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Combining Ability Studies For Some Polygenic Traits in *Aestivum* spp.

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Abstract

Combining ability of some polygenic traits was studied in a set of diallel cross involving five varieties/lines of bread wheat. Mean squares for general combining ability were highly significant for plant height; extrusion length, grains per spike, 1000-grain weight and grain yield per plant and non-significant for flag leaf area, tillers per plant and spikelets per spike. Mean squares for specific combining ability were highly significant for plant height, flag leaf area, tillers per plant, extrusion length, grains per spike, 1000-grain weight and grain yield per plant and non-significant for spikelets per spike. Mean squares for reciprocal effects were also highly significant for plant height, tillers per plant, extrusion length, grains per spike, 1000-grain weight and grain yield per plant, significant for spikelets per spike. The magnitude of σ^2_s was higher than σ^2_g for all the traits except spikelets per spike. Hence non-additive gene effects were important in the inheritance of all traits except spikelets per spike. The parent genotypes, 7028 and Rohtas 90 and hybrids Parwaz 94 x Pitic 62, Rohtas 90 x Pitic 62 had high GCA and SCA effects, respectively and they could be exploited for further selection of high yielding progenies.

Introduction

Wheat (*Triticum aestivum* L.) is the most important cereal crop of the world. It is the staple food and major source of calorie and other valuable nutrients of a majority of the people in Pakistan. An immense deal of research work on the study of combining ability of different plant characters of wheat has been carried out by various workers. Chowdhry and Ahmad (1990) studied combining ability in a 7 x 7 complete diallel cross of spring wheat varieties and found significant reciprocal effects for plant height, tillers per plant and spike length. The parents like C-273, WL-711 and LU26S showed high SCA for yield and most of its components under observation.

Khaliq *et al.* (1992) studied traits like plant height, number of tillers per plant and grain yield per plant. General, specific combining ability and reciprocal effects were significant for most of the traits studied. Asad *et al.* (1992) noted that mean squares for general combining ability, specific combining ability and reciprocal effects were significant for almost all the characters except number of kernels per spike.

Chaudhry *et al.* (1992a) reported combining ability for flag leaf area, number of tillers per plant, number of grains per spike, 1000-grain weight and grain yield per plant in F_1's of six varieties. General and specific combining ability effects were significant for all the traits studied. Reciprocal effects were non-significant for number of grains per spike but highly significant for all other characters. Yadav and Mishra (1992) observed significant negative general combining ability effects for plant height. Six crosses exhibited good specific combining ability effects for grain yield per plant, grains per ear and height. Both additive and non-additive gene action was involved in the expression of different characters. Chaudhry *et al.* (1994) reported that the general combining ability mean squares were highly significant for all the traits. Specific combining ability mean squares were non-significant for flag leaf area, number of spikes per plant, spikelets per spike and grain yield per plant, highly significant for plant height, peduncle length and 1000-grain weight. For all these traits general combining ability mean squares were considerably higher than the specific combining ability. Singh and Chatrath (1997) reported that both additive and non-additive gene effects were important in the inheritance of most of the traits like grain yield per plant, spikelets per spike, grains per spike, 1000-grain weight, productive tillers per plant and plant height under salt stress conditions.

Materials and Methods

The experiment was carried out in the experimental area of Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad. The experimental material comprised of five varieties/lines of bread wheat viz., Parwaz 94, Rohtas 90, Pitic 62, 6500 and 7028. These varieties/lines were planted in the field during rabi season 1995-96 and crossed in a diallel fashion in all possible combinations.

The hybrid seed including reciprocals and parents was sown in the field on Nov. 8, 1996, using the randomized complete block design with three replications. Each replicate had 25 lines each of 5 meter length. The plant to plant and row to row distance was 15 and 30 cm respectively. Two seeds per hole were sown with the help of a dibble and thinned to single seedling per site after germination to ensure good plant stand. At the time of maturity 10 guarded plants from each line were selected at random and the data were recorded for the plant height (cm), flag leaf area (cm^2), tillers per plant, extrusion length

(cm), spikelets per spike, grains per spike, 1000-grain weight (g) and grain yield per plant (g).

The data thus collected were subjected to analysis of variance technique as outlined by Steel and Torrie (1980) for all characters under study to observe the level of significance among various F_1 hybrids and their parental lines. The characters which showed significant differences among genotypes were further subjected to combining ability analysis according to Method I, Model II developed and illustrated by Griffing (1956).

