Theor Appl Genet (1985) 70:306–308

Genetic diversity in relation to heterosis and combining ability in spring wheat

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Received October 31, 1984; Accepted November 20, 1984
Communicated by J. MacKey

Summary. Genetic diversity among ten varieties of spring wheat used as parents in a diallel cross was assessed through multivariate analysis (D^2-statistics) and then related to heterosis and SCA effects of their hybrids. The parents fell into three groups. Group I contained the varieties, 'Nobre', 'Girua' and 'Carazinho'; group II contained 'Sonalika', 'Lyallpur' and 'Pitic 62' and group III contained 'Indus 66', 'Balaka', 'Sonora 64' and 'MS1'. The varieties of group I were good general combiners, while the varieties of group III were poor combiners. Significant heterotic and SCA effects for yield and yield components were observed in the hybrids of the parents belonging to different groups but not in the same group. Genetic divergence between the parents had a positive relationship with heterosis and SCA effects of the hybrids.

Key words: Genetic diversity – Heterosis – Combining ability – Selection of parents – Spring wheat

Introduction

It is assumed that parents for any breeding programme should be selected from diverse sources. Parents selected from different geographic origins do not always have a fruitful result on hybrid performance. The multivariate analysis (D^2-statistic) for selection of parents has an important bearing on the assessment of genetic divergence for use in conventional breeding programmes (Bhatt 1970, 1973). The present study reports the information on genetic divergence among a group of parents analysed through this multivariate approach and its evaluation in choosing parents for hybrid breeding programmes in spring wheat.

Materials and methods

The experiment was conducted at the Bangladesh Agricultural University, Mymensingh, during 1982/83. Ten varieties of spring wheat and their F_1's obtained from a half-diallel cross were used. The parents were 'Nobre', 'Indus 66', 'Balaka', 'Sonalika', 'Lyallpur', 'Girua', 'Sonora 64', 'Pitic 62', 'MS1' and 'Carazinho'. The parental and hybrid seeds were sown in the field in a randomized block design with three replications. The plots were comprised of single rows consisting of 20 plants and the spacings were 30 cm between rows and 5 cm between plants in a row.

Data on yield and various yield components were recorded from 10 randomly selected plants of each plot. The data of the parents were analysed for D^2-statistics and the parents were grouped according to the Tocher method (Singh and Chaudhary 1979). The combining ability analysis was carried out according to Griffing (1956) and the heterosis of hybrids were estimated on mid-parental values.

Results and discussion

Genetic diversity among the parents

Genetic diversity among the parents is shown in Fig. 1. The parents fell into three distinct groups on the basis of genetic diversity for yield and yield components. Group I included 'Nobre', 'Girua' and 'Carazinho'; group II included 'Sonalika', 'Lyallpur' and 'Pitic 62' and group III included 'Indus 66', 'Balaka', 'Sonora 64' and 'MS1'. The magnitude of the genetic diversity between groups indicates that group I and III were more diversified followed by groups I and II (Fig. 1). The lowest genetic distance was observed to be between groups II and III. The intra-group distances were always much smaller than inter-group distances suggesting a lower genetic diversity among the parents of the same group. Treating D^2 values as the values of χ^2 it is observed that differences between two parents were

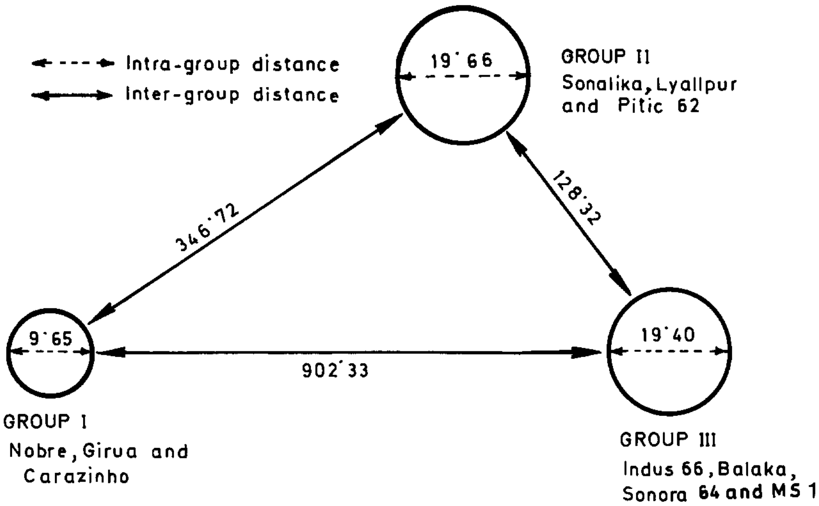

Fig. 1. Genetic diversity of the parents

Table 1. GCA effects of the parents

Group	Parent	Plant height	Spikes/ plant	Grains/ spike	100-grain weight	Grain yield/plant
I	'Nobre'	18.51**	0.25	−0.23	0.01	0.52
	'Girua'	23.21**	0.21	−1.03	0.29**	0.74
	'Carazinho'	17.06**	−0.21	4.90**	0.12**	1.64**
II	'Sonalika'	−5.78**	−0.30	−2.11*	0.17**	0.18
	'Lyallpur'	−0.70	−0.05	0.42	−0.09	0.04
	'Pitic 62'	0.86	0.48	3.05**	−0.08	0.74
III	'Indus 66'	−9.82**	0.06	3.62**	−0.19**	0.08
	'Balaka'	−13.38**	−0.02	−3.22**	0.08	−1.09*
	'Sonora 64'	−11.37**	−0.25	0.72	−0.34**	−1.15*
	'MS1'	−17.98**	−0.16	−6.11**	0.04	−1.69**
SE gi		±0.89	±0.27	±0.85	±0.05	±0.36

