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COMBINING ABILITY STUDIES IN BREAD WHEAT (*TRITICUM AESTIVUM* L.)

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Abstract

Combining ability analysis was conducted in a diallel cross made among four wheat varieties viz., NA6, Sanine, LU16E and HD2009. The general combining ability variance was highly significant for plant height, tillers per plant, spike length, spikelets per spike, kernels per spike and 1000-kernel weight, and significant for yield per plant. Specific combining ability was highly significant for all the characters studied except for tillers per plant for which it was only significant. Better combining parents were NA6 and Sanine. Additive gene effects appeared to be more important for plant height, number of tillers per plant and spikelets per spike, and non additive effects for peducnle length and grain yield per plant. Both additive and non additive genetic components were involved in determining the inheritance of spike length, kernels per spike and 1000 kernel weight.

Introduction

The genetic improvement of field crops for various characters of economic importance is a constant exercise breeders have to pursue to meet their obligations in an ever evolving environment. Information on the relative importance of general and specific combining ability is significant in the development of an effective wheat breeding programme.

Sprague & Tatum (1942) defined general combining ability as the average performance of lines in hybrid combinations. They used specific combining ability to designate deviations of certain crosses from expectations on the basis of average performance of the lines involved. They also stated that general combining ability is due to the genes which are largely additive in their effects and specific combining ability is due to the genes with dominant or epistatic effects. Present investigations were planned to estaimate general and specific combining ability in a diallel cross of four promising wheat varieties, so that the desirable parents may be identified for use in conventional breeding programmes.

Materials and Methods

The study was conducted in the experimental field of the Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad. Four wheat varieties viz., LU16E, HD2009, Sanine and NA6 were sown in the field during 1980-81 and all possible

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Table 1. Mean values for some agronomic characters of four wheat varieties.

Varieties	Plant height (cm.)	Tillers per plant	Spike length (cm.)	Peduncle length (cm.)	Spikelets per spike	Kernels per spike	1000 kernel weight (g.)	Grain yield per plant (g.)
	Mean values							
Sanine	112.13	13.30	11.33	39.33	19.87	54.33	39.35	26.97
NA6	110.57	12.43	15.37	38.07	24.07	79.57	39.43	37.41
LU16E	110.18	10.80	12.30	36.90	19.60	69.03	39.01	28.63
HD2009	100.37	11.03	13.10	37.67	21.47	66.00	38.55	27.48

crosses, including reciprocals were made. In the following year, the F1's including reciprocals and parents were space planted in the experimental field using randomized complete block design of layout with three replications. These various genotypes were assigned at random to experimental unit in each block at the rate of twenty plants per row. The row to row and plant to plant distance was kept at 30 cm and 24 cm apart, respectively. At the end of each row non experimental plants were also raised to eliminate possible competitive advantage for the marginal plants.

At maturity for each entry, ten guarded plants were harvested and data were recorded on plant height (cm), tillers per plant, spike length (cm), peduncle length (cm), spikelets per spike, kernels per spike, 1000 kernel weight (gm) and grain yield per plant (gm). Analysis of variance was applied to determine the significance of means differences. The data were further subjected to Method 1, Model 1 of combining ability analysis, developed and illustrated by Griffing (1956).

Table 2. Analysis of variance for plant height, yield and its components in 4 x 4 complete diallel.

Sources variation	D.F.	Plant height (cm.)	Tillers per plant	Spike length (cm.)	Peduncle length (cm.)	Spikelets per spike	Kernels per spike	1000 kernel weight (g.)	Grain yield per plant (g.)
		Mean squares							
Reps.	2	46.00**	12.87*	6.64**	3.34 NS	3.35**	52.06*	27.56**	198.38**
Crosses	15	74.82**	8.35**	5.81**	6.36**	5.81**	194.57**	28.86**	119.33**
Eroor	30	6.54	2.77	0.28	1.49	0.49	15.34	4.48	26.34

* = Significant at 5% level
** = Significant at 1% level
NS = Non significant

Results and Discussion

The varieties used in the experiment showed considerable variability for the characters under study (Table 1). Differences among the crosses for yield and its components were highly significant (Table 2).

