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BIOMETRICAL ANALYSIS FOR COMBINING ABILITY OF FOUR SPRING WHEAT CULTIVARS

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Combining ability analysis of four wheat varieties was carried out for yield and its major components like number of heads per plant, number of grains per head and grain weight. Mean square values for general and specific combining ability were highly significant ($P \leq 0.01$). The greater proportion of variance component for general combining ability revealed the nature of gene action to be predominantly additive for all the characters. Cultivar LU 21 proved to be the best general combiner for number of grains per head and yield per plant whereas C273 and LU75 respectively showed their promise for grain weight and number of heads per plant. The varietal crosses i.e., LU21 x LU75, LU75 x LU235 and C273 x LU21 reflected highest specific combining ability for number of heads per plant, number of grains per head and grain weight respectively.

INTRODUCTION

The continued efforts made over the years in wheat breeding have made remarkable progress through the widespread adoption of high yielding wheat varieties in this area. This country not only achieved self sufficiency in food through increased grain productivity but wheat production also contributed substantially to the foreign exchange reserves through the exportable surplus. However, the efforts must be continued to exploit further the yield potential of the varieties, to meet the future food requirements of the increasing population.

For successful plant improvement, an adequate knowledge about the combining abilities of the parents which may be involved in the hybridization programme should be collected. This crucial task for the plant breeder has greatly been eased by the use of the combining ability analysis developed by Griffing [4]. This biometrical technique has helped the collection of authentic information about the generative value of the parents and the prediction of the productivity of their hybrids.

Estimates about the general and specific combining ability of parents have been determined by several poineer workers [1,5,8,11]. These studies related a major part of the total genetic variation for yield with significant general combining ability, which is a measure of the additive genetic variance, and also to specific combining ability indicating non-additive genetic variance. Nanda *et al.* [6] stated that the general and specific combining abilities for yield were highly significant while those for ear length, number of grains per ear and 1000-grain weight of the hybrids were non-significant. Similarly Chaudhry *et al.* [2], Sadiq *et al.* [7] and Shaheen *et al.* [9] advocated that general and specific combining ability effects contributed significantly to yield and its various components. However, the relative magnitude for general and specific combining ability of different parents differed for various characters.

In the present study, four wheat cultivars have been analysed in order to collect information about general and specific combining ability for yield and its components, which would be useful for the breeders when planning any wheat improvement programme.

MATERIALS AND METHODS

The diallel cross experiment involving three new wheat cultivars developed at the Agricultural University Campus, namely LU21, LU75, LU235, and an old, tall-statured indigenous variety C273, was conducted in the Department of Plant Breeding and Genetics. The four parents were crossed in all possible combinations to obtain sufficient hybrid seed for experimental plantings. All necessary precautions were taken while making the crosses.

At maturity, the seeds of all the crosses and of the selfed parents were harvested separately. The F_1 progenies of the twelve hybrids, including reciprocals, and their parents were planted as single plant at a distance of 30 cm between rows and 22.5 cm apart within the row, keeping

16 plants per row. A Randomized Complete Block Design with four replications was used. At maturity, 10 plants were selected from within rows and the data were recorded for number of heads per plant, number of grains per head, 1000-grain weight(g) and grain yield per plant(g).

The values in each progeny for each character were averaged and the analysis of variance was calculated according to the technique recommended by Fisher [3] to establish the level of significance among the twelve F_1's and their parents.

The estimates about general combining ability (GCA) of four cultivars, specific combining ability (SCA) and reciprocal effects of twelve crosses were calculated according to the method I, Model I given by Griffing [4].

