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Heterosis estimation of wheat grown under boron deficient soil of *terai* region of West Bengal

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ABSTRACT

Present investigation was conducted to estimate the extent of heterosis in 15 cross combinations developed following half diallel mating design involving 6 parents under boron deficient soils of West Bengal. The material generated (F_1) along with parents were grown during rabi season of (2007) in the experimental plot following randomized block design with 3 replications and data were recorded on ten randomly selected plants and extent of heterosis was estimated. Significant heterosis as well as heterobeltiosis towards desirable direction was noticed in most of the hybrids for the concerned traits, however, filled grain spike^{-1} was found to be most influencing trait to enhance yield plant^{-1}. The cross (HD-2733 × Schomburgk) was found to be most promising for superior per- se performance for yield with high heterosis and heterobeltiosis for the characters considered in the present investigation and some elite lines suitable for boron- deficient soil may be evolved from the cross following selection in the successive generations.

Key words: Boron-deficiency, grain yield, heterosis, wheat

Wheat is second most important cereal crop after rice in West Bengal producing 8 lakh 42 thousand ton from 3 lakh 16 thousand hectares area (Anon., 1989). The terai zone of West Bengal has some inherent natural advantages conducive for successful wheat production like prolonged winter season with longer duration of bright sunshine hour and high residual soil moisture, etc (Anon.,1989). Despite the presence of these natural advantages productivity of wheat in the region is very poor. The major constraint in wheat yield is identified as deficiency of micronutrients, particularly boron (B) (Mitra and Jana, 1991). In boron-deficient soils in the region, its concentration was found to be 0.27 ppm which severely affect wheat yield (Chowdhury *et al.*, 2008). Bodruzzaman *et al.*, 2003 reported that boron deficiency in soil is responsible for failure in grain set and thereby causing losses in yield by producing proportionately high extent of chaffy grains. A variable response among wheat varieties for boron deficiency has been reported (Jamjod and Rerkasem, 2004) which may provide scope for selection of least affected genotypes against the deficiency of this micro-nutrient. Such genotypes can be utilized in combination breeding for development of high yielding elite lines adaptable to such an abiotic stress situation.

Estimation of heterosis helps to identify superior crosses bearing potentiality to develop improved cultivars for different agronomic traits. For the first time, evidences are indicated the scope of utilization of heterosis in wheat (Inamullah *et al.*, 2006). The present research work, therefore, was undertaken to estimate the magnitude and direction of relative heterosis and heterobeltiosis with the purpose of utilizing the information in wheat breeding programme to develop high yielding lines to benefit the farmers in the region.

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MATERIALS AND METHODS

The field experiment was carried out at the Institutional farm, Uttar Banga Krishi Viswavidyalaya, Pundibari, Coochbehar, West Bengal during the *rabi* seasons of 2008-09 after obtaining F_1 seeds in the previous year from crossing block. The farm is located at the terai zone of West Bengal. Soil texture was sandy to sandy loam with detrimental effect of leaching of major macro and micronutrients. The concentration of boron which implicated lower productivity of wheat in the region was estimated as less than 0.21 ppm. Six commercial varieties of bread wheat (*Triticum aestivum L*) with different levels of tolerance to boron deficiency were considered; of these six parents the tolerant, moderately tolerant and susceptible genotypes were DBW 14 and Schomburgk, Halna and PBW 343, WH 736 and HD 2733, respectively. The 6 parents were considered in combination breeding following diallel design without reciprocals and the F_1s along with their parents were sown following randomized block design with three replications, three rows in each replication with row length 1.5 m. The row-to-row and plant to plant spacing were maintained as 30 cm and 15 cm, respectively. Recommended doses of major nutrients, micronutrients (except boron) were applied and standard agronomic practices were followed. Ten plants were selected randomly from each plot for recording data on different characters like filled grains spike^{-1}, chaffy grains (%), 1000-grain weight (g), yield plant^{-1} (g) and harvest index (%). Analysis of variance was done following Gomez and Gomez (1984). Heterosis and heterobeltiosis for the characters were estimated following Matzinger *et al.* (1962).

