http://www.pjbs.org

PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 4 (11): 1303-1305, 2001

Analysis of Combining Ability in Wheat (*Triticum aestivum* L.) Using F_2 Generation

[1]Asif Javaid, [1]Shahid Masood and [2]Nasir Mahmood Minhas
[1] Plant Genetic Resources Institute, NARC Islamabad, Pakistan
[2] University of Arid Agriculture, Rawalpindi, Pakistan

Abstract: The F_2 data from a 4 parent half diallel cross was used for combining ability analysis. Significant genetic variability existed for days to heading, days to maturity, plant height, number of spikes per plant, number of grains per spike, grain yield per plant and 1000 grain weight. The major portion of the total genetic variability for these traits was due to additive type of gene action. Small, but significant SCA estimates for most of the traits with the exception of days to heading and maturity suggests that some of the total genetic variability was due to non-additive type of gene action. The cross Faisalabad-85 x Rawal-87 had the best specific combining ability for grain yield per plant, while the best specific combining ability for number of spikes per plant, number of grains per spike and 1000 grain weight was found in case of the cross Faisalabad-83 x Rawal-87. Faisalabad-83 proved to be the best general combiner for grain yield per plant, number of grains per spike and 1000 grain weight. This cultivar offers the best possibility of exploitation in breeding programs to develop high yielding varieties.

Key words: *Triticum aestivum*, gene action, combining ability, agronomic characters

Introduction

In the hybridization program, plant breeder is often confronted with the difficulty of choosing those parental lines which when crossed will yield the highest proportion of desired segregates. The evaluation of a number of promising lines for combining ability is quite helpful in selecting parents. Diallel analyses in F_1 generation have been used extensively to determine the combining ability for yield and related traits in wheat (Khan, 1991; Asad *et al.*, 1992; Khan *et al.*, 1992; Chaudhry *et al.*, 1994; Rajara and Maheshwari, 1996). All these researchers reported variable estimates of general and specific combining ability and magnitude of additive and non-additive genetic effects for various biometric traits.

In autogamous crops like wheat, raising of sufficient quantity of F_1 seeds is always a difficult task particularly, when a large number of parents are to be included in a crossing program. This eventually imposes restrictions upon the screening of a large number of genotypes for their combining ability. Therefore, investigation on the use of data from F_2 instead of F_1 generation to gather information on the combining ability of the parents is obviously of paramount importance.

Combining ability analysis in F_1, F_2 and F_3 generations were reported by Bhullar *et al.* (1979a) and Masood and Kronstad (2000). The GCA estimates were quite consistent over the generations for all the traits evaluated. Estimates of SCA showed little consistency and lacked repeatability over generations. A greater degree of consistency was observed in GCA when compared to SCA estimates in F_1 and F_2 generation of wheat in another study conducted by Bhullar *et al.* (1985). Similar findings were also reported by Mihalgiv (1980), Khan and Bajwa (1989) and Mahmood *et al.* (1990) from F_1 and F_2 of a diallel cross of wheat.

The literature suggests that F_2 and latter generations could effectively be used for assessing GCA for quantitatively inherited traits. Estimates of genetic effects over generations can provide additional information about the predominant type of gene action involved. Because of inbreeding the contribution to the population mean due to non-additive genetic effects is expected to be reduced by one half with each successive generation. Moreover, later generation evaluation could also offer an opportunity to test the experimental material under different environmental conditions, as the limitation of seed supply encountered in F_1 generation could be avoided. The present study was undertaken to provide more information on the use of F_2 data for general and specific combining ability estimates in wheat.

Materials and Methods

The experimental material consisted of four wheat varieties namely Faisalabad-83, Faisalabad-85, Rawal-87, Rohtas-90 and their F_2s. A half diallel set was generated by the Department of Plant Breeding and Genetics, University of Arid Agriculture, Rawalpindi (UAAR). Seeds of F_2 along with the four parental varieties were raised during 1998-99 at UAAR in a randomized complete block design with three replications. The plot size was kept 5 x 1.8 m^2 with plant to plant and row to row distance of 20 and 30 cm, respectively. At maturity, 150 plants from each F_2 population of a cross (50 from each replication) and 30 plants from each parent (10 from each replication) were randomly chosen to record the observations. The data were taken from individual plants and arranged for each plot for days to heading, days to maturity, plant height, number of spikes per plant, number of grains per spike, grain yield per plant and 1000 grain weight. Statistical analysis was done as outlined by Steel and Torrie (1980) to determine the significance of differences between the means. Combining ability analysis was performed following the procedure of Griffing (1956) using Method II Model I as elaborated by Singh and Chaudhry (1985). The variance resulting from the cross was partitioned into the variance due to general combining ability effects and specific combining ability effects.