Combining ability analysis computed on the means for parents, single and reciprocal crosses are presented in Table 3. Mean squares for general combining ability were highly significant for plant height, tillers per plant, spike length, spikelets per spike, kernels per spike, and 1000 kernel weight, and significant for grain yield per plant. The specific combining ability variances were highly significant for plant height, spike length, peduncle length, spikelets per spike, kernels per spike and 1000 kernel weight, and significant for tillers per palnt. The reciprocal effects were non significant for all the characters. These results showed that total variability for each trait was associated with both general and specific combining ability. Signnificant contribution of general and specific combining ability in the expression of these various characters has also been reported in more or less similar pattern by other workers (Brown *et al.*, (1966), Gyawali *et al.*, (1968), Sadiq *et al.*, (1977), Ahmed *et al.*, (1979), Chowdhry *et al.*, (1980), Bhullar *et al.*, (1981) and Khurana *et al.*, (1983).

Estimates of general and specific combining ability effects (GCA & SCA) were made for all the characters and are given in Tables 4 & 5, respectively.

Table 3. Combining ability analysis for eight quantitative characters in a 4 x 4 complete diallel.

Sources of variation	D.F.	Mean squares							
		Plant height (cm.)	Tillers per plant	Spike length (cm.)	Peduncle length (cm.)	Spikelets per spike	Kernels per spike	1000 kernel weight (g.)	Grain yield per plant (g.)
General combining ability	3	** 73.63	** 5.56	** 3.28	NS 1.11	** 5.67	** 93.76	** 19.97	* 35.00
Specific combining ability	6	** 21.32	* 2.42	** 3.00	** 4.37	** 1.86	** 106.05	** 13.02	** 64.98
Reciprocal effects	6	NS 4.21	NS 1.76	NS 0.20	NS 0.38	NS 0.15	NS 9.21	NS 1.05	NS 16.96
Error	30	2.18	0.92	0.09	0.50	0.16	5.11	1.49	8.78

* = Significant at 5% level

** = Significant at 1% level

NS = Non significant

Table 4. Estimates of general combining ability effects for plant height, Yield and its components in a diallel cross among four wheat varieties.

Varieties	Specific combining ability effects							
	Plant height (cm.)	Tillers per plant	Spike length (cm.)	Peduncle length (cm.)	Spikelets per spike	Kernels per spike	1000 kernel weight (g.)	Grain yield per plant (g.)
Sanine	+ 3.8304	+ 1.0021	0.0000	– 0.5188	– 0.1292	– 2.0396	+ 0.3462	+ 1.8253
NA6	+ 0.1304	– 0.5354	+ 0.7625	– 0.0062	+ 1.0542	+ 5.0730	+ 1.4871	+ 1.6448
LU 16 E	– 0.3871	– 0.8042	+ 0.3312	– 0.9958	– 2.0938		+ 0.4017	– 2.4657
HD2009	– 3.5737	+ 0.3521	+ 0.0417	+ 0.1938	+ 0.0708	– 0.9396	– 2.2350	– 1.0044
SE (gi-gj)	0.7386	0.4806	0.1516	0.3525	0.2025	1.1307	0.6107	1.4815

The general combining ability effects indicated that the variety NA6 showed high positive effects for five characters and was thus, proved to be the best general combiner in the group of parents. Sanine was the second best variety which exhibited high positive effects for three characteristics. These two varieties might contribute significantly the higher yields through their influence on individual yield components. In a hybridization programme, crosses involving these two varieties should produce segregates with near optimal level of yield components, consequently expecting a better yield potential.

Table 5. Estamates of specific combining ability effects for plant height, yield and its components in a diallel cross among four wheat varieties.

