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TRANSGRESSION VIS-A-VIS GENETIC DIVERGENCE AND COMBINING ABILITY IN TRIPLE TEST CROSS PROGENY OF WHEAT (*TRITICUM AESTIVUM* L.)

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ABSTRACT

Triple test cross (TTC) progenies, resulting from matings between 15 divergent lines and 3 testers, were raised in randomized block design under normal (irrigated) and stress (rainfed) environments. Observations were recorded on tiller number, grains/spike, 1000-grain weight, grain yield/plant, and Mahalanobis' D^2 values were computed using multivariate analysis. Correlations between divergence ($\sqrt{D^2}$) and progeny means showed independence of each other in both environments. The frequency as well as the level of transgression and progeny means were cross-specific and independent of $\sqrt{D^2}$ values among the parents. TTC design permitted a wholistic approach to select potent crosses based on gene effects, comparative segregational potential and divergence between parents.

Key words: Triple test cross, wheat, *Triticum aestivum*, transgression.

Genetic diversity among parents in a cross is due to their differences for the number and nature of genes and their functional relationship in a given environment [1, 2]. Such genetic divergence may not be truly represented by empirical D^2 statistic alone [3]. However, divergence of two compatible parents could logically be reflected in their segregational potential, which is also influenced by gene effects, combining ability and linkage relationship [4]. Use of homozygous and heterozygous testers in a cross series, as in TTC, would facilitate meaningful interpretation of diversity. Such analysis would be based on the inherent potential of crosses rather than on the statistical parameters like D^2 which only discern population into various groups. In the present study an attempt is made to draw inferences on the breeding behaviour of divergent lines crossed to common testers in TTC matings in wheat.

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MATERIALS AND METHODS

The material of the present investigation consisted of 17 homozygous lines of spring wheat, namely, WL 711, WG 377, Red Poll, HD 1981, UP 262, HD 1925, HD 2122, Raj 821, Sonalika, WH 147, HD 2009, Raj 1579, Kharchia 65, P 1200, Chat, HD 2160 and NP 846. Of these, HD 2160 and NP 846 were used as L_1 and L_2 testers and their F_1 (HD 2160 x NP 846) as L_3 tester. Among the lines used, the L_1 and L_2 testers were the phenotypic extremes for grains/spike and 1000-grain weight. The three testers were crossed with each of the remaining 15 lines to produce 45 families. The 45 TTC families and 17 parents were raised in randomized block design with three replications under two conditions: irrigated (normal) and rainfed (stress). Ten competitive plants from all the families of line x homozygous tester crosses were observed for tiller number/plant, grains/spike, 1000-grain weight and grain yield/plant.

Mahalanobis' D^2 statistic as described by Rao [5] was used for assessing genetic divergence among genotypes. General combining ability (gca) effects [6] were estimated for grain yield. Level of transgression in lines x F_1 matings was computed as per cent increase in the transgressive segregates over the better parent using data on grain yield and its components recorded on 30 competitive plants.

RESULTS AND DISCUSSION

The genetic distance ($\sqrt{D^2}$) between lines (1 to 15) and homozygous testers ranged from 4.7 (Kharchia 65 x NP 846) to 17.9 (Raj 821 x HD 2160) in normal environment and from 6.1 (WG 377 x HD 2160) to 18.7 (Kharchia 65 x HD 2160) in stress environment. On the other hand, $\sqrt{D^2}$ between testers HD 2160 and NP 846 was 18.8 in normal and 14.2 in stress environment. Thus, the $\sqrt{D^2}$ values exhibited considerable range of genetic distance among lines and testers involved in the crosses in both environments.