RESULTS AND DISCUSSION

Mean squares from the analysis of variance for number of heads per plant, number of grains per head, 1000-grain weight and yield per plant, given in Table 1, indicated that the genotypic differences were highly significant ($P \leqslant 0.01$) for all the characters. The total genetic variability observed in each character was partitioned into various causal components i.e., general and specific combining ability as defined by Sprague and Tatum [10] and also into reciprocal effects according to Griffing [4]. Combining ability analysis was conducted on the parental means, single and reciprocal crosses. The mean square values, presented in Table 2, showed that the effects both for general and specific combining ability were statistically significant, at 1% probability, for all the characters under observation except for the number of grains per head where specific combining ability effects were not statistically significant ($P \geqslant 0.05$). Similarly, reciprocal effects were highly significant ($P \leqslant 0.01$) only for yield per plant whereas for the other three characters the probability was not significant.

General Combining Ability (GCA). The relative performance of individual cultivars in general combining ability for various characters and the corresponding standard error are given in Table 3. These estimates are the numerical values obtained from the four parents according to their average performance in different hybrid combinations.

The comparative values revealed that cultivar LU75 with its highest positive magnitude i.e. +1.72 attained the first position in ranking order and proved to be the best general combiner for number of heads per plant. The greatest numerical values i.e. +7.45 and +4.35 carried by LU21 displayed best general combining ability for number of grains per head and yield per plant respectively. As regards GCA for 1000-grain weight, C273 with its highest positive GCA index i.e. +1.94 reflected its superiority over the others in the ranking order.

Table 1. Mean squares from the analysis of variance for yield and its components in spring wheat.

Source of Variation	D.F.	Number of heads per plant	Number of grains per head	1000-grain weight	Yield per plant
Replication	3	54.82	36.29	20.30	15.13
Genotypes	15	64.23**	238.41**	44.72**	181.56**
Error	45	15.74	47.96	3.10	6.76

** = Highly significant.

Table 2. Mean squares of combining ability analysis for yield and its components in spring wheat.

Source of Variation	D.F.	Number of heads per plant	Number of grains per head	1000-grain weight	Yield per plant
GCA effects	3	43.11**	229.04**	40.83**	132.26**
SCA effects	6	12.82**	19.02 NS	6.87**	19.79**
Reciprocal effects	6	5.77 NS	15.47 NS	0.67 NS	27.56**
Error	45	3.94	11.99	0.78	1.69

** = Highly significant. NS = Non-significant.

The results for GCA, Table 3, clearly suggested that these varieties may make worthwhile contributions to increase of the productivity of the plant through their influence on individual yield components. For example, LU21 effectively increased number of grains per head and C273 strongly affected grain weight. Similarly LU75 contributed to greater number of heads per plant. Therefore, under the limits of the present study, it can be concluded that the progenies originated from crosses involving these three varieties may serve as promising source populations for wheat improvement.

Table 3. Estimates of general combining ability of the four cultivars for yield and its components in spring wheat.

Varieties	General Combining Ability Effects			
	Number of heads per plant	Number of grains per head	1000-grain weight	Yield per plant
C 273	+ 0.29	– 4.55	+ 1.94	– 5.03
LU 21	– 3.36	+ 7.45	+ 1.79	+ 4.35
LU 75	+ 1.72	+ 0.20	– 2.68	– 1.25
LU 235	+ 1.35	– 3.10	– 1.05	+ 1.93
SE (Gi-Gj)	0.99	1.73	0.44	0.65

Specific Combining Ability (SCA). Estimates of specific combining ability of six crosses for all the characters studied are presented in Table 4. The results showed that the cross, LU21 x LU75, with highest positive SCA index i.e. +0.21 appeared to be the best specific combination for number of heads per plant whereas for number of grains per head the varietal combination LU75 x LU235, possessing the highest ranking value (+3.39), revealed promise. Similarly from the comparison of the crosses with respect to grain weight, C273 x LU21, with +3.02, reflected the best specific combining ability. However, for yield per plant, all the crosses displayed negative specific combining ability effects. This implies that the varieties utilized in hybridization programme with respect of yield characters did not prove better as far as their specific combining ability is concerned.