Results and Discussion

Analysis of variance for all the traits showed highly significant differences among the parents and crosses (Table 1). Analysis of variance for GCA, SCA and reciprocal effects are presented in Table 1. The variance due to GCA was highly significant for plant height; significant for extrusion length, grains per spike, 1000-grain weight and grain yield per plant; non-significant for flag leaf area, tillers per plant and spikelets per spike. Similarly, the variance due to SCA was highly significant for all the traits except spikelets per spike, indicating that the parents and crosses differ significantly in their combining ability effects. Reciprocal effects were also highly significant for plant height, tillers per plant, extrusion length, grains per spike, 1000-grain weight, grain yield per plant; significant for spikelets per spike. Baker (1978) suggested that the importance of general and specific combining ability should be assessed by estimating the components of variance.

The estimates of GCA and SCA variance reflected the additive and non-additive genetic components are involved in determining the inheritance of the characters under study (Table 1). The magnitude of σ^2_s was higher than σ^2g for all the characters except spikelets per spike. Hence, non-additive genetic variance is playing an important role in the inheritance of these traits as also observed in wheat in F_1 generation by various workers (Chowdhry and Ahmad, 1990; Chaudhry *et al.*, 1992a; Chaudhry *et al.*, 1994; Singh and Chatrath, 1997). But these results were not confirmed by the findings of Khaliq *et al.*, 1992; Asad *et al.*, 1992; Chaudhry *et al.*, 1992a) who reported the additive type of gene action for yield and yield related traits. Although the additive gene action would imply some scope for selection in segregating generations, but presence of marked non-additive gene action suggests the population improvement followed by recurrent selection to accumulate desirable genes and breaking of undesirable linkage would be more appropriate.

The GCA effects of the parents (Table 2) indicated that variety Parwaz 94 followed by genotype 6500 were the best general combiners for plant height. While genotype 7028 exhibiting high GCA for tillers per plant, spikelets per spike, grains per spike and 1000-grain weight. Parent Rohtas 90 proved to be high general combiners for grain yield per plant. Parent 6500 was good combiner for flag leaf area and extrusion length. Parent Parwaz 94 was also a good general combiner for extrusion length and 1000-grain weight. Parent Pitic 62 was also good general combiner for grains per spike and grain yield per plant. Similar findings were reported by Baker (1978) that population exhibiting high GCA estimates are good candidates to be used as parents in population improvement programme.

The estimates of SCA effects of the crosses for grain yield and other related traits are presented in Table 2. Hybrid Parwaz 94 x 6500, Pitic 62 x 7028, Parwaz 94 x 7028 and Rohtas 90 x Pitic 62 had low SCA effects for plant height under normal conditions, indicating that selection would be made for short statured plants from these cross combinations. Cross combination like Parwaz 94 x 7028, Parwaz 94 x Pitic 62, Rohtas 90 x Pitic 62 and Parwaz 94 x 6500 had high SCA effects for flag leaf area.

Table 1: Analysis of variance and components of variance for polygenic traits in bread wheat

		Mean Squares							
Source of variation	D.F.	Plant height	Flag leaf area	Tillers per plant	Extrusion length	Spikelets/ spike	Grains/ spike	1000-grain weight	Grain yield/plant
Replication	2	10.57	3.114	0.891	1.553	0.069	11.338	0.308	0.326
Genotypes	24	117.32**	13.10**	65.21**	2.60**	2.03**	125.92**	27.49**	14.16**
Error	48	7.01	1.41	0.74	0.38	0.89	1.18	0.91	0.93
				Combining abilities					
GCA	4	40.24**	0.95NS	0.68NS	1.50*	0.72NS	5.22*	2.28*	1.96*
SCA	10	24.62**	9.66**	2.38**	0.56**	0.14NS	82.47**	20.07**	8.75**
Reciprocal effects	10	53.05**	0.67NS	2.32**	0.92**	1.10*	16.14**	5.15**	1.61**
Error	48	2.339	0.47	0.24	0.12	0.29	0.39	0.30	0.31
				Components of variance for combining ability analysis					
		1.66	-0.83	-0.16	0.09	0.05	-7.33	-1.68	-0.63
		13.26	5.47	1.27	0.26	-0.08	48.85	11.76	5.02
		25.35	0.10	1.037	0.39	0.40	7.87	2.42	0.65
		2.33	0.47	0.24	0.12	0.29	0.39	0.304	0.31

** = significant at 0.05 and 0.001 level of probability, respectively. NS = Non-significant.

Table 2: Estimates of general, specific combining ability and reciprocal effects in bread wheat.