The progeny means of the lines x L_3 matings showed considerable variation for all the characters in both environments. An attempt has been made to draw inferences on dependence of progeny means on gca and $\sqrt{D^2}$ among parents on the basis of all the 45 crosses. However, for brevity and simplicity, data only on a few selected crosses are presented in Table 1. On overall basis, parental divergence ($\sqrt{D^2}$) was not correlated with progeny means for grains/spike and grain weight in normal environment, and tiller number, grain weight and grain yield in stress environment. However, negative association between $\sqrt{D^2}$ and progeny means for tiller number and grain yield in normal environment and grains/spike in stress environment perhaps suggests that a compatible limit of parental divergence would favour better expression of these traits in the progeny. Thus, parental divergence per se may not be very important in choosing parents for a cross. As also reported

Table 1. Breeding behaviour of selected crosses of triple test cross progeny in wheat

Cross	$\sqrt{D^2}$	Gca effects for grain yield		Tiller number		Grain per spike		1000-grain weight		Grain yield per plant	
		P_1	P_2	mean	trans-gressive segregates (%)	mean	trans-gressive segregates (%)	mean	trans-gressive segregates (%)	mean	trans-gressive segregates (%)
Irrigated (normal environment)											
WG 377 x HD 2160	14.3	Average	Average	11.7		49.6		38.8		16.8	
WG 377 x NP 846	9.5	Average	Poor	13.3		59.6		46.6		21.8	
WG 377 x F_1				15.1	77.0	55.5	76.5	45.3	51.3	28.6	47.3
HD 2009 x HD 2160	12.6	Good	Average	9.5		51.1		47.2		16.4	
HD 2009 x NP 846	10.4	Good	Poor	12.6		53.3		47.9		18.8	
HD 2009 x F_1				18.1	23.5	65.8	72.8	49.6	53.7	37.0	45.1
P 1200 x HD 2160	15.5	Average	Average	10.3		47.3		48.9		16.2	
P 1200 x NP 846	12.4	Average	Poor	11.5		53.5		50.3		20.8	
P 1200 x F_1				13.7	18.8	59.9	69.5	51.4	56.0	29.6	40.7
UP 262 x HD 2160	15.5	Average	Average	10.7		39.1		52.2		13.9	
UP 262 x NP 846	9.2	Average	Poor	14.1		43.7		49.8		20.6	
UP 262 x F_1				13.1	20.4	47.8	62.0	49.9	57.5	21.2	40.6
Raj 821 x HD 2160	17.9	Poor	Average	11.5		41.6		53.4		20.1	
Raj 821 x NP 846	14.2	Poor	Poor	14.1		44.5		49.9		21.3	
Raj 821 x F_1				16.6	24.1	50.5	62.8	50.0	56.5	25.2	38.7
Correlation coefficient				-0.4^{*}		-0.2		0.1		-0.04^{*}	
CD (5%)				2.3		5.0		2.4		4.4	
Rainfed (stress environment)											
WG 377 x HD 2160	6.1	Average	Average	5.0		43.5		44.5		8.3	
WG 377 x NP 846	11.6	Average	Poor	4.9		40.5		47.8		8.6	
WG 377 x F_1				7.2	3.0	47.7	31.0	44.6	52.0	13.1	19.5
HD 2009 x HD 2160	13.1	Good	Average	5.1		44.7		47.6		9.8	
HD 2009 x NP 846	10.3	Good	Poor	5.9		48.9		50.8		12.0	
HD 2009 x F_1				6.7	9.8	48.5	62.1	49.3	55.5	15.8	27.2
P 1200 HD 2160	10.5	Poor	Average	4.1		42.3		53.6		7.4	
P 12000 x NP 846	14.8	Poor	Poor	5.3		34.3		54.1		8.2	
P 1200 x F_1				6.3	10.1	42.7	32.0	52.8	58.2	12.6	19.7
WL 711 x HD 2160	12.6	Average	Average	5.7		40.9		45.7		9.4	
WL 711 x NP 846	6.4	Average	Poor	6.0		46.1		49.4		13.9	
WL 711 x F_1				6.5	9.0	45.4	83.5	46.5	—	12.0	21.4
Chat x HD 2160	14.3	Average	Average	6.1		39.5		43.7		10.3	
Chat x NP 846	11.2	Average	Poor	6.6		49.5		45.0		11.0	
Chat x F_1				6.1	11.0	48.1	57.6	47.7	50.0	12.0	19.7
Correlation coefficient				0.0		-0.5^{**}		0.1		-0.1	
CD (5%)				1.3		6.4		2.5		2.0	

