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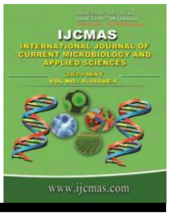

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Heterosis Analysis in F_1 Hybrids of Bread Wheat (*Triticum aestivum* L. em. Thell.) Over Environments

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ABSTRACT

The present investigation entitled "Heterosis Analysis in F_1 Hybrids of Bread wheat (*Triticum aestivum* L. em. Thell.) Over Environments" was undertaken using ten genetically diverse parents following diallel mating design excluding reciprocals. The resultant 45 F_1s and all the ten parents were evaluated in randomized block design with three replications under three different environments created by three dates of sowing [15 November (E_1), 1 December (E_2), 15 December (E_3)]. Sufficient degree of heterosis and heterobeltiosis was observed for all the attributes. The crosses WH 1021 x PBW 550, Raj 3765 x Raj 3077 and Raj 4238 x WH 1021 in E_1; WH 1021 x PBW 550, Raj 3765 x Raj 3077 and DBW 90 x PBW 550 in E_2 and WH 1021 x PBW 550, Raj 4238 x WH 1021 and Raj 3765 x HD 3086 in E_3 emerged as heterotic as well as heterobeltiotic crosses for grain yield per plant. These crosses were the product of good x good, good x poor or poor x poor general combiners. These crosses were considered promising for their use for yield improvement in wheat. Heterosis and heterobeltiosis were also observed maximum for grain yield per plant.

Keywords

Heterosis,
Heterobeltiosis,
Bread wheat

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Introduction

Bread wheat is considered as a staple food source for a large population of the world and also provides a range of diversified baked food products. Hence, wheat and its production are the chief food sources for human diet (Kumar *et al.*, 2013). To feed flourishing population of India; the genetic improvement of wheat genotypes for high yield potential is a dire need. For this purpose, the exploitation of maximum genetic potential from available genetic resources of wheat is a pre- requisite.

F_1 hybrid carrying heterotic effects, which are featured in all crop species, the yield gains are limited to the F_1 generation. The F_2 and succeeding generations obtained through selfing are discarded since reduced yields and developmental characters (Wang *et al.*, 2015). Heterosis is considered as the superiority of the hybrids in comparisons to either of its parents. It is the allelic or non-allelic interaction of genes under the influence of specific environment. Heterosis has been estimated in a range of cultivated crops and has been the purpose of considerable importance to study as mean of increasing productivity of crop plant.

It is now well established that heterosis does occur with proper combination of parents. Formerly, utilization of heterotic effects for grain yield was mainly ascribed to cross-pollinated crops. However, later it was reported in wheat as being predominantly self-pollinated for the first time by Freeman (1919), who well-versed the supremacies of F_1 crosses over their parents (Özgen, 1989). Briggle (1963) described existence of heterosis in substantial quantity for grain yield components in different F_1 wheat crosses. Keeping in view the above facts, the current research was designed to estimate heterotic effects in forty five crosses of wheat.

Materials and Methods

The present investigation aimed to gather information's on the genetic basis of yield and its contributing traits in ten diverse genotypes of bread wheat (*Triticum aestivum* L. em. Thell.). These selected genotypes were planted at Research Farm, College of Agriculture, Swami Keshawanand Rajasthan Agricultural University, Bikaner for hybridization in diallel fashion excluding reciprocals. The experiment was laid out in a randomized block design with three replications. Row to row and plant to plant spacing was maintained at 22.5 cm and 10 cm. Observations were recorded on ten randomly selected competitive plants of each parent and 45 F_1's. Observations on days to heading, days to maturity and grain filling period were recorded on whole plot basis. The data on plant height, flag leaf area, number of effective tillers per plant, spike length, number of grains per spike were recorded on the tagged plant in the field, while data for characters like 1000 seed weight (g), grain yield per plant and harvest index were recorded after uprooting the randomly selected plants from the field. The heterosis (H%) and heterobeltiosis (HB%) values were estimated as the deviation of the F_1 value from the mid-parent and the better-parent values as suggested by Matzinger *et al.*, (1962) and Fonseca and Patterson (1968), respectively.

