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DIALLEL CROSS ANALYSIS FOR COMBINING ABILITY IN BREAD WHEAT (TRITICUM AESTIVUM L.EM. THELL

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A STRACT

The nature of combining ability was studied in a complete 5 × 5 set of diallel crosses for yield and its primary components like plant height, tillers per plant, spikelets per spike, kernels per spike and 1000-grain weight. General combining ability variances were highly significant for all the characters. Significant specific combining ability variances were also found for grains per spike and 1000-grain weight, whereas 1000-grain weight also showed significant reciprocal effects. Additive gene effect were found to predominate all the characters as evidenced by greater GCAvariance. Variety Barani 79 was found to be the best general combiner in this group of parents followed by Yecora. The cross combinations 71 – 3 × Barani 79, LU 60 x Yecora, and Yecora x Barani 79 exhibited high SCA effects for yield per plant and were considered to be the best combinations.

INTRODUCTION

One of the most crucial tasks in plant improvement is the selection of suitable parents for hybridization. Genotypes with expressed productivity may not nick well. The primary concern in breeding, therefore, is to be able to predict the potential of a particular genotype as a prospective progenitor of new improved strains through hybridization. In this task, breeders have been greatly helped by the development of biometrics and now the analysis techniques are available through which the generative value of plants can be predetermined with a high degree of precision. Combining ability analysis developed by Griffing (1956) can be cited as an example. Several reports (Brown *et al.*, 1966; Gyawali *et al.*, 1968; Bitzer and Fu, 1972; Kumar *et al.*, 1977; Mani and Rao, 1977; Siddique *et al.*, 1977 and Chowdhry *et al.*, 1980) have attributed a

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large part of genetic variation for plant height, yield and its components in wheat to general combining ability. Crosses between promising varieties and strains were attempted in the present studies to pick up better combining parents ultimately to search out the most promising hybrids and to advance improvement effort for greater economic benefits.

MATERIALS AND METHODS

Five wheat varieties of diverse genetic background namely 71 ~3, LU 60, Pari 73, Yecora and Barani 79 served as experimental material. All the twenty hybirds derived from these varieties by crossing in a diallel fashion were planted with their parents in research field of the Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad, in a triplicated randomized complete block design of layout on 15th November, 1981. Single rows of 1.5 meter length were planted with plant and row distance of 15 and 30 cm, respectively. The experiment was conducted under normal cultural and agronomic conditions.

At maturity, ten randomly selected guarded plants were marked from each genotype for recording the data on plant height (cm), number of tillers per plant, spikelets per spike, kernels per spike, 1000 grain weight (gm) and yield per plant (gm).

Analysis of variance was run on the mean values of each character and where the differences of means among various genotypes were found significant, the data were further subjected to combining ability analysis. Method 1, model 1 of Griffing (1956) was followed as design of analysis for interpretation of experimental data.

RESULTS AND DISCUSSION

The genotypes used in the diallel cross provided a broad range of expression for the characters studied (Table 1). Similarly, all the characters were conditioned with highly significant difference among crosses and parents (Table 2).

Combining ability analysis (Table 3) revealed that mean squares for general combining ability were significant at 1% level of probability for all the

Table 1. *Mean values for plant height, yield and its components of five wheat varieties used in a set of diallel crosses*

Varieties	Mean values					
	Plant height (cm)	Tillers per plant	Spikelets per spike	Grains per spike	1000-grain weight (gm)	Grain yield per plant (gm)
71–3	92.50	14.70	23.73	78.23	36.87	31 85
LU 60	78.83	12.50	23.40	66.57	42.28	27.26
Pari 73	85.73	11.10	23 00	64.67	44.29	26.70
Yecora	88.20	17.70	22.73	55.53	43.56	31.81
Barani 79	126.50	15.67	26.20	77.03	40.59	42.70

Table 2. *Analysis of varience for plant height, yield and its components in a set of diallel crosses among five wheat varieties*

Sources of variation	Degrees of freedom	Mean squares					
		Plant height (cm)	Tillers per plant	Spikelets per spike	Grains per spike	1000-grain weight (gm)	Grain yield per plant (gm)
Replications	2	8.64 N.S	3.40 N.S	0.09 N.S	37.82 N.S	34.54**	19.53 N.S
Crosses	24	398.63**	10.05**	2.87**	216.95**	23.20**	122.41**
Error	48	8.82	2.98	0.37	23.32	3.09	39.28
Total	74	416.09	16.43	3.33	283.09	60.83	181.22

