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Genetic Analysis for Some Metric Traits in *Aestivum* Species

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Abstract: Mean squares for General Combining Ability (GCA) were highly significant for number of spikelets per spike while non-significant for spike density, number of grains per spike, 1000-grain weight and grain yield per plant. Specific combining ability mean squares were highly significant for spike density, number of grains per spike; 1000-grain weight and grain yield per plant. While significant for number of spikelets per spike. Mean squares for reciprocal effects were highly significant for number of spikelets per spike and number of grains per spike while non-significant for spike density and 1000-grain weight. Additive gene effects controlled the expression of the traits like number of spikelets per spike and number of grains per spike as is evident by greater mean squares for general combining ability. However the gene action was non-additive for spike density, number of grains per spike, 1000-grain weight and grain yield per plant as indicated by the greater mean squares of SCA variances than GCA ones. It is therefore suggested from the results that number of spikelets per spike and number of grains per spike can be transferred from the parents to the progeny with additive effects, which are ultimately responsible for increased grain yield.

Key words: Spring wheat, combining ability, genetic effects

INTRODUCTION

Wheat is an important cereal crop in the world after rice. Wheat, rice and maize together make up three-fourths of the worlds grain production. Wheat is used mainly for food, but substantial quantities are also used as feed for livestock. For food, most of the wheat is made into flour, the base of most baked foods as breads, cakes, etc. Macaroni is made from durum wheat. Most of the flour used in this country is white. In making white flour the bran and germ are removed mechanically and the resulting product consists essentially of the ground endosperm. Whole wheat flour is also an important food. Some of the bran and germ separated out in milling also are used as food. In addition to food and feed uses, some wheat is used as a source of starch and in the making of alcoholic beverages.

Any breeding programme aiming at the evolution of improved cultivars depends primarily on the selection of suitable parents for hybridization. Combining ability analysis developed by Griffing[1] helps the plant breeders in providing such information in early generations, such as the ability of a genotype to transmit superior performance to its crosses. The results of Prodanovic[2] and Shahzad *et al.*[3] indicated that general combining ability (GCA) effects in wheat were more important for number of spikelets per spike. Rabbani[4] reported that Specific Combining Ability (SCA) effects in wheat were significant for spike density. The results of Kalwar *et al.*[5] and Sudesh *et al.*[6] indicated the significant GCA effects for number of grains per spike whereas Rajara and Maheshwari[7] reported significant SCA mean squares for 1000-grain weight. While Wagoire *et al.*[8] found highly significant GCA mean squares for grain yield per plant. Keeping in view the above information, present studies were carried out to evaluate promising wheat genotypes for grain yield and yield components, which may be useful for further breeding programme.

MATERIALS AND METHODS

Experiment was carried out in the Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad. The experimental material comprising five different lines/varieties of spring wheat, namely Uqab 2000, Pasban-90, Fsd.83, 8779 and 5039 were crossed in a diallel fashion during crop season 2001-2002.

At maturity seeds were collected from selfed parents and all hybrids of these parents. Seeds of F_1's were sown in the field along with their parents in a triplicated Randomized Complete Block Design during 2nd week of November, 2002. The seeds were dibbled in rows. Each

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replication had one row of 5 meters length for each treatment while plant-to-plant and row-to-row distance was 15 and 30 cm, respectively. Two seeds per hole were sown and later thinned to single seedling per site. Other cultural and agronomic practices were kept constant for the whole experiment. Ten guarded plants from each row were taken randomly and data were recorded for number of spikelets per spike, spike density, number of grains per spike, 1000-grain weight and grain yield per plant. Analysis of variance technique of Steel and Torrie[9] was applied to determine the significance among genotypes and where the differences were significant, data were further subjected to combining ability analysis. The GCA and SCA estimates were calculated according to Griffing[1] by using Method I, Model II. Estimates of GCA, SCA, reciprocal effects and their components of variance were calculated from the mean values of F_1 data.