Reciprocal Effects. Reciprocal genotypic effects for all the characters are provided in parenthesis in Table 4. The highest positive reciprocal effects, i.e., +0.88 and +4.32, were recorded in crosses like C273 x LU21 and C273 x LU235 for number of heads per plant and number of grains per head respectively. Similarly the highest value of +0.81 for grain weight was noted in C273 x LU75. For yield per plant the reciprocal effect was observed to be +3.60 in cross of C273 x LU235. These reciprocal effects were highly significant ($P \leq 0.01$) for yield per plant whereas for the remaining characters these effects were non-significant (Table 2). The significant effects suggested that single crosses involving the varieties under observation could not

Table 4. Estimates of specific combining ability (SCA) and reciprocal effects for yield and its components in spring wheats. (The values given in the parenthesis are the reciprocal effects of the crosses).

[Specific Combining Ability (SCA)]

Crosses	Number of heads per plant	Number of grains per head	1000-grain weight	Yield per plant
C273 x LU21	–1.10 (+0.88)	+ 2.85 (–1.71)	+3.02 (–0.82)	–1.26 (–6.50)
C273 x LU75	–0.73 (–3.05)	–2.43 (–1.37)	–0.54 (+0.81)	–1.36 (–2.08)
C273 x LU235	–1.18 (+ 0.35)	+ 1.63 (+ 4.32)	+0.96 (+ 0.19)	–8.36 (+3.60)
LU 21 x LU75	+0.21 (–2.30)	+ 2.20 (–0.63)	+0.21 (–0.26)	–2.86 (+1.80)
LU21 x LU235	–2.09 (–1.33)	+ 1.12 (+3.18)	–1.61 (–0.63)	–1.38 (+1.07)
LU75 x LU235	–2.06 (–0.14)	+ 3.39 (–3.54)	–0.63 (–0.39)	–6.50 (–4.34)
SE ($S_{ij}-S_{ik}$)	1.72	3.00	0.76	1.13
SE ($S_{ij}-S_{kl}$)	1.40	2.44	0.62	0.92
SE ($r_{ij}-r_{ki}$)	1.98	3.46	0.88	1.30

Table 5. Components of variance for general and specific combining ability and reciprocal effects for yield and its components in spring wheat.

Variance components	Number of heads per plant		Number of grains per head		1000-grain weight		Yield per plant	
	Compo-nents	%age	Compo-nents	%age	Compo-nents	%age	Compo-nents	%age
Variance for GCA (σ^2_g)	+ 6.91	40.10	+ 26.32	59.31	+ 4.30	48.97	14.23	35.57
Variance for SCA (σ^2_s)	+ 5.46	31.69	+ 4.33	9.76	+ 3.75	42.71	11.14	27.85
Variance for Reciprocals (σ^2_r)	+ 0.92	5.34	+ 1.74	3.92	–0.05	– 0.56	12.94	32.36
Variance for Error (σ^2_e)	+ 3.94	22.87	+ 11.99	27.01	+ 0.78	8.88	1.69	4.22

be composited with their reciprocals if only yield is to be kept in view.

The proportion of variance components for general and specific combining ability and the reciprocal effects for the characters studied were determined and are presented in Table 5. The proportion of these components in the total variance indicated the relative importance of the additive and non-additive effects of the genes responsible for the expression of these characters. The larger amount of variance components was 40.10% for number of heads per plant, 59.31% for number of grains per head, 48.97% for the grain weight and 35.57% for yield per plant.

The greater amount of variance for general combining ability resulted primarily from additive gene effects and those for specific combining ability and reciprocal effects were due to genes non-additive in action, as assumed by Griffing [4] Thus from the present investigations it is apparent that the inheritance of number of heads per plant, number of grains per head, 1000-grain weight and yield per plant were under additive control of the genes. These results obviously suggested that larger proportion of the variability for yield and other components were attributed to significant general combining ability effects. These observations are in accord with those of other workers (1,5,6,8 and 11) who also reported significant contribution of general combining ability for these characters. Further additive genetic effects were pronounced in all the characters, which has also been reported [2,6,9 and 11] for additive genetic control for these characters. It can safely be concluded that for increased productivity of the grains, the breeders should exploit these additive effects of the genes responsible for the expression of yield and its components.

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