Asian Journal of Plant Sciences

ISSN 1682-3974

science alert

ANSInet
an open access publisher
http://ansinet.com

Asian Journal of Plant Sciences 4 (4): 405-408, 2005
ISSN 1682-3974

Combining Ability Analysis for Some Polygenic Traits in a 5X5 Diallel Cross of Bread Wheat (*Triticum aestivum* L.)

Muhammad Aslam Chowdhry, Muhammad Sajjad Saeed, Ihsan Khaliq and Muhammad Ahsan
Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad, Pakistan

Abstract: The experiment was conducted to evaluate and select strains/varieties of wheat in terms of their genetic values and also to make selection criteria for further breeding program. Mean squares for general combining ability were highly significant for flag leaf area, number of fertile tillers per plant and significant for spike length while non-significant for plant height and peduncle length. Specific combining ability mean squares were highly significant for plant height, number of fertile tillers per plant and peduncle length, while non-significant for flag leaf area and spike length. Mean squares for reciprocal effects were non-significant for all the traits under study. Additive gene effects controlled the expression of the traits like flag leaf area, number of fertile tillers per plant and spike length as is evident by greater mean squares for general combining ability while non-additive type of gene action indicated the pre-dominant role for plant height and peduncle length. However it is concluded from the results that flag leaf area, number of fertile tillers per plant and spike length might be used as selection criteria for further breeding program.

Key words: Quantitative parameters, additive genetic effects, general, specific combing ability

INTRODUCTION

Plant breeding programmes success needs the selection of suitable parents for hybridization at the evolution of improved genotypes. The combining ability technique developed by Griffing[1] provides useful information regarding the selection of parents in terms of the performance of their hybrids. The wheat breeders equipped with such information on combining ability can evolve productive and resistant verities.

Mahmood and Chowdhry[2] revealed that general combining ability effects in wheat were significant for flag leaf area. Mishra *et al.*[3] and Atiq-ur-Rehman *et al.*[4] reported that specific combining ability effects in wheat were significant for plant height. The findings of Mahmood and Chowdhry[2] and Chowdhry *et al.*[5] indicated the significant general combining ability effects for number of fertile tillers per plant. Similarly Atiq-ur-Rehman *et al.*[4] reported significant SCA mean squares for peduncle length. While Sudesh *et al.*[6] found highly significant general combining ability mean squares for spike length.

In view of the above literature, present study was conducted to evaluate wheat lines/varieties and as well as their all possible combinations in terms of general and specific combing ability. The information derived will be helpful in selecting useful lines/varieties and in identifying superior crosses.

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 parents and their hybrids. Seed 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 dibbed in rows. Each replication had one row of 5 m length for each treatment while plant-to-plant and row-to-row distance was 15 and 30cm, 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 flag leaf area, plant height, number of fertile tillers per plant, peduncle length and spike length. Analysis of variance techniques of Steel and Torrie[7] were applied to determine the significance among genotypes

Corresponding Author: Dr. Muhammad Ahsan, Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad, Pakistan

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] 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 due to general combining ability effects were found to be highly significant for flag leaf area. The mean squares due to specific combining ability and reciprocal effects were non-significant for this character (Table 1). Varieties, Fsd.83 and Pasban-90 were good combiners with general combining ability effects of 2.670 and 1.665, respectively. The lowest general combining ability effects for flag leaf area were observed for the line 8779, Uqab 2000 and 5039 with negative values of -2.267, -0.240 and -1.828, respectively (Table 2). Among crosses Uqab 2000 x 8779 was top scorer for specific combining ability effects with the value of 1.283 closely followed by Pasban-90 x 5039 (1.139). Cross combinations Pasban-90 x 8779 and Pasban-90 x Fsd.83 with the respective values of -0.885 and -0.373 were the poor specific combiners (Table 3). The cross combination 8779 x 5039 produced the highest value (1.552) for reciprocal effects for flag leaf area, followed by Uqab 2000 x 8779 (0.882). The poorest value was exhibited by the hybrid Uqab 2000 x 5039 (-1.633) (Table 4). The variance due to general combining ability effects was more than specific combining ability effects showing the additive type of gene action (Table 5). These results are in accordance with findings of Mahmood and Chowdhry[2] while Mohy-ud-din and Shahzad[8] reported that SCA was more than GCA for flag leaf area. The deviation may be due to different environment in which experiment was conducted.

