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COMBINING ABILITY IN A SEVEN PARENT DIALLEL CROSS OF SPRING WHEAT

Khurshid Alam, M. Aslam Chowdhry and A. Salam Khan

Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad.

ABSTRACT

Combining ability studies were carried out for plant height, yield and yield components such as tillers per plant, spike length, spikelets per spike and 1000-kernel weight, in a 7 x 7 complete diallel cross of spring wheat varieties using Griffing's method 1 and model 1. Mean squares for general and specific combining ability were highly significant fot all the characters under investigation. Significant reciprocal effects were also found for plant height, tillers per plant and spike length. The parents C 273, WL 711 and LU 26 showed high general combining ability for yield and most of its components under observation. The ranking of the best cross combinations for yield per plant on the basis of per se performance was almost similar to that placed upon SCA effects. The best crosses, in general, involved high x high and high x low general combiners. Additive gene action was found to predominate all the characters except tillers per plant which showed non-additive type of gene action. Selection of the best combinations was suggested to be based on both per se performance and SCA effects.

INTRODUCTION

Recent breeding programmes which aim towards the evolution of new cultivars mostly depend upon blending different germplasms from local and introduced varieties in such a way as would be advantageous in securing high yielding and widely adapted types. For the last couple of years it has been felt that the breeding programmes involving hybridization should be built on the basic knowledge of genetic make up and the nature of gene action. Diallel cross analysis for combining ability developed by Griffing (1956) is greatly helpful for this purpose. It provides valuable information about the nature of genetic variances and the magnitude of each of its components after only one generation. The present studies involved genetic analysis of characters recorded from a set of diallel crosses between seven wheat varieties of local and exotic origin. The aim was to pool some information about the genetic nature of some quantitative characters and to select good combiners to be used for hybridization.

MATERIALS AND METHODS

Seven wheat varieties of diverse genetic background namely C 273, WL 711, LU 26, LU 31, Ch. 79, LU 75 and Olsen were crossed in a diallel fashion to obtain 42 crosses. The hybrid seed of these crosses was sown with parent cultivars in the experimental area of the Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad in the month of November, using triplicated randomized complete block design of layout. Two meter long single rows with plant to plant and row to row distances of 20 cm and 30 cm, respectively, served as experimental plots. Eight guarded plants were harvested on individual plant basis at maturity from each genotype and data were recorded on plant height (cm), tillers per plant, spike length (cm), spikelets per spike, 1000-grain weight (g) and yield per plant (g). Means of eight plants from each genotype were subjected to analysis of variance technique and where the differences were significant, the data were further analysed for combining ability assuming that necessary assumptions for combining ability analysis have been fulfilled. The design of analysis corresponded to method 1, model 1 of Griffing (1956).

RESULTS AND DISCUSSION

The combining ability analysis revealed that mean squares for general and specific combining abilities were highly significant for all the quantitative characters under investigation (Table 1). Reciprocal effects were significant for plant height, tillers per plant and spikelets per spike. Significant general and specific combining ability for plant height, yield and yield components indicated that both general and specific combining controlled the expression of all these characters. It is evident from Table 1 that mean squares of general combining ability (GCA) were much greater than those of specific combining ability for all the characters except tiller number in which mean squares for specific combining ability (SCA) are slightly greater. These results are in agreement with earlier findings of Bitzer and Fu (1972), Siddique *et al.* (1977), Mani and Rao (1977) and Chowdhry *et al.* (1980), who reported greater GCA variance for yield and most of its components in wheat.

Estimates of GCA effects are presented in Table 2. GCA effects are the numerical values assigned to parents on the basis of their performance in hybrid combinations. It is obvious from Table 2 that the variety C 273 was conditioned with high positive GCA effects (21.56) for plant height, while Olsen had the highest negative GCA effects for this character and was thus considered to be the best source of height reduction. Only three varieties namely C 273, WL 711 and Ch. 79 showed reasonable values of GCA effects for yield per plant. Similarly, high GCA

Table 1. *Combining ability analysis for plant height, yield and its components in a complete 7 x 7 diallel cross of wheat*

Sources of variations	Degree of freedom	Mean squares: Plant height	Tillers per plant	Spike length	No. of spike-lets per spike	1000-kernel weight	Yield per plant
General combining ability	6	2847.226**	1.827**	4.711**	8.123**	103.732**	44.729**
Specific combining ability	21	44.326**	2.022**	0.405**	0.427**	6.677**	21.157**
Reciprocal effects	21	10.008*	1.398**	0.362**	0.227 NS	0.897 NS	16.469 NS
Error	96	5.948	0.467	0.124	0.151	1.043	10.278

* = Significant at 5% level of probability.

** = Significant at 1% level of probability.

NS = Non-significant.

Table 2. *Estimates of general combining ability effects for plant height, yield and its components in a complete 7 x 7' daillel cross of wheat*

Variety/ character	Plant height	Tillers per plant	Spike length	No. of spikelets per spike	1000-kernel weight	Yield per plant
C 273	+21.55	+0.40	—0.86	—0.83	+2.69	+1.31
WL 711	+ 2.31	+0.32	+0.46	+0.46	—0.30	+2.81
LU 26	+ 5.39	+0.36	+0.16	—0.88	+4.29	+0 03
LU 31	— 8.12	—0.21	+0.49	—0.70	+0.01	—1 09
Ch. 79	+ 3.66	—0.24	+0.68	+0.74	—1.55	+0.83
LU 75	+ 0 65	—0.52	—0 60	+0.46	—1.34	—1.68
Olsen	—25.34	—0.10	—0.24	+0.75	—2.80	—2.21
SE (gi-gi)	± 0.92	±0.26	±0.13	±0.15	±0.39	±1.21

effects for grain weight were associated with C 273 and LU 26, the values being 2.69 and 4.29, respectively. For tillers per plan', spike length and spikelets per spike, three to four varieties showed positive GCA effects, however, the values were not so high. The varieties C 273, WL 711 and LU 26 exhibited moderately positive GCA effects for almost half the characters studied and were thus considerd to be the best general combiners.

