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Heterosis in Durum Wheat

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ABSTRACT

The performance of 60 hybrids of *Triticum duram* Desf. was studied in relation to that of recommended variety Raj 1555 and corresponding better parent over three environments. The heterosis over better parent and over Raj 1555 for grain yield ranged from -14.3 to 65.5% and from -3.8 to 77.9% respectively. 56 hybrids exhibited higher yield over Raj 1555 of which 48 were superior to their respective better parent. Significant values of heterosis over better parent as well as standard variety were also observed for other component characters. Best heterotic crosses did not produce highest specific combining ability effects for most of the characters except number of grains/spike. Crosses MACS 9 x JU 85, Bansi x JU 85 and JU 91 x A 206 were found to be promising for exploitation of heterosis for higher yield on the basis of heterotic response, specific combining ability effects and general combining ability of parents involved.

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INTRODUCTION

The identification of specific parental combination capable of producing the highest level of F_1 transgressive effect can presumably be of greater value in raising the genetic yield potential. The degree of heterosis measured as superiority of F_1 hybrid over the best commercial variety released for cultivation decides whether the hybrid is worth exploiting or not. Several studies have demonstrated significant levels of heterosis in bread wheat. However, there is limited published literature on heterosis in durum wheat, the second most important wheat species grown in India. The heterosis over better parent and commercial variety Raj 1555 was, therefore, evaluted over three environments in relation to g. c. a. and s. c. a. effects to plan the most appropriate breeding programme

MATERIALS AND METHODS

Fifteen durm wheat lines/varieties namely, A 9-30-1, Anhinga, Bansi, Bijaga-yellow, Flamingo, Jairai, Jori C69, JU 12, JU 91, JU 109, JU 129, Kiwi's MACS 9, MACS 1269 and N 59 used as lines and four testers (A 206, JU 85, HDM 22550-3, and Raj 1555) were used in the present investigation. Nineteen parents and their 60 F_1 hybrids were grown in randomized block design with three replications at three dates of sowing, i.e. 25 October, 15 November and 2 December during winter 1982-83. 2.5 meter long single row plot keeping row to row and plant to plant distances 30 cm and 10 cm, respectively, was alloted randomly to each entry. Recommeneded cultural practices were followed to raise the normal crop. Observations on 5 competitive plants per plot were recorded for grain yield/plant, spikes/plant, grains/spike, grain weight/spike, spikeletis/spike, 100 grain weight, plant height and days to flowering. Since Raj 1555 is a commercial durum variety recommended for central zone and was included in the study, standard heterosis was calculated against this variety. Heterosis over better parent as well as standard variety was calculated over the three environment as per standard procedure. Combining ability analysis was done according to Kempthorne (1957).

RESULTS AND DISCUSSION

Differences among parents and hybrids were substantial for the different characters studied (Table 1). Mean square due to parents vs. hybrids comparison indicated presence of heterotic response for most of the characters. The significant mean squares due to environment x parents, environment x hybrids and environment x parents vs. hybrids interaction for grain yield and majority of component traits indicated that the manifestation of heterosis should be assessed over wide range of environmental conditions to draw the valid conclusions.

The number of crosses exhibiting economic heterosis alongwith range and mean of heterosis for characters studied are presented in Table 1. For days to flowering, most of the hybrids were intermediate, but tended towards early parent with mean haterosis -3.9% over early parent. This indicated that earliness was dominant over lateness. Six hybrids viz., Jairaj x A 206, Anhinga x Raj 1555, Flamingo x Raj 1555 Jairaj x 1555, MACS 9 x Raj 1555 and N 59 x Raj 1555 were significantly earlier than the corresponding early parent. Dhonukshe and Rao (1979) observed haterosis for days to flowering in macaroni wheat. In case of plant height, 45 hybrids were taller than the Raj 1555 of which 20 showed significant positive haterosis over the respective taller parent to the extent of 17.5 per cent. No hybrid was dwarfer than the respective dwarfer parent. Presence of heterosis for plant height has been reported by Widner and Lebsock (1973) and Dhonukshe and Rao (1979). However, Ahmed *et al.* (1979) did not observe heterosis for plant height against durum variety Raj911.