The combining ability analysis depicted that the mean squares for general combining ability and reciprocal effects were found to be non-significant for plant height while the mean squares due to specific combining ability were found to be highly significant (Table 1).

The desirable results regarding the general combining ability estimates for plant height were obtained in the line 8779 which possessed the lowest negative value of -1.902 because the short stature plants are preferred. Then the genotype Pasban-90 with the negative value of-0.623 was the next scorer for general combining ability effects. Line 5039 gave the highest results, which is un-desirable for plant height with a value of 1.300 (Table 2). Similarly desirable results regarding the specific combining ability effects for plant height were observed

Table 1: Combining ability mean squares values for different parameters in a 5 x 5 diallel cross of wheat

Source of variation	D.F	Flag leaf area	Plant height (cm)	Fertile tillers per plant (No.)	Peduncle length (cm)	Spike length(cm)
General combining ability effects	4	46.084**	16.486^{NS}	2.101**	7.150^{NS}	1.548*
Specific combining ability effects	10	1.672^{NS}	4.813**	0.336**	3.132**	0.311^{NS}
Reciprocal effects	10	1.634^{NS}	0.828^{NS}	0.078^{NS}	1.062^{NS}	0.374^{NS}
Error	48	0.905	1.126	0.059	0.697	0.187

^{NS} = Non-Significant. * = Significant at 5% level of probability. ** = Significant at 1% level of probability

Table 2: Estimates of general combining ability for different parameters in a 5 x 5 diallel cross of wheat

Variation	Flag leaf area (cm)	Plant height (cm)	Fertile tiller plant (No.)	Peduncle length (cm)	Spike length (cm)
Uqab 2000	-0.240	0.341	-0.337	-0.928	0.031
Pasban-90	1.665	-0.623	0.173	-0.534	-0.471
Fsd. 83	2.670	0.884	-0.391	-0.129	0.593
8779	-2.267	-1.902	-0.164	0.331	0.052
5039	-1.828	1.300	0.719	1.260	-0.204
$SE(g_i-g_j)$	0.425	0.475	0.109	0.373	0.193

Table 3: Estimates of specific combining ability effects for different parameters in a 5×5 diallel cross of wheat

Cross	Flag leaf area (cm)	Plant height (cm)	Fertile tiller per plant (No.)	Peduncle length (cm)	Spike length (cm)
Uqab 2000×Pasban-90	0.153	1.549	-0.009	1.006	0.048
Uqab 2000×Fsd. 83	0.120	-0.491	0.404	0.279	-0.262
Uqab 2000×8779	1.283	-0.521	0.327	-0.036	0.191
Uqab 2000×5039	-0.168	0.675	-0.206	-0.555	0.349
Pasban-90×Fsd. 83	-0.373	1.180	0.511	0.818	0.103
Pasban-90×8779	-0.885	-1.851	-0.249	-2.041	0.211
Pasban-90×5039	1.139	-1.814	0.284	0.979	0.224
Fsd. 83×8779	0.415	1.130	-0.069	0.112	0.320
Fsd. 83×5039	0.507	-1.662	0.164	1.193	0.220
8779×5039	0.440	2.546	0.187	0.530	0.110
SE (S_{ij}-S_{ik})	0.851	0.949	0.217	0.746	0.387
SE (S_{ij}-S_{kl})	0.737	0.822	0.188	0.646	0.335

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

Cross	Flag leaf area (cm)	Plant height (cm)	Fertile tiller per plant (No.)	Peduncle length (cm)	Spike length (cm)
Uqab 2000×Pasban-90	-0.193	-0.880	-0.150	0.032	-0.627
Uqab 2000×Fsd. 83	0.388	-0.002	0.033	-0.370	-0.032
Uqab 2000×8779	0.882	0.055	0.050	-0.502	0.367
Uqab 2000×5039	-1.633	0.197	0.167	-0.128	0.095
Pasban-90×Fsd. 83	-0.293	-0.465	0.117	-0.862	-0.522
Pasban-90×8779	-1.162	-1.125	0.083	-1.633	-0.362
Pasban-90×5039	-0.435	-1.010	-0.267	-0.828	0.065
Fsd. 83×8779	0.287	0.290	-0.067	-0.125	0.025
Fsd. 83×5039	0.648	-0.717	0.283	-0.098	0.328
8779×5039	1.552	0.472	-0.400	0.885	0.903
SE (R_{ij}-R_{kl})	0.951	1.061	0.243	0.835	0.433

