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ESTIMATION OF HETEROSIS FOR YIELD AND SOME YIELD COMPONENTS IN BREAD WHEAT (*TRITICUM AESTIVUM* L.)

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ABSTRACT

Heterosis estimated over mid and better parents in 7 x 7 half diallel design for ten different cross combinations of bread wheat. The crosses were estimated for yield and yield contributing characters. The maximum heterobeltiosis was recorded for Productive tillers per plant (47.64%) and Weight of grains per spike (26.41%). The crosses DI-9 x MP-4080, LOK-62 × PHS-0622, PHS-0622 × MP-4080 and DI-9 × PHS-0622 were identified as promising for many desirable traits and they may be useful in exploiting hybrid vigour. The data provides information on heterotic advantage of important yield and associated components. The highest heterotic genotypes can be exploited in future breeding programs to attain self-sufficiency in food grains. However, comprehensive field evaluation over locations and years is advocated for the crosses having significant heterosis before their commercial exploitation.

INTRODUCTION

Wheat is one of the first cereals known to have been domesticated, and wheat's ability to self-pollinate greatly facilitated the selection of many distinct domesticated varieties. There is a little increase in yearly crop yield comparison to the year 1990. The reason for this is not in development of sowing area, but the slow and successive increasing of the average yield.

The solution lies in heterosis breeding, providing the way to overcome the yield barriers. Wheat production can be enhanced through the development of new cultivars having wider genetic base and better performance under various agro-climatic conditions.

Researchers (Griffing, 1956; Hayman, 1954; Mather and Jinks, 1982) developed techniques to analyze genotypes for all possible crosses. The scope for utilization of heterosis largely depends on the direction and magnitude of heterosis. The magnitude of heterosis provides a basis for determining the parents used to exploit the heterosis. Exploitation of heterosis appears to be cheap and easy way for increasing yield in many crops. Significant efforts have been made to find the economically feasible systems for the production of F_1 hybrids. The possible heterosis exploitation in wheat crop continues to be a critical question. Singh *et al.* 2004, suggested that especially heterosis over better parent (heterobeltiosis) can be useful for determining true heterotic cross combinations. Selecting suitable parents is the basic need for designing a useful and successful hybridization programme. The studies on heterosis in wheat has also been done by Srivastava and Singh (2008); ZhaoPeng *et al.* (2009); Ashutosh *et al.* (2011); Beche *et al.* (2013) and Devi *et al.* (2013).

Mostly work of heterosis was done in cross pollinated crops to exploit hybrid vigour. The present investigation was under taken to estimate the level of heterosis and heterobeltiosis among F_1 hybrids of seven wheat varieties/lines. These information would be useful to investigate the performance and relationship of F_1 hybrids and parents and to select suitable parents and population for designing an effective wheat breeding programme.

MATERIALS AND METHODS

In order to formulate valuable information regarding heterotic aspects of wheat hybrids this investigation was undertaken during, 2010-11 at Department of Agricultural Botany, College of Agriculture, Pune. The genotypes DI-9, LOK-62, FLW-8, WH-147, WR-1392, PHS-0622 and MP-4080 were used to attempt F_1 crosses in half diallel. The list of significant crosses is given in Table 1.

The seven promising parents with crosses were grown in randomized block design (RBD) with three replications during, *Rabi,* 2010. Each treatment consist of two rows of two meter length consisting of 20 plants in row with 10 cm distance within row and 22.5 cm distance was kept between rows. The observations were recorded on five randomly selected plants of each treatments for six important yield contributing characters *viz*. number of productive tillers per plant, spikelets per spike, grain weight per spike (g), 100 grain weight (g), yield per plant (g) and glutent content (%).

The estimation of heterosis was done as per Rai (1979). Analysis of variance was performed to test the significance of difference among the genotypes for the characters studied, as suggested by Panse and Sukhatme, (1957).