So for as the specific combining ability effects are concerned, the cross combination C 273 x Olsen showed the highest positive SCA effects for yield per plant (5.17). Other crosses which possessed high SCA effects for yield per plant were C 273 x WL 711, WL 711 x LU 26 and LU 26 x LU 31, the values being 3.41, 3.47 and 3.66, respectively. The crosses C 273 x Olsen and C 273 x WL 711 also showed high specific combining ability effects for plant height and 1000-grain weight, whereas the cross WL 711 x LU 26, in addition also exhibited the highest positive SCA effects for tillers per plant (1.98). Still other crosses which possessed high SCA effects for at least one importent yield component were C 273 x LU 26, LU 26 x Olsen, LU 31 x Ch. 79 and LU 75 x Olsen. The character concerned with yield per plant was also conditioned with high reeiprocal cross effects. The crosses C 273 x LU 26, LU 26 x LU 75, Ch. 79 x LU 75 and Ch. 79 x Olsen were particularly important in this respect

Table 3. *Estimates of specific combining ability effects and reciprocal effects*

Crosses	Plant height	Specific combining ability effects and reciprocal effect				
		Tillers per plant	Spike length	Spikelets per spike	1000-kernel weight	Yield per plant
C 273 x WL 711	+5.19	+0.74	+0.23	—0.03	+3.18	+3.41(+0.87)
C 273 x LU 26	+0.54	+0.55	+0.29	+0.14	+2.21	—4.36(+3.31)
C 273 x LU 31	+6.71	—0.44	—0.19	+0.23	+1.24	—0.35(+2.25)
C 273 x Ch. 79	+4.79	+0.23	—0.43	—0.36	+0.38	0.43(—0.67)
C 273 x LU 75	—2.03	—0.86	+0.97	+0.47	+0.68	—1.65(+1.29)
C 273 x Olsen	+5.12	—0.25	—0.21	+0.52	+2.15	+5.17(—0.71)
WL 711 x LU 26	+2.25	+1.98	+0.54	+0.50	+1.43	+3.47(—3.26)
WL 711 x LU 31	—6.71	—0.94	—0.26	—0.13	—1.52	—1.59(—0.40)
WL 711 x Ch. 79	+0.87	—0.49	—0.46	—0.20	+0.29	—1.64(—2.16)
WL 711 x LU 75	—0.71	—1.04	—0.50	—0.33	—0.84	—2.71(—2.01)
WL 711 x Olsen	—3.89	—0.28	—0.13	—0.26	—1.29	—3.50(+0.22)
LU 26 x LU 31	+4.90	—0.16	+0.42	—0.16	+1.19	+3.58(—6.56)
LU 26 x Ch 79	—3.70	—1.30	—0.18	+0.19	—1.57	+0.40(+2.03)
LU 26 x LU 75	—1.02	—1.69	—0.36	—0.27	+0.65	—2.94(+5.12)
LU 26 x Olsen	+0.35	+0.65	+0.25	+0.68	+1.67	+2.84(+0.56)
LU 31 x Ch. 79	+0.76	—0.08	+0.58	+0.71	+0.86	+1.38(—0.72)
LU 31 x LU 75	+2.85	+1.94	—0.10	+0.22	+0.69	+0.41(+1.24)
LU 31 x Olsen	—2.62	—0.75	—0.25	+0.35	—0.18	—5.55(+2.81)
Ch. 79 x LU 75	+0.30	+0.69	+0.49	+0.36	+0.63	+2.76(+6.06)
Ch. 79 x Olsen	+0.98	+0.97	+0.26	—0.28	+0.14	+2.24(+3.71)
LU 75 x Olsen	+1.75	+1.19	—0.16	+0.04	+1.01	+2.31(+1.92)
$SE(S_{ij} - S_{ik})$	±2.26	±0.63	±0.33	±0.36	±0.94	±2.97
$SE(S_{ij} - S_{kl})$	±2.06	±0.58	±0.30	±0.33	±0.86	±2.71
$SE(r_{ij} - r_{kl})$						±3.21

Figures in parentheses are reciprocal effects.

(Table 3).

The results show that mean squares due to GCA are much greater than those of SCA for all the traits except tillers per plant. With the assumption that differences in GCA were mainly due to additive gene effects and that of SCA and reciprocal effects were due to non-additive gene effects as suggested by Griffing (1956), it may be concluded that the expression of all these characters was, by and large, under additive genetic control except tillers per plant which showed non-additive type of gene action. Four cross combinations, i.e., C 273 x WL 711, C 273 x Olsen, WL 711 x LU 26 and LU 26 x LU 31 presented high SCA effects for yield per plant. These crosses involved high x high and high x low general combiners. These crosses possessed high mean values for yield and ranking of these crosses on the basis of per se performance for yield was reflected by the ranking based on SCA effects. As the per se performance is the realised value, while the SCA effect is an estimate, the selection of cross combinations on the basis of both of these would be more realistic as compared to that practised on the basis of only per se performance

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