Table 5: Estimates of components of variation due to general, specific combining ability and reciprocal effects for different parameters in a 5×5 diallel cross of wheat

Source of variation	Flag leaf area (cm)	Plant height (cm)	Fertile tiller per plant (No.)	Peduncle length (cm)	Spike length (cm)
General combining ability	4.445 (84.41)	1.185 (35.07)	0.178 (50.42)	0.413 (20.20)	0.124 (42.76)
Specific combining ability	0.457 (8.68)	2.194 (64.93)	0.165 (46.74)	1.450 (70.90)	0.073 (25.17)
Reciprocals	0.364 (6.91)	-0.149	0.009 (2.83)	0.183 (8.95)	0.093 (32.07)
Error	0.905	1.126	0.059	0.697	0.187

Values in the parenthesis indicate the percentage of variance components

in cross combination Pasban-90 x 8779, which possessed the negative value of-1.851 because the short stature plants are preferred. Cross combination, Pasban-90 x 5039 and Fsd.83 x 5039 with the negative values of -1.814 and -1.662, respectively were the next scorers for specific combining ability effects. Cross combination 8779 x 5039 gave the highest value (2.546), which is undesirable for plant height (Table 3). Regarding the reciprocal effects the desirable results were exhibited by the hybrid Pasban-90 x 8779 (-1.125), followed by the hybrid Pasban-90 x 5039 (-1.010). Cross combination 8779 x 5039 gave the highest results with positive magnitude (0.472), which is undesirable for this traits (Table 4).

The variance due to specific combining ability effects was more than general combining ability showing non-additive type of gene action (Table 5). Similar findings were reported by research worker like Mishra *et al.*[3], while Lakshmi *et al.*[9] reported that general combining ability effects were more than the specific combining ability effects showing additive type of gene action. The present results are not in support of them, may be due to difference of genetic material and environment.

The combining ability analysis indicated that the mean squares due to general and specific combining ability were found to be highly significant for number of fertile tillers per plant, while the mean squares due to reciprocal effects were non-significant for this trait. Among parents 5039 proved to be the best combining line with general combining ability effects of 0.719. Genotype Pasban-90 stood second attaining the value of 0.173 and Fsd.83 showed the lowest general combining ability effects with negative value of-0.391 (Table 2). Among cross combinations, the highest value of 0.511 for specific effects was attained by Pasban-90 x Fsd.83 followed by cross Uqab 2000 x Fsd.83 with the value of 0.404. Cross combination Pasban-90 x 8779 gave the lowest value of -0.249 (Table 3).

Regarding the reciprocal effects the highest value of 0.283 was exhibited by the cross combination Fsd.83 x 5039, followed by Uqab 2000 x 5039 for number of fertile tillers per plant having the value of 0.167. The lowest value (-0.400) was recorded for the cross 8779 x 5039 (Table 4).

The variance due to general combining ability was higher than the specific combining ability showing additive type of gene action (Table 5). The present results are therefore supported by the findings of Chowdhry *et al.*[5] while Sangwan and Chaudhary[10] observed high specific combining ability for number of fertile tillers per plant. The deviation may be due to different environment in which the experiments were conducted.

The mean squares due to general combining ability and reciprocal effects were found to be non-significant while the mean squares due to specific combining ability were highly significant for peduncle length (Table 1). Table 2 indicates that the highest general combining ability effects were observed for the line 5039 with the value of 1.260 while Uqab 2000 showed the lowest value of GCA effects, (-0.928). It is apparent from table 3 that the hybrid Fsd.83 x 5039 was the best specific combiner for peduncle length possessing the highest value (1.1930) followed by the cross Uqab 2000 x Pasban-90 (1.006). The hybrid Pasban-90 x 8779 showed the poorest performance for peduncle length having the lowest value of SCA effects (-2.042). In case of reciprocal effects the highest

value (0.885) for peduncle length was exhibited by the hybrid 8779 x 5039, followed by Uqab 2000 x Pasban-90 (0.032). The lowest magnitude of reciprocal effects (-1.633) was observed in hybrid Pasban-90 x 8779 (Table 4).