RESULTS AND DISCUSSION

The combining ability analysis revealed that mean squares for GCA and reciprocal effects were highly significant for number of spikelets per spike while the mean squares due to specific combining ability were significant for this character. Variety Fsd.83 exhibited high positive GCA effect (1.136) for number of spikelets per spike, while the genotypes 8779 and Pasban-90 showed maximum negative GCA effects of -0.691 and-0.213, respectively for this character. The maximum specific combining ability effects for number of spikelets per spike were exhibited by the cross Uqab 2000 x 5039 with the value of 0.363. The cross combinations Fsd.83 x 8779 and Fsd.83x5039 with the values of 0.354 and 0.33, respectively were the next scorers for specific combining ability effects. Hybrid Pasban-90 x 5039 gave the maximum negative value of -0.787 closely followed by cross combination Uqab 2000 x Fsd.83 (-0.607).

Regarding the number of spikelets per spike, the highest value (1.150) of reciprocal effects was obtained from Fsd.83x5039, followed by 8779x5039 with the value of 0.933. The lowest negative value of -0.250 was observed for cross combination Pasban-90 x 5039 while highest negative value of -1.283 was obtained by the hybrid Pasban -90 x Fsd.83. The variance component due to general combining ability effects was greater than the variance due to specific combining ability effects showing additive type of gene action. These results confirmed the inferences of research Shahzad *et al.*[3] and Chaudhry *et al.*[10]. The present results are not in support of Atiq-ur-Rehman *et al.*[11], differences may be due to different genetic material and environment.

The combining ability analysis (Table 1) showed that the mean squares due to general combining ability and reciprocal effects were found to be non-significant for spike density while the mean squares due to specific combining ability were noted to be highly significant. Highest relative general combining ability effects were observed for the parental variety Pasban-90 with a value of 0.038. The genotype Fsd.83 stood second with a value of GCA effects of 0.016. Line 8779 proved to be poor general combiner with the value of -0.055. In case of crosses, the highest magnitude of specific combining ability effects for spike density trait was expressed by Uqab 2000x8779 with a value of 0.004, followed by 8779x5039 (0.001). Cross combination Pasban-90x5039 was the poorest specific combiner having the value of -0.083. The highest reciprocal effects in case of spike density was obtained by cross combination Uqab 2000 x Pasban-90 with a value of 0.070, followed by Fsd.83 x 5039 having the value of 0.045.The lowest value of -0.041 was obtained for reciprocal effects by the hybrid Uqab 2000x5039 (Table 4). The component variance due to specific combining ability effects was greater than the variance due to general combining ability effects showing non-additive type of gene action (Table 5). These results are in accordance with the findings of Rabbani[4] for this trait.

Table 1 shows that mean squares due to general combining ability were found to be non-significant for number of grains per spike. The mean squares due to specific combining ability and reciprocal effects were highly significant for the trait under study. It is apparent from Table 2 that the highest general combing ability effects was exhibited by the genotype Uqab 2000 with the value of 3.667, while minimum value (-2.827) of GCA was shown by the genotype Pasban-90.

In case of hybrids, Uqab 2000xFsd.83 and Uqab 2000x5039 gave the highest specific combining ability values of 4.220 and 3.830 respectively, followed by the cross Pasban-90 x 5039 (3.510). Whereas the poorest performance for this character was shown by the cross Fsd.83x5039 having the lowest negative specific combining ability effect, -3.950. The highest reciprocal effects in case of number of grains per spike 2.150 was obtained by the cross Fsd.83x5039, followed by the cross Pasban-90x5039 having the value of 1.333. The minimum negative value of -0.317 was exhibited by Pasban-90x8779 while the cross combination Fsd.83x8779 showed the highest negative value of -3.727 (Table 4). The variance component due to specific combining ability was higher as compared to that of general combining ability showing non-additive type of gene action (Table 5). These results coincided with the findings of Sangwan and Chaudhary[12]. Whereas results differ from the findings of Kalwar *et al.*[5] and Sudesh *et al.*[6] who reported the general combining ability variance component higher than