Results and Discussion

In present investigation, heterosis over mid parent and better parent has been estimated in order to explore the possibility of using in the production of hybrids. The expression of heterosis and heterobeltiosis, in general, was variable for different traits under all the environments. Heterotic expression was fairly high and desirable for grain yield per plant (82.72 per cent in E_2), number of effective tillers per plant (67.50 per cent in E_1), biological yield per plant (49.64 per cent in E_3), harvest index (44.82 per cent in E_3), number of grains per spike (37.89 in E_3), grain filling period (36.36 per cent in E_2), spike length (35.72 per cent in E_3), flag leaf area (35.16 per cent in E_3) and 1000-seed weight (25.03 per cent in E_3). Similarly, magnitude of heterobeltiosis was fairly high and desirable for grain yield per plant (76.59 per cent in E_2), number of effective tillers per plant (58.77 per cent in E_1), biological yield per plant (42.24 per cent in E_3), grain filling period (35.01 per cent in E_2), number of grains per spike (32.46 per cent in E_3), flag leaf area (32.24 per cent in E_1), harvest index (32.22 per cent in E_3), spike length (30.07 per cent in E_3) and 1000-seed weight (22.46 per cent in E_3). The results are in agreement with those of others obtained in varying environments for different characters Afiah *et al.*, (2000), Rasul *et al.*, (2002), Singh and Singh (2003), Singh *et al.*, (2004), Akbar *et al.*, (2010), Kumar and Maloo (2011), Beche *et al.*, (2013), Kumar *et al.*, (2014) and Saren (2018) also reported maximum heterosis for grain yield per plant..

In current study, the highest range of heterosis has been estimated for all the attributes. The range of heterosis over mid-parent for grain yield per plant from -46.28 per cent to 60.86 per cent in E_1, -47.42 per cent to 82.72 per cent in E_2 and -41.22 per cent to 81.05 per cent in E_3. The results in varying environments for different characters are in conformity with the findings of Rasul *et. al.* (2002), Punia *et al.*, (2005), Akinci (2009), Lal *et al.*, (2013) and Gaur *et al.*, (2014). The superiority of hybrids particularly over better parent (heterobeltiosis) is more important and useful in determining the feasibility of commercial exploitation of heterosis and also indicating the parental combinations capable of producing the highest level of transgressive segregants.

Three best heterotic and heterobeltiotic crosses for grain yield per plant along with their SCA effects and *per se* performance in different environments are presented in Table 1. Perusal of this table indicated that the crosses WH 1021 x PBW 550 in all three environments, Raj 3765 x Raj 3077 in E_1 and E_2 and Raj 4238 x WH 1021 in E_1 and E_3 emerged as good heterotic as well as heterobeltiotic crosses for grain yield per plant. Among top three crosses for grain yield per plant in all the environments, the crosses WH 1021 x PBW 550 and Raj 4238 x WH 1021 showed desirable heterosis and heterobeltiosis for one or more characters in all the environments.

Table.1 Best three heterotic and heterobeltiotic crosses for grain yield per plant along with their SCA effects and *per se* performance in different environments

Envs.	**Heterotic crosses**	**Heterosis**	**SCA effect**	***Per se* performance (g)**	**Heterobeltiotic crosses**	**Hetero-beltiosis**	**SCA effect**	***Per se* performance (g)**
E_1	WH 1021 x PBW 550	60.86	10.06**	29.59	WH 1021 x PBW 550	52.84	10.06**	29.59
	Raj 3765 x Raj 3077	55.99	10.31**	30.16	Raj 4238 x WH 1021	49.71	7.69**	26.17
	Raj 4238 x WH 1021	49.93	7.69**	26.17	DBW 90 x PBW 550	36.83	7.74**	26.49
E_2	WH 1021 x PBW 550	82.72	9.75**	25.80	WH 1021 x PBW 550	76.59	9.75**	25.80
	Raj 3765 x Raj 3077	54.07	8.39**	26.57	DBW 90 x PBW 550	43.98	7.13**	23.44
	DBW 90 x PBW 550	51.76	7.13**	23.44	Raj 3765 x Raj 3077	35.29	8.39**	26.57
E_3	WH 1021 x PBW 550	81.05	7.48**	20.35	Raj 4238 x WH 1021	67.79	7.04**	18.91
	Raj 4238 x WH 1021	75.09	7.04**	18.91	WH 1021 x PBW 550	67.49	7.48**	20.35
	Raj 3765 x HD 3086	59.79	7.00**	19.35	DBW 90 x PBW 550	35.88	5.65**	16.51