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

Correlation coefficients of genetic distance $\sqrt{D^2}$ between parents of the crosses and their progeny (F_1s and selfed F_1s between lines x F_1 tester) means.

P_1 and P_2 are the first and second parent, respectively, in each cross.

earlier [3, 7], progeny means in the present study were generally independent of $\sqrt{D^2}$ and cross-specific phenomena. This is elucidated by the present study by comparing few crosses, e.g., the $\sqrt{D^2}$ distances between WG 377 x HD 2160 and Raj 821 x NP 846 were comparable and high but their means for different traits varied significantly in normal environment. Similarly, in the crosses HD 2009 x 846 and P 1200 x 2160 $\sqrt{D^2}$ distance was comparable and moderate but their progeny means differed significantly in stress environment. On the contrary, the progeny means of the crosses UP 262 x NP 846 and Raj 821 x HD 2160 in normal environment and WG 377 x HD 2160 and WG 377 x NP 846 in stress environment were almost comparable but the $\sqrt{D^2}$ values between the two combinations varied greatly. Therefore, no specific trend for $\sqrt{D^2}$ values among parents and progeny means was evident.

Goodman [8] indicated that relative variability for any quantitative trait in any segregating generation is the direct test for degree of divergence between two compatible parents. In turn, the segregational potential in terms of frequency and extent of transgressive segregates of a cross depends on the gca of parents, gene effects, linkage relationship, and genotypes x environment interactions. Therefore, any cross meeting this criterion is desirable irrespective of the genetic distance among the parents of crosses. As we have recorded the transgressive segregates in selfed F_1s (lines x L_3 tester), the genic contribution of each line and L_3 would be equal and 50% in each cross. Differences in the progeny means of line x F_1 could, therefore, be attributed to the differences among lines since the contribution of L_3 is common in all the crosses.

Estimation of the segregational ability of progenies obtained through selfing of F_1s between lines and heterozygous tester (L_3) provide a basis for comparative evaluation of crosses. However, this assumption is true if we assume predominance of additive gene effects. Significant amount of dominance as well as i, j and l type of epistasis were observed following TTC analyses as per [9, 10] in the present material for grain yield and its components as reported earlier [4]. Thus, the differences in the progeny means of lines x homozygous testers failed to show any parallelism with the differences in lines for $\sqrt{D^2}$ values. Various crosses differed considerably with regard to the frequency and extent of transgression for each character. However, the crosses WG 377 x F_1, P 1200 x F_1, UP 262 x F_1 and Raj 821 x F_1 in normal environment and WG 377 x F_1, HD 2009 x F_1, P 1200 x F_1, WL 711 x F_1 and Chat x F_1 in stress environment showed considerable level of transgression (38.7% to 47.3% in normal and 19.5% to 27.2% in stress environment) and higher frequency of transgressive segregates in the segregating generation for grain yield and its component traits (Table 1). The results obtained were, thus, in conformity with the findings of [2, 4]. Crosses WG 377 x F_1 and P 1200 x F_1 had integrated homoestasis as their performance was high even in the contrasting environments. Therefore, the worth of a cross depends on how the genes interact to influence character expression in a given environment. Although the level of transgression was also independent of $\sqrt{D^2}$ in the present case, the most desirable situation would be when crosses among highly divergent lines have transgressive segregates. This will increase the scope of selection proportionately.

Thus, it is concluded that for selection of parents, breeding behaviour of crosses besides genetic diversity in parents should be considered.

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