yield components may lead to expression of heterosis in respect of yield. Hegberg (1952) observed similar

effects and termed it “combinational heterosis”.

A comparison of best performing three crosses in order with first three most standard heterotic crosses (Table 3) further revealed that all the three crosses are common in both the comparison for most of the characters. This indicated that selection of crosses on the basis of either *per se* performance or heterotic response would be equally important, but the former being more desirable. Thus, on the basis of both the criteria the crosses HW-5018 x K-604, RAJ-4136 x UAS-281, HW-5018 x HI-1544, and RAJ-4136 x HI-1544 appeared to be most suitable for practical plant breeding programme in bread wheat.

The correlation coefficients (Table 4) had been worked out with a view to know the relationship between different statistical parameters used in the present investigation. Hybrid *per se* performance was compared with heterobeltiosis revealed that there was significant and positive correlation between both parameters for all the traits. Similarly, there was also significant and positive association between heterobeltiosis and standard heterosis.

CONCLUSION

From the above results and discussion, F₁ hybrid, RAJ-4136 x UAS-281 showed highest, significant and positive heterobeltiosis (39.60%) which was ranked second for both standard heterosis (16.69%) and high grain yield per plant (27.92g) could be further exploited for further for getting transgressive segregants.

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Table 1 : Range of heterobeltiosis (H) and standard heterosis (SH) as well as number of crosses with specific heterotic effects for various traits in bread wheat

Sr. No.	Characters	Range of Heterosis (%)		Number of Crosses with Significant Heterosis			
		H (%)	SH (%)	H (%)		SH (%)	
				+Ve	-Ve	+Ve	-Ve
1.	Number of effective tillers per plant	-35.50 to 23.42	-23.01 to 29.51	4	12	7	6
2.	Length of main spike	-17.45 to 25.93	-5.38 to 45.00	5	8	29	0
3.	Number of spikelets per main spike	-29.25 to 19.50	-17.99 to 20.29	4	15	12	6
4.	Peduncle length of main spike	-14.05 to 39.83	-21.86 to 15.27	13	3	2	18
5.	Number of grains per main spike	-35.05 to 24.58	-12.11 to 34.07	3	27	32	2
6.	Grain weight per main spike	-35.26 to 10.82	10.42 to 81.15	1	18	42	0
7.	100-grain weight	-41.53 to 28.94	-14.08 to 56.84	9	13	42	0
8.	Grain yield per plant	-29.99 to 39.60	-23.92 to 20.05	7	5	3	4

Table 2 : Comparative study of seven most heterobeltiosis crosses for grain yield per plant along with *per se* performance and their heterotic effects for component characters in bread wheat.

Sr. No.	Crosses	Heterobeltiosis (%)								
		Grain Yield per Plant	Number of Effective Tillers per Plant	Length of Main Spike	Number of Spikelets per Main Spike	Peduncle Length of Main Spike	Number of Grains per Main Spike	Grain Weight per Main Spike	100 Grain Weight	<i>Per se</i> Grain Yield per Plant (g)
1.	RAJ-4136 x UAS-281	39.60**	23.42**	-7.67	-17.25**	8.00*	-26.26**	-3.80	3.75	27.92
2.	HW-5018 x K-604	30.56**	2.12	-0.33	-13.95**	9.42*	-18.11**	-9.22*	0.43	28.72
3.	KYZ-300 x HW-5018	22.32**	6.06	-15.00	-23.88**	16.68**	-3.97	-17.57**	1.74	26.91
4.	HW-5018 x UAS-281	19.76**	15.15*	0.00	-0.78	-2.73	-22.69**	3.80	28.94**	26.35
5.	KYZ-300 x RAJ-4136	19.53*	15.45*	3.86	0.00	8.03	-23.23**	5.82	18.45**	26.30
6.	GW-173 x RAJ-4136	16.42*	-17.87**	25.50**	-1.61	-14.05**	-23.34**	-15.67**	-1.47	25.61
7.	HW-5018 x HI-1544	16.18*	-4.44	-2.33	3.14	-1.39	-22.69**	-14.33**	10.11**	27.47

*,** Significant at 5% and 1% levels, respectively

Table 3 : Best three crosses in respect of standard heterosis and *per se* performance in bread wheat.

Character	Best heterobeltiosis crosses	Best standard heterotic crosses	Best performing crosses
Number of effective tillers per plant	RAJ-4136 x UAS-281	Lok-1 x UAS-281	RAJ-4136 x UAS-281
	RAJ-4136 x HI-1544	RAJ- 4136xUAS-281*	RAJ-4136 x HI-1544
	KYZ-300 x RAJ-4136	RAJ-4136 x HI-1544*	HW-5018 x UAS-281
Length of main spike	GW-173 x RAJ-4136	GW-173 x RAJ-4136*	GW-173 x RAJ-4136
	GW-173 x HI-1544	GW-173 x HI-1544*	GW-173 x HI-1544
	UAS-281 x HI-1544	GW-496 x HW-5018*	GW-496 x HW-5018
Number of spikelets per main spike	Lok-1 x GW-173	GW-496 x KYZ-300*	GW-496 x KYZ-300
	GW-496 x KYZ-300	RAJ-4136 x HW-5018*	RAJ-4136 x HW-5018
	GW-173 x HI-1544	GW-322 x KYZ-300	KYZ-300 x UAS-281
Peduncle length of main spike	GW-173 x RAJ-4136	GW-496 x GW-322*	GW-496 x GW-322
	GW-173 x HW-5018	GW-322xLok-1*	GW-322 x Lok-1
	GW-496 x K-604	GW-173 x RAJ-4136*	GW-173 x RAJ-4136
Number of grains per main spike	GW-173 x HI-1544	GW-496 x HW-5018*	GW-496 x HW-5018
	Lok-1 x UAS-281	HW-5018 x HI-1544*	HW-5018 x HI-1544
	Lok-1 x HI-1544	KYZ-300 x K-604*	KYZ-300 x K-604
Grain weight per main spike	GW-322 x RAJ-4136	HW-5018 x K-604*	HW-5018 x K-604
	-	HW-5018 x UAS-281*	HW-5018 x UAS-281
	-	HW-5018 x HI-1544*	HW-5018 x HI-1544
100-grain weight	HW-5018 x UAS-281	HW-5018 x UAS-281*	HW-5018 x UAS-281
	GW-322 x K-604	GW-322 x K-604*	GW-322 x K-604
	KYZ-300 x RAJ-4136	KYZ-300 x RAJ-4136	Lok-1 x RAJ-4136
Grain yield per plant	RAJ-4136 x UAS-281	HW-5018 x K-604*	HW-5018 x K-604
	HW-5018 x K-604	RAJ-4136 x UAS-281*	RAJ-4136 x UAS-281
	KYZ-300 x HW-5018	HW-5018 x HI-1544*	HW-5018 x HI-1544

* Cross combination common in both comparisons

Table 4 : Correlation coefficient between *per se* performance of hybrid, heterobeltiosis, as well as standard heterosis in bread wheat.

Sr. No.	Characters	<i>Per se</i> Performance and Heterobeltiosis	Heterobeltiosis and Standard Heterosis
1	Number of effective tiller per plant	0.732**	0.732**
2	Length of main spike	0.922**	0.922**
3	Number of spikelet per main spike	0.743**	0.743**
4	Peduncle length of main spike	0.769**	0.763**
5	Number of grains per main spike	0.862**	0.862**
6	Grain weight per main spike(g)	0.469**	0.469**
7	100-grain weight	0.374*	0.368*
8	Grain yield per plant	0.899**	0.899**

*,** Significant at 5% and 1% levels, respectively