The percent increase or decrease of F_1 hybrids over mid parent as well as better parent was calculated to estimate possible heterotic effects for above mentioned parameters, as below

$$Ht(\%) = \frac{F_1 - MP}{MP} \times 100$$

$$Hbt(\%) = \frac{F_1 - BP}{BP} \times 100$$

Where,

Ht = Heterosis, Hbt = Heterobeltiosis, MP = Mid Parent Value and BP = Better Parent Value

The 't' test was manifested to determine whether F_1 hybrid means were statistically different from mid parent and better parent means. The heterosis was tested by least significant difference at 5 per cent and at 1 per cent level of significance for error degrees of freedom as follows,

For testing heterosis over mid parent

$$SE\ (diff.)\ (MP) = \sqrt{3Me/2r}$$

For testing heterosis over better parents and standard check

$$SE\ (diff)\ (BP) = \sqrt{2Me/r}$$

SE (diff) (SC) =

Where,

Me = Error variance

r = Number of replications

RESULTS AND DISCUSSION

The analysis of variance for Productive tillers per plant, 100 grain weight, 100 grain weight and grain yield per plant manifested highly significant differences between parents and F_1 crosses except for weight of grains per spike. The gluten content shows highly significant differences among parents, while, least deviated among the F_1's (Table 1). The mean performance of parents and F_1 crosses regarding above mentioned traits is presented in Table II. The estimates of heterosis of F_1's over mid and better parent(s) for all five traits are presented in Table 3.

Productive tillers per plant

Maximum productive tillers per plant was observed in LOK-62 (17.27) among parents and FLW-8 × WH-147 (18.07) among crosses. Positive heterosis over mid parent was observed from all crosses and positive heterosis over better parent was observed from 9 crosses out of 10 crosses. DI-9 × MP-4080 showed highest value for heterosis i.e. 55.90 % as well as for heterobeltiosis (47.64 %). Similar results were reported by Boqun *et al.* (2003) and Singh (2003).

Spikelet's per spike

Among parents, FLW-8 contributed maximum mean value (23.13) for number of spikelets per spike. The 7 crosses out of 10 crosses shown negative heterosis although, among crosses DI-9 × MP-4080 showed maximum mean value (21.60) for this trait. In case of heterotic effects, DI-9 × MP-4080 contributed highest value for mid-parent heterosis (9.64 %) as well as for better parent heterosis (7.64 %). These results are in agreement with Mujahid *et al.* (2000) and Srivastava and Dhirendra Singh (2008).

Weight of grains per spike

PHS-0622 gave maximum weight of grains per spike (3.19) among parents and from crosses, LOK-62 × PHS-0622 showed maximum mean value (3.56) for this trait. The estimates of heterotic effects revealed that maximum mid-parent and better parent heterosis was contributed by the cross DI-9 × MP-4080, 26.81 % and 26.41 %, respectively. Hybrid vigour expressed for this character had also been reported earlier by Boqun *et al* (2003), Nawracaa *et al* (2006), Lamalakshmi Devi *et al.* (2013) and Narendra *et al.* (2013).

100 grain weight

The parent PHS-0622 showed maximum 100-grain weight

Table 1: List of significant crosses in half diallel for different traits in wheat

S. No.	Crosses
1.	DI-9 × FLW-8
2.	DI-9 × WH-147
3.	DI-9 × PHS-0622
4.	DI-9 × MP-4080
5.	LOK-62 × PHS-0622
6.	FLW-8 × WH-147
7.	FLW-8 × MP-4080
8.	WH-147 × MP-4080
9.	WR-1392 × PHS-0622
10.	PHS-0622 × MP-4080

Table 2: Analysis of variance (mean square values) for different traits in wheat

Source of variation	Mean sum of squares					
	Replications	Treatments	Parents	Crosses	Parent × Cross	Error
Degrees of freedom	2	27	6	20	1	54
Productive tillers per plant (no.)	6.03	14.47**	30.66**	8.59**	34.99**	2.93
Spikelet's per spike (no.)	1.63	15.57**	19.26**	13.51**	34.69**	4.60
Weight of grains per spike (g)	0.12	0.21*	0.20	0.22	4.89**	6.39
100 grain weight (g)	0.13	0.94**	1.53**	0.79*	0.35	0.17
Grain yield per plant (g)	29.19	30.88**	50.64**	24.47**	40.34**	8.81
Gluten content (%)	0.31	0.34*	1.84**	0.71	0.21	0.20