Table 1: Analysis of variance for the characters studied

Source	df	Mean sum of square (MSS)				
		Filled grains spike^{-1}	Chaffy grain	1000 grain weight	Yield plant^{-1}	Harvest index
Replication	2	0.17	0.27	2.02	0.04	1.64
Genotypes	20	146.31**	253.21**	10.23**	5.90**	13.88**
Error	40	0.14	0.62	0.18	0.04	0.40

*Note: ** significant at 1% level of probability*

Table 2: Mean performance of the parents and crosses for the characters studied

Parents / Crosses	Filled grains spike^{-1}	Chaffy grain (%)	1000 grain weight (g)	Yield plant^{-1} (g)	Harvest index
WH 736	10.42	38.93	36.03	1.59	14.87
HD 2733	10.95	39.55	35.89	1.71	15.67
Halna	24.48	26.84	37.70	3.15	19.05
PBW 343	25.18	27.46	37.18	3.17	19.39
DBW 14	30.59	15.10	39.10	5.26	20.19
Schomburgk	31.23	11.99	39.00	5.48	20.27
WH 736 × HD 2733	9.98	39.14	33.23	2.68	14.44
WH 736 × Halna	20.39	26.94	38.99	4.33	18.41
WH 736 × PBW 343	19.71	28.20	39.30	4.22	18.81
WH 736 × DBW 14	20.63	25.94	38.94	5.19	19.62
WH 736 × Schomburgk	27.01	23.55	39.19	5.50	20.09
HD 2733 × Halna	21.06	25.89	38.34	4.66	19.23
HD 2733 × PBW 343	20.09	30.80	37.97	3.91	16.29
HD 2733 × DBW 14	29.30	12.55	39.59	6.00	19.58
HD 2733 × Schomburgk	32.34	12.37	40.06	6.13	20.90
Halna × PBW 343	20.33	23.22	38.04	4.81	19.32
Halna × DBW 14	31.81	13.69	39.73	6.09	20.50
Halna × Schomburgk	22.70	25.72	39.32	4.69	18.84
PBW 343 × DBW 14	27.97	14.52	39. 43	5.77	19.91
PBW 343 × Schomburgk	30.78	12.44	38.41	6.04	20.01
DBW 14 × Schomburgk	31.17	12.46	40.22	6.06	20.06
SEm (±)	**0.21**	**0.45**	**0.25**	**0.12**	**0.36**
LSD (0.05)	**0.61**	**1.29**	**0.70**	**0.34**	**1.04**

RESULTS AND DISCUSSION

The analysis of variance (Table 1) indicated presence of significant genotypic effect for all the characters studied and predicted wider variation among the genotypes for the characters which may provide ample scope for improvements on the traits. Mean performance of different characters and their heterosis were highlighted in table- 2 and 3, respectively.

Filled grain spike^{-1} was found to be highest in Schomburgk followed by DBW 14 and lowest in WH736 and HD 2733. Filled grains in rest of the genotypes were found to be moderately high. The cross HD 2733 × Schomburgk showed highest value for the character with no significant difference from Halna × DBW 14 whereas, WH736 × HD 2733 showed least filled grains. The grain filling was also found to be better in (DBW 14 × Schomburgk) and (PBW 343 × Schomburgk). Least chaffy grain was found in Schomburgk and also in the hybrids like (HD 2733 × DBW 14), (PBW 343 × Schomburgk), (DBW 14 × Schomburgk). Chaffy grain was also found to be low in DBW 14 and in the hybrids, (Halna × DBW 14), (PBW 343 × DBW 14). Highest 1000-grain weight was found in the genotypes DBW 14 and Schomburgk and lowest in HD 2733 and WH 736. The hybrids (DBW 14 × Schomburgk), (Halna × DBW 14), (HD 2733 × DBW 14) and (PBW 343 × DBW 14) had shown maximum improvement over this trait.

Yield plant^{-1} was found to be highest in Schomburgk and DBW 14 with no significant difference between themselves. Poorest yield was found within the genotypes WH 736 and HD 2733 and rest of the genotypes had higher yield. The hybrid (HD 2733 × Schomburgk) was found to be highest yielder and showed no significant difference with other 3 hybrids like (Halna × DBW 14), (DBW 14 × Schomburgk), (HD 2733 × DBW 14). Significant heterosis as well as heterobeltiosis for yield were found only in the crosses (HD 2733 × Schomburgk), (Halna × DBW 14) whereas other

Table 3: Estimation of heterosis (%) of F_1 generation over mid parents (MP) and better parents (BP) for the characters