Results and Discussion

The mean squares for seven traits involving the parents and F_2s are presented in Table 1. Results of this study suggested that substantial genetic variability existed among the parental lines and F_2 population for seven measured traits. This justified an analysis of the type of gene action controlling the expression of these characters. The mean squares for general combining ability were highly significant for all the characters. The data also revealed significant values for specific combining ability for most of the characters with the exception of days to heading (7.0390) and days to maturity (2.143). The magnitude of general combining ability was higher when compared with specific combining ability. This indicates the preponderance of additive gene effects (Table 2). These research findings are in agreement with the results of Khan (1991), Khan *et al.* (1992), Chaudhry *et al.* (1994) and

Table 1: Mean squares for various plant characters in a 4x4 F_2 diallel cross of wheat sown at UAAR during 1998-99.

S. O. V.	D. F.	Days to heading	Days to maturity	Plant height	Spikes per plant	Grains per spike	Yield per plant	1000 grain weight
Genotypes	9	119.590**	58.458**	214.326**	2.142**	223.649**	17.371**	31.429**
Replications	2	2.031	2.500	17.594	2.034	4.203	2.254	1.865
Error	18	8.699	13.649	12.039	0.107	9.986	3.447	6.602

** Significant at 1% level.

Table 2: Mean squares due to general combining ability and specific combining ability for various plant characters in a 4x4 F_2 diallel cross of wheat sown at UAAR during 1998-99.

S. O. V.	D. F.	Days to heading	Days to maturity	Plant height	Spikes per plant	Grains per spike	Yield per plant	1000 grain weight
GCA	3	105.507**	54.346**	192.456**	0.919**	158.410**	8.332**	15.496**
SCA	6	7.039	2.143	10.931*	0.574**	32.622**	4.518*	7.987*
Error	18	2.900	4.550	4.013	0.036	3.329	1.149	2.208
GCA/SCA		14.99	25.36	17.61	1.60	4.85	1.84	1.94

** Significant at 1% level. * Significant at 5% level.

Table 3: Estimates of general combining ability effects for various plant characters in a 4x4 F_2 diallel cross of wheat sown at UAAR during 1998-99.

Variety	Days to heading	Days to maturity	Plant height	Spikes per plant	Grains Per spike	Yield per plant	1000 grain weight
Faisalabad-83	-4.694	1.722	2.143	0.275	6.228	1.573	1.383
Faisalabad-85	-2.083	-4.166	-5.189	-0.084	-6.332	-1.220	0.902
Rawal-87	4.694	2.611	7.004	-0.519	-0.368	-0.442	-0.044
Rohtas-90	2.083	-0.166	-3.958	0.328	0.470	0.089	-2.300

Table 4: Estimates of specific combining ability effects for various plant characters in a 4x4 F_2 diallel cross of wheat sown at UAAR during 1998-99.

Variety	Days to heading	Days to maturity	Plant height	Spikes per plant	Grains per spike	Yield per plant	1000 grain weight
Faisalabad-83 x Faisalabad-85	-1.525	2.244	6.049	3.345	3.345	-1.997	1.834
Faisalabad-83 x Rawal-87	-0.967	0.467	2.142	4.742	4.742	1.237	3.094
Faisalabad-83 x Rohtas-90	3.089	-0.645	-0.615	-0.395	-1.679	-3.000	-0.350
Faisalabad-85 x Rawal-87	-3.689	-0.090	-2.489	-1.093	-6.953	1.878	2.941
Faisalabad-85 x Rohtas-90	5.700	-1.201	-0.379	0.510	2.396	-0.325	1.548
Rawal-87 x Rohtas-90	-1.077	1.689	-0.425	-0.634	-7.363	0.475	-0.326

Table 5: Components of variance due to general and specific combining ability, specific combining ability and error for various plant characters in a 4x4 F_2 diallel cross of wheat.