Crosses	Specific combining ability effects							
	Plant height (cm.)	Tillers per plant	Spike length (cm.)	Peduncle length (cm.)	Spikelets per spike	Kernels per spike	1000 kernel weight (g.)	Grain yield per plant (g.)
Sanine x NA6	+ 2.75	+ 0.01	+ 1.030	+ 1.69	+ 9.77	+ 3.68	+ 3.62	+ 4.58
Sanine x LU16E	+ 1.33	+ 0.18	+ 0.812	– 1.13	+ 0.63	+ 6.50	+ 0.11	+ 3.54
Sanine x HD2009	+ 3.45	+ 1.11	+ 1.167	+ 0.14	+ 0.88	+ 6.78	– 1.52	+ 5.32
NA6 x LU16E	– 1.18	– 1.05	– 0.533	+ 1.81	– 0.17	– 1.39	+ 1.98	– 2.12
NA6 x HD2009	+ 0.14	+ 0.13	+ 0.004	– 0.51	– 0.15	+ 3.67	– 1.20	+ 0.18
LU16E x HD20009	+ 0.90	+ 1.03	+ 0.154	+ 0.77	+ 0.35	– 2.95	+ 0.56	+ 1.77
SE (Sij-Sik)	1.28	0.83	0.263	0.61	0.35	1.96	1.06	2.57
SE (Sij-Ski)	1.04	0.68	0.214	0.50	0.29	1.60	0.86	2.09

Table 6. Estimates of reciprocal effects for plant height, yield and its components in a diallel cross involving four wheat varieties.

Crosses	Reciprocal effects							
	Plant height (cm.)	Tillers per plant	Spike length (cm.)	Peduncle length (cm.)	Spikelets per spike	Kernels per spike	1000 kernel weight (g.)	Grain yield per plant (g.)
Sanine x NA6	+ 0.52	+ 1.43	+ 0.37	+ 0.33	– 0.03	+ 1.37	– 0.89	+ 3.27
Sanine x LU16E	+ 1.72	+ 1.62	+ 0.65	+ 0.33	+ 0.55	+ 3.22	– 0.49	+ 6.25
Sanine x HD2009	– 0.02	– 0.22	– 0.12	– 0.43	0.00	+ 2.48	+ 0.76	+ 0.76
NA6 x LU16E	+ 0.57	– 0.08	+ 0.13	+ 0.65	+ 0.37	+ 2.83	– 0.47	+ 0.24
NA6 x HD2009	– 2.30	– 0.13	+ 0.05	– 0.17	– 0.02	– 0.88	– 0.10	– 0.17
LU16E x HD2009	– 1.95	– 0.45	+ 0.10	– 0.52	– 0.13	– 0.67	+ 1.14	– 0.69
SE (rij-rki)	1.48	0.96	0.30	0.70	0.40	2.26	1.22	2.96

Estimates of specific combining ability effects revealed that the cross combinations; Sanine x NA6, Sanine x LU16E, Sanine x HD 2009 and LU16E x HD2009 had positive values for most of the characters. The cross, Sanine x HD2009 topped the list regarding effects for plant height, number of tillers per plant, spike length, number of grains per spike, and grain yield per plant, whereas for 1000 kernel weight and peduncle length, the crosses Sanine x NA6 and NA6 x LU16E were the best.

Estimates of reciprocal effects were calculated for all the characters under study and are presented in Table 6. The largest estimate of reciprocal effects were indicated by the cross combination Sanine x LU16E for all the traits studied except 1000 kernel weight, for which highest positive effect was noticed in the cross LU16E x HD2009. Reciprocal genotypic effects for all the characteristics were found to be non significant. This would suggest that single crosses studied here could be composited with their reciprocal crosses. Hussain (1972) while working on wheat recommended this type of composition.

The higher magnitude of general combining ability component of variance for plant height, number of tillers per plant and spikelets per spike was indicative of predominance of additive gene effects for these attributes. However, the higher magnitude of specific combining ability component of variances for peduncle length and grain yield per plant indicated the predominance of non additive gene effects for these characters. Both GCA and SCA variances for spike length, kernels per spike and 1000 kernel weight were highly significant and almost equal in magnitude showing that additive as well as non additive genetic components were involved in determining the inheritance of these traits. It may thus be concluded from the present investigations that maximum yield may be achieved with a system that can manipulate both additive and non additive gene effects in an effective manner.

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