Table.2 Crosses possessing high heterosis and heterobeltiosis for grain yield per plant along with desirable (+) heterotic expression for other characters in different environments

Particulars	Environments	Crosses	Magnitude of SCA effect of grain yield per plant	*Per se* performance for grain yield per plant	Magnitude of heterosis or heterobeltiosis in per	Days to heading	Days to maturity	Grain filling period	Plant height	Flag leaf area	Number of effective tillers per plant	Spike length	Number of grains per spike	1000-Seed weight	Biological yield per plant	Harvest index
Heterosis	**E_1**	WH 1021 x PBW 550	10.06	29.59	60.86	+	+	-	-	+	+	+	+	+	+	+
		Raj 3765 x Raj 3077	10.31	30.16	55.99	+	-	+	-	-	+	+	+	+	+	+
		Raj 4238 x WH 1021	7.69	26.17	49.93	+	+	-	-	+	+	+	+	+	+	+
	E_2	WH 1021 x PBW 550	9.75	25.80	82.72	+	+	+	-	+	+	+	+	+	+	+
		Raj 3765 x Raj 3077	8.39	26.57	54.07	-	-	+	-	-	+	+	+	+	+	+
		DBW 90 x PBW 550	7.13	23.44	51.76	+	+	-	-	-	+	+	+	+	+	+
	E_3	WH 1021 x PBW 550	7.48	20.35	81.05	+	+	+	-	+	+	+	+	+	+	+
		Raj 4238 x WH 1021	7.04	18.91	75.09	+	+	+	-	+	+	+	+	+	+	+
		Raj 3765 x HD 3086	7.00	19.35	59.79	+	-	+	-	-	+	+	+	+	+	+
Heterobeltiosis	**E_1**	WH 1021 x PBW 550	10.06	29.59	52.84	+	+	-	-	-	+	+	+	+	+	+
		Raj 4238 x WH 1021	7.69	26.17	49.71	+	+	-	-	+	+	+	+	+	+	+
		DBW 90 x PBW 550	7.74	26.49	36.83	+	+	-	-	-	+	-	+	+	+	+
	E_2	WH 1021 x PBW 550	9.75	25.80	76.59	+	+	+	-	+	+	+	+	+	+	+
		DBW 90 x PBW 550	7.13	23.44	43.98	+	+	-	-	-	+	-	+	+	+	+
		Raj 3765 x Raj 3077	8.39	26.57	35.29	+	-	-	-	-	+	+	+	+	+	+
	E_3	Raj 4238 x WH 1021	7.04	18.91	67.79	+	+	-	-	+	+	+	+	+	+	+
		WH 1021 x PBW 550	7.48	20.35	67.49	+	+	-	-	+	+	+	+	+	+	+
		DBW 90 x PBW 550	5.65	16.51	35.88	-	+	-	-	+	+	-	+	+	+	+

Hence, these crosses may be considered as promising type for tangible advancement of bread wheat yield under normal sown and thermal stress condition. Crosses possessing high heterosis and heterobeltiosis for grain yield per plant along with desirable (+) heterotic expressions for other traits in different environments are presented in Table 2. Assessment of Table 2 divulged an interesting relation between heterosis and heterobeltiosis of grain yield per plant and other yield attributing traits.

The parents, who showed desirable heterosis and heterobeltiosis for grain yield per plant, also exhibited desirable heterosis and heterobeltiosis at least for one or more yield attributing traits. Such as, heterosis for grain yield per plant was mainly contributed by number of grains per spike and number of effective tillers per plant while heterobeltiosis by number of grains per spike and number of effective tillers per plant in all the three environments. Findings of this investigation supported the contentions of Grafius (1959), who suggested that there could be no separate gene system for yield *per se* as yield is an end product of the multiplicative interactions among its various contributing attributes.

Thus, heterobeltiosis for various yield contributing characters might be result in the expression of heterobeltiosis for grain yield. However, the crosses showing heterotic expression for grain yield per plant were not heterotic for all the characters. It was also noted that the expression of heterosis and heterobeltiosis was influenced by the environments for almost all the characters. This was because of significant G x E interaction. The results are in harmony with Singh *et al.,* (2004), Kumar and Sharma (2005), Hassan *et al.,* (2007), Akbar *et al.,* (2010), Kumar and Maloo (2011), Lal *et al.,* (2013) and Baloch *et al.,* (2016).

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