Table 1: Combining ability analysis for different traits in a 5x5 diallel cross of wheat

Source of variation	df	Spikelets per spike	Spike density	Grains per spike	1000-grain weight	Grain yield per plant
GCA effects	04	4.635**	0.012^{NS}	83.816^{NS}	7.106^{NS}	16.905^{NS}
SCA effects	10	0.571*	0.007**	26.748**	5.439**	6.284**
Reciprocal effects	10	0.935**	0.003^{NS}	5.081**	1.102^{NS}	0.238^{NS}
Error	48	0.214	0.002	0.859	0.907	0.164

NS = Non-significant. * = significant at 5% level of probability, ** = Significant at 1% level of probability

Table 2: Estimates of general combining ability effects for different traits in a 5x5 diallel cross of wheat

Varieties	Spikelets per spike	Spike density	Grains per spike	1000-grain weight	Grain yield per plant
Uqab 2000	-0.030	-0.005	3.667	0.215	0.099
Pasban-90	-0.213	0.038	-2.827	0.295	-0.740
Fsd. 83	1.136	0.016	2.397	0.265	2.207
8779	-0.691	-0.055	-0.873	-1.469	-0.552
5039	-0.201	0.006	-2.363	0.695	-1.014
$SE(g_i-g_j)$	0.207	0.021	0.414	0.426	0.180

that of specific combining ability one which may be attributed due to the difference in genetic material used in studies.

The mean squares due to general combining ability and reciprocal effects were found to be non-significant for 1000-grain weight whereas the mean squares due to specific combining ability were highly significant for this character. Table 1 indicates that the highest general combining ability effects were observed for the parental genotype 5039 with a value of 0.695. Variety Pasban-90 stood second with the GCA value of 0.295. Line 8779 proved to be poor general combiner (-1.469). The hybrids Pasban-90 x Fsd.83 and Fsd.83 x 5039 excelled in their performance from the rest of crosses for 1000-grain weight by scoring the highest specific combining ability values of 1.392 and 1.392, respectively followed by the cross 8779 x 5039 with the value of 1.375.The cross like Uqab 2000 x Fsd.83 reflected the poor specific combining ability effects with the value of -0.045 (Table 3). In case of reciprocal effects, maximum reciprocal value of 1.167 was obtained by Uqab 2000 x Pasban-90, followed by cross combination Fsd.83 x 8779 having the value of 1.017 while Uqab 2000 x 8779 showed the highest negative value (-1.083) of reciprocal effects (Table 4). The variance component due to specific combining ability was greater than the variance component for general combining ability showing non-additive type of gene action (Table 5). These findings were confirmed through combining ability analysis made by Rajara and Maheshwari[7] whereas the results differ from the findings of Shahzad *et al.*[3] who reported that general combining ability variances were higher than that of specific combining ability variances showing additive type of gene action which may be attributed due to difference in genetic material and environment.

The combing ability analysis depicted (Table 1) that the mean squares due to general combining ability and reciprocal effects were non-significant for grain yield per plant while the mean squares due to specific combining ability effects were highly significant for this trait. Regarding GCA effects, the greatest value (2.207) was obtained for the parent variety Fsd.83. Genotype 5039 has lowest value of -1.014. It is obvious from the data for general combining ability effects for various characters,

Table 3: Estimates of SCA effects for different traits in a 5×5 diallel cross of wheat