Variance components	Days to heading	Days to maturity	Plant height height	Spikes per plant	Grains per spike	Yield per plant	1000 grainweight
Vr.g	17.101	8.299	31.409	0.147	26.014	1.197	2.215
	(70.841)	(50.923)	(71.183)	(20.388)	(44.365)	(20.945)	(21.709)
Vr.s	4.139	3.448	6.918	0.538	29.293	3.369	5.780
	(17.146)	(21.157)	(16.339)	(74.618)	(49.957)	(58.950)	(56.650)
Vr.e	2.900	4.550	4.013	0.036	3.329	1.149	2.208
	(12.013)	(27.919)	(9.478)	(4.993)	(5.677)	(20.105)	(21.641)

Figures without parenthesis are estimates of components of variance and figures within parenthesis are percentages of components of variance.

Siddique (1999). The ratio of GCA and SCA mean squares is higher than one in all the traits. The low ratio of GCA/SCA for spikes per plant (1.60), 1000 grain weight (1.94), and yield per plant (1.84) suggested that there was more non-additive than additive gene action controlling these traits (Table 2). In contrast the high ratio of GCA/SCA for days to maturity, plant height, days to heading, and grains per spike would indicate that these were mainly controlled by genes which were largely additive in their mode of action.

General combining ability effects: To identify good combining parents it is necessary that the contribution of each parental line GCA and SCA be determined for the traits of interest. General combining ability effects for all the characters are presented in Table 3. In this study Rawal-87 showed the highest GCA for days to heading (4.694) and days to maturity (2.611). It seems to be a good parent to develop short duration varieties. Faisalabad-85 and Rohtas-90 showed negative values for plant height. Both these varieties could be the better source for shorter plant type. Much of the positive GCA estimates for grains per spike (6.228), yield per plant (1.573) and 1000 grain weight (1.383) were contributed by the cultivar Faisalabad-83. The same variety proved to be the best general combiner for number of spikes per plant, 1000 grain weight and grain yield per plant as revealed by Siddique (1999). This cultivar would be a good parent to improve these traits in wheat. Rohtas-90 had the highest value of 0.328 as regard to number of spikes per plant followed by Faisalabad 83 having value of 0.275.

Specific combining ability effects: Specific combining ability would not contribute in the improvement of self pollinated crops except for the exploitation of hybrid wheat where non-additive genetic variability could be utilized. The results of specific combining ability analysis are presented in Table 4. The greatest SCA effect for days to heading was detected in the cross Faisalabad-85 with Rohtas-90 (5.700) followed by Faisalabad-83 with Rohtas-90 (3.089). Other crosses had

negative values for specific combining ability. Similarly considering dwarfness, Faisalabad-83 x Faisalabad-85 had the highest value (6.049) for plant height followed by Faisalabad 83 x Rawal-87 with a value of 2.142. All other crosses had negative values of specific combining ability effects for plant height with lowest value shown by Faisalabad-85 x Rawal-87. In case of number of spikes per plant highest specific combining ability effects were found in the cross Faisalabad-83 x Rawal-87 (0.760) while Faisalabad-85 x Rohtas-90 had a value of 0.510. All other crosses showed negative value of specific combining ability. Faisalabad-83 x Rawal-87 had the highest specific combining ability effects for yield per plant with a value of 4.742. It is followed by Faisalabad-83 x Faisalabad-85 (3.345) and Faisalabad-85 x Rohtas-90 (2.396). Other crosses had negative values for specific combining ability. For grain yield per plant, Faisalabad 85 x Rawal-87 (1.878) is the best specific combiner followed by Faisalabad-83 x Rawal-87 (1.237) and Rawal-87 x Rohtas-90 (0.475). Regarding 1000 grain weight, Faisalabad-83 x Rawal -87 (3.094) had the highest value for specific combining ability effects followed by Faisalabad-85 x Rawal-87 (2.941), Faisalabad-83 x Faisalabad-85 (1.834) and Faisalabad-85 x Rohtas-90 (1.548). Faisalabad-83 also performed better in different combination with other varieties as reported by Siddique (1999).

Estimates of variance components: Keeping in view the expectations of the mean squares for Model I, the estimates of components of variance due to GCA and SCA were obtained and presented in Table 5. The proportions of these components were also calculated in terms of percentage in order to obtain an estimate of the relative importance of additive and non-additive effects of genes. The variance components due to general combining ability were greater in case of days to heading (70.841), days to maturity (50.923) and plant height (71.183), indicating that these traits were controlled by additive type of gene action. Barakat and El-Din (1993), Chaudhry *et al*. (1994) and Tandon *et al*. (1989) also reported similar results for days to heading, days to maturity, and plant height, respectively. The variance components due to specific combining ability were higher for spikes per plant, grains per spike, 1000 grain weight, and yield per plant indicating that non-additive type of gene action played a major role in their expression. It is also known that all these characters are influenced to a great extent by environmental factors. This is in agreement with the results reported by Tandon *et al*. (1989), Rajara and Maheshwari (1996), Malik *et al*. (1988).