The variance due to specific combining ability effect was much higher than that of general combining ability showing non-additive type of gene action (Table 5). The results are in accordance with the findings of Atiq-ur-Rehman *et al.*[4], while Chaudhry *et al.*[11] observed high general combining ability for peduncle length. The present results are not in support of them, may be due to difference of genetic material and environment.

The mean squares due to general combining ability were found to be significant for spike length while the mean squares for specific combining ability and reciprocal effects were non-significant for this character (Table 1). Maximum general combining ability effects were shown by the genotype Fsd.83 with the value of 0.593 and variety Pasban-90 exhibited the lowest value of general combining ability, i.e.,-0.471 (Table 2). Among cross combinations the hybrid Uqab 2000 x 5039 showed the excellent performance with highest specific combining ability value (0.349) followed by Fsd.83 x 8779 (0.320). The poorest performance was exhibited by the hybrid Uqab 2000 x Fsd.83 with the lowest negative value (-0.262) for this trait (Table 3). Cross combination 8779 x 5039 with a value of 0.903 gave the highest reciprocal effects for spike length, followed by crosses Uqab 2000 x 8779 and Fsd. 83 x 5039 with the respective values of 0.367 and 0.328. The lowest reciprocal effect (-0.627) was shown by the cross Uqab 2000 x Pasban-90 (Table 4).

The variance due to general combining ability was greater than that of specific combining ability showing additive type of gene action (Table 5). The results are in accordance with the findings of Sudesh *et al.*[6], while Atiq-ur-Rehman *et al.*[4] observed high specific combining ability for spike length. These results are not in favour of them, may be due to difference of genetic material and environment.

REFERENCES

1. Griffing, B., 1956. Concept of general and specific combining ability in relation to diallel crossing system. Aust. J. Biol. Sci., 9: 363-393.
2. Mahmood, N. and M.A. Chowdhry, 2002. Ability of bread wheat genotypes to combine for high yield under varying sowing conditions. J. Genet. Breed., 56: 119-125.
3. Mishra, P.C., T.B. Singh, O.P. Singh and S.K. Jain, 1994. Combining ability analysis of grain yield and some of its attributes in bread wheat under timely sown condition. Intl. J. Tropical Agric., 12: 188-194.
4. Atiq-ur-Rehman, I. Khaliq, M.A. Khan and R.I. Khushnood, 2002. Combining ability studies for polygenic characters in *Aestivum* species. Intl. J. Agric. Biol., 4: 171-174.
5. Chowdhry, M.A., M.T. Mahmood, N. Mahmood and I. Khaliq., 1996. Genetic analysis of some drought and yield related characters in Pakistani spring wheat varieties. Wheat Inform. Service, 82: 11-18.
6. Sudesh, R., K. Yadava and O.P.S. Rana., 2002. Combining ability effects in bread wheat involving gigas spike genotypes as tester. Res. Crops, 3: 426-431.
7. Steel, R.G.D. and J.H. Torrie, 1980. Principles and Procedures of Statistics: A Biometrical Approach. McGraw Hill Co., New York, USA.
8. Mohy-ud-din, Z. and K. Shahzad., 1998. Combining ability for some physiological and yield contributing traits in spring wheat (*Triticum aestivum* L.). J. Agric. Res., 36: 1-6.
9. Lakshmi, K., H.S. Gupta and L. Kant, 2002. Potential yield advancement by combining winter and spring wheat gene pools. SABRAO. J. Br. Genet., 34: 95-106.
10. Sangwan, V.P. and B.D. Chaudhary., 1999. Diallel analysis in wheat (*Triticum aestivum* L.). Ann. Biol. Ludhiana, 15: 181-183.
11. Chaudhry, M.H., G.M. Subhani, F.A. Khan, M.A. Ali, N. Khan and A. Sattar, 1994. Combining ability analysis of physiological and agronomic traits of wheat. J. Agric. Res., 32: 227-233.