Parents/crosses	Plant height	Flag leaf area	Tillers per Plant	Extrusion length	Spikelets/ spike	Grains/ Spike	1000-grain weight	Grai yiel Plan
			General combining ability effects					
Parwaz94	-3.12	-0.113	-0.318	0.199	-0.348	0.256	0.432	-0.2
Rohtas90	1.00	-0.180	-0.320	-0.122	-0.088	0.012	-0.105	0.3
Pitic62	1.60	-0.301	-0.124	0.167	-0.105	0.308	-0.636	0.3
6500	-0.880	0.468	-0.091	0.372	0.255	-1.198	-0.207	0.1
7028	1.40	0.126	0.213	-0.616	0.286	0.620	0.516	-0.6
SE(gi-gj)	0.684	0.307	0.224	0.161	0.245	0.281	0.247	0.2
			Specific combining ability effects					
Parwaz 94 x Rohtas 90	0.48	0.123	-0.681	0.162	-0.202	-0.630	1.758	1.2
Parwaz 94 x Pitic 62	1.13	1.563	1.453	-0.353	0.445	2.039	4.035	2.7
Parwaz 94 x 6500	-4.49	1.024	-0.065	0.083	-0.330	2.060	0.530	1.1
Parwaz 94 x 7028	-1.95	2.326	-0.519	0.026	0.303	6.521	-1.284	-1.6
Rohtas 90 x Pitic 62	-0.17	1.246	-0.291	0.899	0.100	4.873	-0.453	1.7
Rohtas 90 x 6500	3.22	0.892	0.281	0.005	-0.240	5.044	2.813	-0.8
Rohtas 90 x 7028	4.51	0.569	2.037	-0.772	-0.042	1.810	1.364	0.1
Pitic 62 x 6500	1.22	0.917	0.140	-0.980	0.177	1.008	-2.931	0.9
Pitic 62 x 7028	-3.72	0.094	0.586	-0.262	-0.020	3.429	1.245	-1.4
6500 x 7028	2.13	0.435	-0.322	0.494	-0.245	0.855	3.341	1.4
SE (sij - skl)	1.185	0.531	0.386	0.278	0.423	0.487	0.429	0.4
			Reciprocal effects					
Parwaz 94 x Rohtas 90	-4.06	-0.150	0.795	-1.090	-0.385	-1.660	1.190	-0.0
Parwaz 94 x Pitic 62	0.19	0.040	-0.555	1.305	-0.915	-1.525	0.730	0.9
Parwaz 94 x 6500	6.76	0.320	-0.780	-0.145	-0.170	1.210	0.195	-0.4
Parwaz 94 x 7028	1.02	0.160	-1.050	0.440	-0.165	-0.720	-3.260	-0.8
Rohtas 90 x Pitic 62	2.30	0.515	0.760	0.535	0.000	-4.725	-1.100	0.9
Rohtas 90 x 6500	-6.73	-0.030	2.035	-0.805	0.820	-5.460	-1.295	-1.2
Rohtas 90 x 7028	5.38	1.295	-0.905	-0.020	0.750	-1.855	1.920	-0.2
Pitic 62 x 6500	0.59	0.965	0.460	-0.240	-1.080	1.250	-2.540	-1.4
Pitic 62 x 7028	-0.82	-0.070	1.660	0.180	-1.085	2.950	-0.250	-0.4
6500 x 7028	-11.01	0.580	0.675	0.190	-0.950	-2.800	0.235	-1.2
SE (rij - rkl)	1.529	0.686	0.498	0.359	0.546	0.629	0.551	0.3

The hybrid Rohtas 90 x 7028, Parwaz 94 x Pitic 62 and Pitic 62 x 7028 showed highest specific combining ability effects for tillers per plant. For extrusion length, cross Rohtas 90 x Pitic 62 exhibited maximum SCA effects. Highest SCA effects were found for spikelets per spike in cross combination Parwaz 94 x Pitic 62. In case of grains per spike, cross combination Parwaz 94 x 7028, Rohtas 90 x 6500 and Rohtas 90 x Pitic 62 showed maximum SCA effects, respectively. The cross Parwaz 94 x Pitic 62 produced maximum SCA effects for 1000-grain weight followed by cross 6500 x 7028 and Rohtas 90 x 6500. As regards grain yield per plant maximum SCA effects were exhibited by cross Parwaz 94 x Pitic 62 followed by Rohtas 90 x Pitic 62 and 6500 x 7028.

Most of the crosses with high SCA for yield had at least one high GCA parent. However, some of the crosses with high SCA had one or both parent with average GCA. The superiority of average x average or average x low combination may be due to the presence of genetic diversity among the parents and there could be some complementation indicating importance of non-addi effects.

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