For number of tillers/plant, heterosis over better parent ranged from -25.2 to 59.7%. 32 crosses showed significant positive haterosis. When compared with standard variety, 51 hybrid were found to be superior and standard heterosis ranged from -8.6 to 86.6% Winder and Lebsock (1973), Dhonukshe and Rao (1979) and Ahmed *et al.* (1979) have reported heterosis for tillers/plant in durum crosses.

Heterotic effects were also evident in 12 crosses over better parent and 25 crosses against Raj 1555 for spikelets/spike. The value of heterosis ranged from -7.7 to 8.6% over corresponding better parent and from -7.7 to 13.6% over standard variety. Jori C69 x HDM - 22550-3 and Bansi x HDM 22550-3 registered highest value of heterosis for spikelets/spike. Dhonukshe and Rao (1979) reported heterosis to the extent of 8.03% for number of spikelets in macaroni wheat.

Heterosis for grains/spike and grain weight/spike ranged from -23.3 to 23.8% and -15.0 to 47.4%, respectively. 12 hybrids for grains/spike and 7 hybrids for grain weight/spike showed positive significant heterosis over corresponding better parent. When compared with Raj 1555 fifteen crosses for grains/spike and seven crosses for grain weight/spike were found superior. Four crosses viz., A 9-30-1 X Raj 1555, Anhinga X HDM 22550-3, Anhinga x Raj 1555 and Jairaj x HDM 22550-3 exhibited significant positive heterosis over better parent as well as standard variety for both, number of grains/spike and grain weight/spike. Dhonukshe and Rao (1979) observed heterosis for grains/spike in 19 out of 36 hybrids in durum wheat. Whereas for grain weight/spike heterosis in almost all the crosses was reported.

For 100 grain weight 40 hybrids over better parent and 45 hybrids over Raj 1555 showed significant positive heterosis. It ranged from -4.4 to 28.4% and from -7.0 to 36.5% over better parent and standard variety, respectively. Heteriosis for 100 grain weight to the extent of 20% by Winder and Lebsock (1973), 55.07% by Dhonukshe and Rao (1979) and 18.90 by Ahmed *et al.* (1979) have been reported in durum crosses.

The grain yield/plant over the environment in the present material for parents ranged from 12.90 gm(Kiwi's') to 21.66 gm (MACS 9) and from 16.35 gm (JU 129 x Raj 1555) to 30.23 cm (Bansi x JU 85) for the hybrids. Forty eight crosses over their respective better parent and 56 crosses over Raj 1555 showed significant positive heterosis for grain yield/plant. The range of heterosis was from -14.3 to 65.5% when compared to corresponding better parent and from -3.8 to 77.9% when compared to Raj 1555. Considering mean performance and heterosis of crosses, Bansi x JU 85, MACS 9 x JU

TABLE 1

Analysis of variance for eight characters in macaroni wheat.

Source of variance	*d.f.*	*Mean squares*							
		days to flowering	*Plant height*	*Tillers/ plant*	*Spikelets/ spike*	*Grains/ spike*	*Grain weight spike*	*100 grain weight*	*Grain yield/ plant*
Environments (Env)	2	7055.09**	368.90**	1666.81**	6.44**	5179.18**	29.74**	12.78**	19530.42**
Treatments	78	221.63**	1546.22**	22.33**	7.25**	156.26**	0.91**	1.98**	141.84**
Parents	18	519.60**	2138.09**	8.74**	7.18**	137.09**	0.91**	1.34**	46.19**
Hybrids	59	125.71**	1288.37**	10.11*	5.62**	151.87**	0.68**	1.12**	83.14**
Parents vs, hybrids	1	517.07**	6106.11**	687.95**	104.55**	760.68**	4.23**	58.93**	532.69**
Env x Treatments	156	25.64**	11.43**	4.71	0.96*	85.60**	1.21**	0.10**	27.36**
Env x Parents	36	37665.39**	1.61	3.05	1.29*	79.98**	0.57**	0.21*	33.17**
Env x Hybrids	118	6635.65**	145.53**	2.04	0.79*	87.78**	0.46**	0.05	24.80**
Env x Parents vs, hybrids	2	390351.62**	5692.19**	61.56**	0.57	58.90**	2.38**	0.54*	625.71**
Error	486	0.38	8.35	4.20	0.58	5.66	0.31	0.11	10.55
Number of corsses above better parent		11	20	32	12	12	8	45	48
Number of crosses above Raj 1555		6	45	51	25	15	7	40	56
Better parent heterosis		-10.6 to 4.2	-11.6 to 17.5	-25.2 to 59.7	-7.7 to 8.6	-23.3 to 23.8	-15.0 to 47.4	-4.4 to 28.4	-14.3 to 65.5
Standard heterosis		-2.2 to 24.4	-12.1 to 40.9	-8.6 to 86.6	-7.7 to 13.6	-17.9 to 16.5	-25.4 to 50.4	-7.7 to 36.5	-3.8 to 77.9