*, ** Significant at 5 and 1 per cent level, respectively

Table 3: Estimation of percent heterosis (Ht%) and heterobeltiosis (Hbt%) for different parameters

Crosses	Productive tillers plant^{-1}		Spikelets spike^{-1}		Weight of grains spike^{-1} (g)		100 grain weight (g)		Grain yield plant^{-1} (g)		Dry gluten content (%)	
	Ht %	Hbt %	Ht %	Hbt %	Ht %	Hbt %	Ht %	Hbt %	Ht %	Hbt %	Ht %	Hbt %
DI-9 × FLW-8	45.40**	38.09**	-25.77**	-30.69**	-10.14**	-15.41**	-6.95**	-8.16**	12.19**	5.35*	-0.45	-8.35**
DI-9 × WH-147	39.20**	27.31**	-2.198	-11.29**	5.74**	5.40**	6.76**	2.63**	20.04**	15.00**	1.32**	-12.10**
DI-9 × PHS-0622	10.02**	2.01	-2.83	-8.97**	-0.05	-8.77**	0.35	-11.11**	12.19**	-0.91	-6.27	-20.45**
DI-9 × MP-4080	55.90**	47.64**	9.64**	7.64**	26.81**	26.41**	24.83**	22.85**	23.03**	20.90**	1.36**	-7.09**
LOK-62 × PHS-0622	-12.70**	-26.29**	2.15	1.67	13.39**	11.49**	4.11**	0.49	3.13	2.60	2.35**	-4.88**
FLW-8 × WH-147	37.56**	32.19**	3.71*	-11.52**	4.61**	-1.22**	3.97**	1.23**	12.13**	9.81**	-1.45**	-7.69**
FLW-8 × MP-4080	31.37**	18.51**	-10.20**	-17.57**	-2.72**	-8.15**	-2.86**	-5.62**	-5.58*	-12.77**	3.74**	3.22**
WH-147 × MP-4080	32.77**	15.61**	-14.39**	-21.03**	5.91**	5.91**	4.08**	-1.46**	6.42**	0.27	1.19**	-4.76**
WR-1392 × PHS-0622	2.20*	-9.02**	-4.71**	-14.50**	1.57**	-8.88**	5.28**	-10.23	5.77**	-1.50	2.81**	-1.63**
PHS-0622 × MP-4080	21.93**	7.53**	-10.66**	-14.82**	4.68**	-4.18**	1.262**	-11.57**	15.51**	0.48	1.77**	-6.51**

(6.81 g) while among hybrids, DI-9 × MP-4080 revealed maximum mean value (6.45 g). Regarding heterotic estimates, DI-9 × MP-4080 contributed maximum mid parent heterosis i.e. 24.83 % as well as maximum better parent heterosis i.e. 22.85 %. The results are in agreement with the findings of Lokendra Singh *et al.* (2007) and Boqun *et al* (2003).

Grain yield per plant

Among parents LOK-62 gave maximum grain yield per plant (39.73 g) while among crosses, it was maximum for LOK-62 × PHS-0622 (40.77 g). The estimates of heterotic effects revealed that maximum mid-parent and better parent heterosis was contributed by the cross DI-9 × MP-4080, 23.03% and 20.90%, respectively. Hybrid vigour expressed for this character had also been reported earlier by Subhani *et al.* (2000), Yagdi *et al.* (2000), Singh (2003), Nawraca *et al.* (2006), Lokendra Singh *et al.* (2007), Srivastava and Dhirendra Singh (2008), E. Devi *et al.* (2013), Lamalakshmi Devi *et al.* (2013), Narendra *et al.* (2013) and Singh *et al.* (2013).

Gluten content

The parent DI-9 showed maximum gluten content (7.98%) while among hybrids, DI-9 × MP-4080 revealed maximum mean value (7.42%). Regarding heterotic estimates, FLW-8 × MP-4080 contributed maximum mid parent heterosis i.e. 3.74% as well as maximum better parent heterosis i.e. 3.22%.

It is concluded from present studies that cross DI-9 × MP-4080 could be further evaluated for selecting high yielding wheat genotypes due to its highest heterotic value for important yield related traits. i.e. productive tillers per plant, spikelet's per spike, weight of grains per spike, 100 grain weight and grain yield per plant.

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