Crosses	Filled grains spike^{-1}		Chaffy grain (%)		1000 grain weight (g)		Yield plant^{-1} (g)		Harvest index	
	MP	BP	MP	BP	MP	BP	MP	BP	MP	BP
WH 736 × HD 2733	2.56	2.47	1.22	1.05	3.67**	-0.31	-27.01**	-36.24**	6.44*	4.47
WH 736 × Halna	74.48**	35.55**	-17.29**	-31.19**	1.43	-1.67	-10.50*	-37.52**	11.34**	-0.90
WH 736 × PBW 343	65.60**	23.52**	-11.74**	-29.60**	0.42	-2.27*	-6.85	-34.07**	13.00**	0.36
WH 736 × DBW 14	61.11**	9.36**	-43.57**	-61.28**	3.22	-1.46	-32.76**	-10.62**	15.50**	1.26
WH 736 × Schomburgk	53.41**	2.68*	-40.52**	-53.65**	1.01	-5.39**	27.46**	-15.36**	16.43**	1.54
HD 2733 × Halna	45.36**	12.92**	-16.97**	-30.92**	7.28**	1.68	7.62*	-14.20**	10.83**	-4.23
HD 2733 × PBW 343	29.96**	-3.07*	-9.35**	-17.09**	7.06**	0.46	7.94*	-12.40**	12.91**	-2.64
HD 2733 × DBW 14	8.68**	-26.23**	-3.05	-33.48**	10.64**	-1.65	18.31**	-10.10**	15.72**	-1.46
HD 2733 × Schomburgk	58.88**	5.31**	-53.41**	-69.26**	9.29**	0.81	41.00**	5.20*	31.12**	11.64**
Halna × PBW 343	4.80**	-1.23	25.17**	18.47**	-0.12	-0.18	-20.31**	-21.80**	-15.72**	-15.00**
Halna × DBW 14	27.47**	3.06*	-51.92**	-68.28**	2.41**	0.35	13.55**	5.95*	6.90**	4.45
Halna × Schomburgk	10.91**	-12.04**	22.48**	-9.41**	-1.07	-4.94**	-9.04**	-17.22**	-6.52*	-3.75
PBW 343 × DBW 14	-11.39**	-24.01**	58.24**	29.07**	1.63*	-0.41	-13.49**	-19.28**	-6.68*	-4.50
PBW 343 ×Schomburgk	-10.46**	-26.07**	45.06**	11.83**	-0.74	-4.62**	-15.47**	-23.07**	4.79*	1.79
DBW 14 × Schomburgk	8.27**	3.50**	-9.40*	-17.97**	1.97*	2.31*	7.83*	3.01	2.08	1.10
SEm (±)	**0.26**	**0.39**	**0.55**	**0.64**	**0.30**	**0.35**	**0.15**	**0.17**	**0.44**	**0.51**

*Note: *, ** significant at 5% and 1% level of probability, respectively*

two crosses like (WH 736 × Schomburgk) and (HD 2733 × DBW 14) depicted higher magnitude of significant heterosis but their heterobeltiosis were significantly negative (Table 3). Afiah *et al.* (2000) reported significant heterosis and heterobeltiosis in wheat but Singh *et al.* (2004), Khatun *et al.* (2010) observed significant negative heterosis and heterobeltiosis in some of the crosses.

Highest significant heterosis and heterobeltiosis for filled grains spike^{-1} was observed in WH 736 × Halna followed by WH 736 × PBW 343, other 7 crosses also showed significant positive heterosis and heterobeltiosis for the trait. Superior per-se performance with significant heterosis as well as heterobeltiosis was also observed in crosses HD 2 733 × Schomburgk and Halna × DBW 14. Significant positive heterosis in wheat hybrid for this trait was also reported by Cifci and Yagdi (2000) though Baric *et al.* (2004) observed negative heterosis. Highest significant heterosis and heterobeltiosis in desired direction for chaffy grain was observed in HD 2733× Schomburgk followed by Halna × DBW 14, WH 736 × DBW 14 and WH 736 × Schomburgk. HD 2733 × Schomburgk was also found to be superior for its lowest amount of chaffy grains. Likewise, DBW 14 × Schomburgk were also sorted out as desirable having lowest amount of chaffy grain accompanied by heterosis as well as heterobeltiosis. Though desirable performance for the trait was also observed in PBW 343 × Schomburgk, its heterosis and heterobeltiosis were not at all favourable. Febriozino *et al.* (1998) and Hussain *et al.* (2007) also found significant heterosis for the trait in some hybrids.

Out of the six genotypes considered in the present investigation Schomburgk and DBW 14 was found to be most promising for cultivation in boron deficient soil having potentiality to give maximum yield with high test weight and filled grain percentage and less chaffy grain and these can be utilized for further maximization of yield in boron deficient soil as some crosses involving these genotypes like (HD 2733 × Schomburgk) , (Halna × DBW 14) showed maximum heterotic effects for yield and other related traits.

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