The breeders of self pollinating crops are mainly concerned with GCA effects for quantitatively inherited traits. Overall our results indicated that F_2 generation can effectively be used for assessing GCA in wheat. Both Faisalabad-83 and Rohtas-90 are the good parents to be used in breeding program aimed at varietal improvement of this important crop of Pakistan.

References

Asad, M. N., K. Alam and M. A. Chowdhry, 1992. Combining ability computation from diallel crosses comprising five bread wheat cultivars. J. Agric. Res., 30: 307-314.

Barakat, M. N. and T. M. S. El-Din, 1993. An *in vivo* and *in vitro* analysis of a diallel cross in wheat (*Triticum aestivum* L.) J. Genet. Breed., 47: 211-216.

Bhullar, G.S., K.S. Gill and A. Bhattia, 1979a. Combining ability over successive generations in a diallel crosses of bread wheat. Cereal Res. Comm., 7: 207-213.

Bhullar, G.S., K.S. Gill and A. S. Khehra, 1979b. Combining ability analysis over F_1-F_5 generations in diallel crosses of bread wheat. Theor. Appl. Genet., 55: 77-80.

Bhullar, G.S., C.S. Nijjar and D.S. Pannu, 1985. Combining ability analysis involving generations and environments in durum wheat. Crop Improvements., 12: 101-105.

Chaudhry, M. H., G. M. Subhani, F. A. Khan, M. A. Ali, N. I. Khan and A. Sattar, 1994. Combining ability analysis of wheat varieties. J. Agric. Res., 32: 228-238.

Corral, L. R., 1983. Influence of competition on combining ability estimates and subsequent prediction of progeny performance in wheat. *Triticum aestivum*. Ph.D. Thesis Oregon State University.

Griffing, B., 1956. Concept of general and specific combining ability in relation to diallel crossing. Aust. J. Biol. Sci., 9: 463-493.

Khan, F. A., M. Aslam and M. S. K. Rana, 1992. Genetic studies on yield and its components and plant height in spring wheat diallel crosses. Sarhad J. Agric., 8: 153-157.

Khan, N. I., 1991. Implication of combining ability analysis in wheat breeding. J. Agric. Res., 29: 1-6.

Khan, N.I. and M.A. Bajwa, 1989. Feasibility of applying combining ability analysis in F_2 generation of spring wheat. J. Agric. Res., 27: 1-7

Mahmood, A., M.S. Swati and S. Rehman, 1990. Combining ability analysis in F_2 population of *Triticum aestivum* L. Sarhad J. Agric., 6: 393-398

Malik, A. J., A. R. Chaudhry, M. M. Rajpur and K. A. Siddiqui, 1988. General and specific combining ability estimates in spring wheat diallel crosses. Pak. J. Agric. Res., 9: 10-15.

Masood, M. S. and W.E. Kronstad, 2000. Combining ability analysis over various generations in a diallel cross of bread wheat. Pak. J. Agric. Res., 16:1-4.

Mihalgiv, I., 1980. Combining ability for grain yield in F_1-F_6 generation of diallel wheat crosses. Proc. of Third International wheat conference, Spain, pp: 102-109.

Rajara, M. P. and R. V. Maheshwari, 1996. Combining ability in wheat using line x tester analysis. Madras Agric. J., 83: 107-110.

Siddique, M., 1999. Genetic analysis of seed yield and yield components in crosses involving some important cultivars of wheat. M.Sc. Thesis University of Arid Agriculture, Rawalpindi.

Singh, R. K. and V. D. Chaudhry, 1985. Biometrical methods in quantitative genetic analysis. Klyani Publishers, New Delhi, India.

Steel, R. G. D. and J. H. Torrie, 1980. Principles and procedures of statistics, A biological approach. McGraw Hill Book Co., New york.

Tandon, G., V. Chawla, O. P. Luthra and S. Uppal, 1989. Combining ability of Brown rust resistance and yield attributes in wheat. Haryana Agric. Univ. J. Res., 19: 1-5.