* = Significant at 5% level of probability.
** = Significant at 1% level of probability.
N.S = Non-significant

six quantitative characters measured. Specific combining ability was significant for grains per spike and 1000 kernel weight while the latter trait was also conditioned with highly significant reciprocal effects. Mean squares for general and specific combining ability obviously suggest that both general and specific combining ability cotrolled the expression of grains per spike and 1000-grain weight, whereas the expression of characters like plant height, number of tillers per plant, spikelets per spike and grain yield per plant was mainly influenced by general combining ability. According to Brown *et al.* (1966), Gyawali *et al.* (1968), Bitzer and Fu (1972), Mani and Rao (1977) and Chowdhry *et al.* (1980), plant height, number of tillers per plant, spikelets per spike and yield per plant were influenced by significant geneneral combining ability. Present findings are also in agreement with earlier observations of Kumar *et al.* (1977) and Siddique *et al.* (1977) who also recorded significant contribution of general and specific combining ability for kernels per spike and 1000-grain weight. Mean squares for general combining ability were much greater than those of specific combining ability for all the characters studied (Table 3). Assuming that general combining ability variance was mainly due to additive gene effects and that specific combining ability and reciprocal effects were due to non-additive gene effects, it could be concluded that all the six quantitative characters were by and large under additive genetic control.

Highest positive general combining ability effects for plant height, spikelets per spike and grain yield per plant were exhibited by the variety Barani 79 (Table 4). The values being 15.03, 1.25 and 6.49, respectively. The variety LU 60 possessed the highest negative effect for these characters. Varieties Barani 79 and 71–3 possessed high positive GCA effect for number of grains per spike. As for tiller number and kernel weight Yecora had the highest score. The variety Barani 79 was conditioned with high positive GCA effects for almost all the characters under observation and was considerd to be the best general combiner in this group of parents while the other varieties possessed high GCA effects for at least one character except variety LU 60 which contained negative general combining ability effects for all the characters studied.

As for the specific combining ability effects, three crosses, i. e. 71–3 x

Table 3. *Combining ability analysis for plant height, yield and its components in a complete 5×5 diallel cross of wheat*

Sources of variation	Degrees of freedom	Mean squares					
		Plant height (cm)	Tillers per plant	Spikelets per spike	Grains per spike	1000-grain weight (gm)	Grain yield per plant (gm)
General combining ability	4	780.59**	13.35**	5.07**	331.05**	29.09**	166.84**
Specific combining ability	10	2.44 N.S	1.05 N.S	0.14 N.S	23.55*	2.21*	11.06 N.S
Reciprocal effects	10	4.23 N.S	1.65 N.S	0.12 N.S	17.58 N.S	4.71**	20.13 N.S
Error	43	2.90	0.99	0.12	0.44	1.03	13.09

* = Significant at 5% level of probability; ** = Significant at 1% level of probability.
N.S = Non-significant.

Table 4. *Estimates of general combining ability effects for plant height, yield and its components in a complete 5×5 diallel cross of wheat*

Varieties	General combining ability effects					
	Plant height	Tillers per plant	Spikelets per spike	Grains per spike	1000-grain weight	Grain yield per plant
71–3	−0.21	+0.03	−0.12	+5.13	−2.78	−0.21
LU 60	−7.75	−0.65	−0.45	−3.09	−0.02	−3.74
Pari 73	−3.33	−1.58	−0.35	−0.57	+0.72	−3.18
Vecora	−3.76	+1.18	−0.33	−7.63	+1.82	+0.64
Barani 79	+15.06	+1.01	+1.25	+6.16	+0.26	+6.49
SE ($g_i - g_j$)	0.76	0.45	0.15	1.37	0.45	1.62

Table 5. *Estimates of specific combining ability effects and reciprocal cross effects*