Cross	Spikelets per spike	Spike density	Grains per spike	1000-grain weight	Grain yield per plant
Uqab 2000× Pasban-90	-0.186	-0.022	0.743	0.792	-1.021
Uqab 2000×Fsd. 83	-0.607	-0.013	4.220	-0.045	1.017
Uqab 2000×8779	0.320	0.004	-2.460	0.539	0.395
Uqab 2000×5039	0.363	-0.011	3.830	0.842	1.520
Pasban 90×Fsd. 83	-0.190	-0.029	2.597	1.392	0.640
Pasban 90×8779	-0.280	-0.042	0.550	-0.008	2.171
Pasban 90×5039	-0.787	-0.083	3.510	0.279	-0.674
Fsd. 83×8779	0.354	-0.003	3.160	0.255	-0.133
Fsd. 83×5039	0.331	0.0001	-3.950	1.392	0.983
8779×5039	0.174	0.001	2.137	1.375	1.423
$SE(S_{ij}-S_{ik})$	0.414	0.043	0.829	0.852	0.362
$SE(S_{ij}-S_{kl})$	0.359	0.037	0.718	0.738	0.313

Table 4: Estimates of reciprocal effects for different traits in a 5×5 diallel cross of wheat

Cross	Spikelets per spike	Spike density	Grains per spike	1000-grain weight	Grain yield per plant
Uqab 2000× Pasban-90	0.078	0.070	-0.750	1.167	-0.007
Uqab 2000×Fsd. 83	0.483	0.035	1.117	-0.400	0.815
Uqab 2000×8779	0.250	-0.019	1.233	-1.083	-0.090
Uqab 2000×5039	-0.450	-0.041	0.900	0.883	-0.097
Pasban-90×Fsd. 83	-1.283	-0.036	-0.600	0.817	0.152
Pasban-90×8779	-0.467	0.006	-0.317	-0.527	-0.363
Pasban-90×5039	-0.250	-0.023	1.333	-0.233	0.197
Fsd. 83×8779	0.217	0.011	-3.727	1.017	0.097
Fsd. 83×5039	1.150	0.045	2.150	0.117	0.001
8779×5039	0.933	-0.025	-0.767	0.00	0.552
$SE(R_{ij}-R_{kl})$	0.463	0.048	0.927	0.952	0.404

Table 5: Estimates of components of variation due to GCA, SCA and reciprocal effects for different traits in a 5×5 diallel cross of wheat

Source of variation	Spikelets per spike	Spike density	Grains per spike	1000-grain weight	Grain yield per plant
GCA	00.408	00.001	05.830	00.188	01.091
	(41.64)	(24.39)	(24.97)	(6.30)	(22.87)
SCA	00.212	00.003	15.410	02.697	03.643
	(21.63)	(73.17)	(66.00)	(90.41)	(76.36)
Reciprocals	00.360	00.0001	02.111	00.098	00.037
	(36.73)	(2.44)	(9.04)	(3.29)	(0.78)
Error	00.214	00.002	0.859	0.907	0.164

Values in the parenthesis indicate the percentage of variance components the variety Fsd.83 for which greatest general combining ability effect for yield per plant was observed, also exhibited the highest general combining ability effects for number of spikelets per spike but moderate for spike density and number of grains per spike and low for other characters. So far as grain yield per plant is concerned, the highest specific combining ability value was recorded in the hybrid combination Pasban-90 x 8779 with the value of 2.171 followed by Uqab 2000 x 5039 with the value of 1.520. Cross combination Uqab 2000 x Pasban-90 showed negative value which was the lowest specific combining ability effect, i.e.-1.021 (Table 3). Regarding reciprocal effects, the highest effects (0.815) were observed for the cross Uqab 2000 x Fsd.83, followed by the cross 8779 x 5039 having the value of 0.552. The lowest negative value of -0.007 was observed for Uqab 2000 x Pasban-90 while the cross combination Pasban-90 x 8779 exhibited the maximum negative value of -0.363(Table 4). It is evident from estimates of components of variance that specific combining ability variance was higher than the general combining ability variance showing non-additive type of gene action (Table 5). The results of present study confirmed the previous findings of Sangwan and Chaudhary[12] and Mishra *et al.*[13]. Present results were not favoured by the findings of Wagoire *et al.*[8] where high general combining ability effects as compared to specific combining ability effects were reported, which may be due to the difference among breeding material used.

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