* $P<0.05$; ** $P<0.01$

Table 2. List of hybrids exhibiting significant estimates of heterosis and SCA effects

Hybrids	Plant height		Spikes per plant		Grains per spike		100-grain weight		Grain yield per plant	
	Heterosis (%)	SCA	Heterosis (%)	SCA	Heterosis (%)	SCA	Heterosis (%)	SCA	Heterosis (%)	SCA
'Nobre' × 'Indus 66'	9.74*	8.77**	71.96**	2.63**	18.77	3.51	12.33	0.09	95.54**	4.47**
'Nobre' × 'Balaka'	−4.41	−4.47	63.63*	2.21*	10.39	1.75	17.12**	0.35*	60.28*	1.86
'Indus 66' × 'Sonalika'	8.68	1.36	53.83	1.88*	5.50	−3.11	8.35	0.13	70.62**	1.88
'Indus 66' × 'Girua'	18.57**	8.77**	47.58*	1.97*	26.63*	4.61	11.08	−0.13	92.38**	3.99**
'Indus 66' × 'Carazinho'	2.56	−2.08	−2.59	−1.21	27.97**	4.08	11.82	0.11	50.31*	0.47
'Balaka' × 'Lyallpur'	8.98	5.14	77.31**	2.01*	21.51	2.40	−5.34	−0.52**	78.42**	3.44**
'Sonalika' × 'Girua'	5.74	−2.17	6.84	−0.67	25.28*	4.44	13.32	0.25	55.15*	1.28
'Sonalika' × 'Carazinho'	3.45	1.98	11.26	−0.45	32.79**	6.21*	4.79	0.05	79.35**	2.96*
'Lyallpur' × 'Pitic 62'	−4.92	−6.60*	26.07	0.01	23.14*	3.53	12.17	0.41*	53.22*	2.68*
'Sonora 64' × 'Carazinho'	4.90	3.88	2.39	−0.30	9.58	2.09	12.40	0.06	65.12**	3.20*
'Pitic 62' × 'Carazinho'	0.00	−1.66	45.45*	2.07*	29.41**	6.55*	0.00	−0.20	77.78**	4.05*
'MS1' × 'Carazinho'	1.23	−0.12	48.15	2.11*	30.92**	6.61*	2.08	−0.19	61.58*	2.27
SE sij		±3.01		±0.90		±2.85		±0.17		±1.22

* $P<0.05$; ** $P<0.01$

always significant, with the exception of differences between 'Indus 66' and 'Balaka', and 'Girua' and 'Carazinho'.

Combining ability and heterosis

Estimates of general combining ability (GCA) effect indicate that varieties of group I were good general combiners and varieties of group III were poor general combiners (Table 1). The varieties of group II had both significant positive and negative GCA effects for some of the component characters indicating their intermediate position between group I and group III with respect to general combining ability.

Twelve hybrids out of 45 exhibited positive and significant estimates of heterosis for yield and its different component characters (Table 2). Variances for heterosis were significant for all characters, indicating real differences among the heterotic performances of the hybrid. Estimates of specific combining ability (SCA) effect for the hybrids indicate a close resemblance to heterosis (Table 2). Out of the 12 best hybrids, 7 had significant SCA effects for grain yield. Moreover, heterosis and SCA effects of the hybrids were positively correlated for all characters. This was due to the fact that both heterosis and SCA effects are functions of non-additive gene action.

Relation of diversity with heterosis and specific combining ability

The twelve hybrids, identified for their best performances, show that parents of each hybrid fell into different groups (Fig. 1 and Table 2). The parent 'Nobre' of the crosses 'Nobre'×'Indus 66' and 'Nobre'× 'Balaka' belongs to group I, while 'Indus 66' and 'Balaka' belongs to group III. The same fact was observed for other hybrids. Moreover, parents of the majority of these hybrids belonged to two divergent genetic groups (I and III). This indicates a positive relationship between genetic divergence of parents and their hybrid performances. The correlation of genetic diversity between parents with heterosis for grain yield of hybrids were positive and significant ($r=0.45$, $P<0.01$). The same was true between genetic diversity of parents and SCA effects for grain yield of hybrids ($r=0.44$, $P<0.01$). This suggests that crossing diverse parents could give high heterotic performances in hybrids. Therefore, parents should be selected from genetically diversified groups for hybrid breeding programmes in wheat.

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