Crosses	Specific combining ability effects and reciprocal effects					
	Plant height	Tillers per plant	Spikelets per spike	Grains per spike	1000-grain weight	Grain yield per plant
71-3 x LU 60	+ 0.49	+ 0.04	- 0.19	- 2.86 (-1.02)	- 1.67	-2.72 (-1.86)
71-3 x Pari 73	+ 0.20	- 0.69	+ 0.15	+ 3.40 (-2.23)	-0.18	-0.90 (-4.53)
71-3 x Yecora	+ 1.11	- 0.65	+ 0.29	- 2.65 (+2.92)	+ 1.03	-0.13 (-2.24)
71-3 x Barani 79	- 0.13	+ 1.06	- 0.16	+ 5.75 (+1.68)	+ 0.05	+3.03 (-0.91)
LU 60 x Pari 73	+ 1.55	+ 0.53	- 0.19	- 0.05 (-1.07)	+ 0 23	+1.23 (+0.20)
LU 60 x Yecora	+ 0.02	+ 0.67	- 0.01	+ 2.43 (+5.12)	+0.20	+2.37 (+6.38)
LU 60 x Barani 79	+ 1.81	- 0.64	+ 0.14	- 0.65 (+3.77)	+ 0.57	-1.65 (+3.06)
Pari 73 x Yecora	- 0.78	- 0.50	+ 0.19	+ 0.84 (+1.38)	- 0.85	-1.13 (-3.00)
Pari 73 x Barani 79	+ 0.43	+ 0.80	+ 0.21	+ 1.61 (-0.98)	+ 0.30	-0.07 (-1.70)
Yecora x Barani 79	- 0.36	- 0.46	+ 0.19	+ 0.18 (-5.12)	+ 1.36	+2.34 (+2.97)
SE (S_{ij}-S_{ik})	± 1.52	± 0.89	± 0.31	± 2 75	± 0.91	± 3.24
SE (S_{ij}-S_{kl})	± 1.32	± 0.77	± 0.27	± 2.38	± 0.79	± 2.80
SE (r_{ij}-r_{kl})	-	-	-	± 3.07	-	± 3.62

Figures in parenthesis are reciprocal effects.

Barani 79, LU 60 x Yecora and Yecora x Barani 79 possessed reasonable values of SCA effects for yield per plant (Table 5). The hybrids of 71 – 3 x Barani 79 further exhibited high positive SCA effects for tillers per plant (1.06) and grains per spike (5.75), while LU 60 x Yecora in addition also presented moderate positive SCA effects for tillers per plant (0.67) and grains per spike (2.43), whereas the cross between yecora and Barani 79 was also conditioned with moderate values of SCA effects for 1000-grain weight (1.36). Other crosses which exhibited high value of SCA effects for at lest one primary yield component were 71 – 3 x Pari 73, 71 – 3 x yecora and Pari 73 x Barani 79. The crosses LU 60 x Yecora and LU 60 x Barani 79 were also conditioned with high reciprocal effects for grains per spike and yield per plant while the cross combinations 71 – 3 x Pecora and Yecora x Barani 79 showed moderate positive reciprocal effects for grains per spike and yield per plant, respectively.

The combining ability effects revealed that the variety Barani 79 posessed high GCA effects for five important characters and was thus considered the best general combiner. The second best was Yecora which showed high GCA effects for three traits of economic importance. So for as SCA effects are concerned, three crosses namely 71 – 3 x Barani 79, LU 60 x Yecora and Yecora x Barani 79 presented high SCA effects for yield per plant. These crosses involved at least one parent with high GCA effects and compared with other crosses on the basis of mean values for yield per plant, they were at the top. These hybrids therefore, have an obvious value as breeding material. The present experience thus suggests that in self pollinators like wheat more confidence should be reposed on GCA effects rather than SCA effects as in most characters additive gene effects were more pronounced and the best combinations essentially had one good general combiner.

REFERENCES

Bitzer, M.J. and S.H. Fu. 1972. Heterosis and combining ability in southern soft red winter wheat. Crop. Sci. 12 (1) : 35-37.

Brown, C.M., R.O. Weibel and R.D. Seif. 1966. Heterosis and combining ability in common winter wheat. Crop Sci. 6 (4) . 382-383.

Chowdhry, A.R., M.A. Chowdhry and B. Ahmad. 1980. Combining ability analysis of four wheat varieties. Pak. J. Agri. Sci. 17 (3-4) : 5-14.

Griffing, B. 1956. Concept of general and specific combining ability in relation to diallel crossing system. Aust. J. Biol. Sci. 9 : 263-293.

Gyawali, K.K., C.O. Qualset and W.T. Yamazaki. 1968. Estimates of heterosis and combining ability in winter wheat. Crop Sci. 8 (3) : 322-324.

Kumer, P., Z. Ahmad, R.P. Katiyar, P.P. Gupta and A. N. Khanna. 1977. Studies on combining ability and heterosis in macaroni wheat (*Triticum aestivum* Desf.). Proc. National Seminar on Genetics and Wheat Improvement, P.A.U. Ludhiana.

Mani S.C. and N.V. Rao. 1977. Combining ability and heterosis in wheat *Triticum aestivum* L.). Proc. National Seminar on Genetics and Wheat Improvement, P.A.U. Ludhiana.

Siddique, M.A. Shakoor and M. Yousaf. 1977. Combining ability analysis in a diallel set involving seven wheat varieties/mutant lines. Pak. J. Agri. Sci. 14 (2-3) : 53-60.