*,** Significant at P = 0.05 and P = 0.01 respectively

TABLE 2

Ten best heterotic crosses for grain yield and their performance in related parameters.

Crosses	*Mean*	*Per cent heterosis*		*s.c.a.*	*g.c.a. effects*		*Significant economic heterosis in other traits*
		BP	*Raj 1555*	*effects*	P_1	P_2	
Raj 1555	17.00						
Best parent (MACS 9)	21.66						
Bansi x JU 85	30.23	47.7**	77.9**	1.70	2.41**	2.05**	I, II, IV, V, VI
MACS 9 x JU 85	29.45	35.9**	73.3**	2.85**	0.48	2.05**	I, II, IV
JU 91 x JU 85	29.63	42.7**	68.6**	1.75	0.77	2.05**	I, II, IV
Bansi x HDM 22550-3	28.46	39.9**	67.5**	1.52	2.41**	0.46*	I, II, IV, V, VI
JU 91 x A 206	30.13	31.2**	77.7**	5.57**	0.77	-0.21	I, II, V, VI
JU 12 x HDM 22550-3	27.63	65.5**	62.7**	2.27**	0.84	0.46*	I, IV, VI
JU 12 x A 206	27.55	60.2**	62.1**	2.85**	0.84	-0.21	I, IV
Jori C 69 x A 206	27.55	51.5**	62.2**	2.50*	1.19**	-0.21	I, V, VI
Flamingo x JU 85	27.78	35.9**	60.6**	3.90**	-2.25**	2.05**	I, IV
BJ yellow x JU 85	26.94	34.2	58.6**	0.08	0.74	2.05**	I, IV, V, VI

I	Spikes/plant	IV	Spikelts/spike	V	days to flowering.
II	grains/spike	V	1000 grain weight	*	Significant at P = 0.05
III	grain weight/spike	VI	plant	**	Significatn at P = 0.01

85, JU 91 x JU 85 and JU 91 x A 206 were outstanding. Number of spikes/plant, number of grains/spike, 100 grain weight and spikelets/spike were found to contribute more towards heterosis for yield/plant. The contribution of grain weight/spike seems to be averaged out over the three dates of sowing at which heterosis in the present study was assessed.

The best four heterotic crosses and their specific combining ability effects were compared for all the evaluated characters and it was observed that except for grains/spike and two crosses for 100 grain weight/plant, best heterotic crosses did not produce highest s. c. a. effects for any character. This indicated that ranking on the basis of heterotic response is not reflected by the ranking based on s. c. a. effects. High s. c. a. denotes, undoubtedly, a high heterotic response, but this may be due to the very poor performance of the parent in comparison with their hybrids. Also with the same amount if heterotic effects the s. c. a. effect may be less where the mean performance of the parents are higher. This suggest that the selection of cross combination based on heterotic response would be more realistic rather than on the basis of s. c. a effect. High s. c. a. effects for grain yield and its majority of component traits were found to be produced by average x average, average x low or high x low general combiners. This indicated that high gene interaction for best crosses for most of the traits in the present material is accountable to additive x dominance or dominance x dominance type of gene effects. Ahmed *et al.* (1979) also reported that high s. c. a. effects in durum crosses were accountable to non *fixable type of gene interactions.*

The ten best heterotic crosses for grain yield and their performance in some related parameters are presented in Table 2. MACS 9 x JU 85 was found to be best hybrid exhibiting high mean and heterosis as well as significant s. c. a. effect involving high x average general combiner. The other crosses exhibiting high mean performance and heterosis were Bansi x JU 85 and JU 91 x A 206. The former was cross between high x high general combiner with average s. c. a. effect whereas, later involved average x average combiners to produce highest s. c. a. effects. Thus these crosses could be exploited in the breeding programme for developing high yielding durum wheat varieties.

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