INTERNATIONAL JOURNAL OF AGRICULTURE & BIOLOGY
1560-8530/99/01-1/2-009-012

Genetics of Yield and Some Developmental Traits in Bread Wheat

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ABSTRACT

The estimates of combining ability effects were determined in a 4 x 4 diallel cross of bread wheat for yield and its components. Analysis of variance revealed significant differences among the genotypes for all the traits. The mean squares of general combining ability were greater than the mean squares of specific combining ability for plant height, spike length, number of spikelets per spike, number of kernels per spike, 1000-grain weight and grain yield per plant indicating the preponderance of additive type of gene action for these traits. Non-additive type of gene action was important for tillers per plant. Parent Chakwal 86 was better general combiner for plant height, spike length, spikelets per spike, number of kernels per spike and grain yield per plant while genotype, 4943, was the best general combiner for 1000-grain weight. Thus these crosses provide ample scope for selecting high yielding genotypes in the subsequent segregating generations.

Key Words: Combining ability; Advanced lines; Flag leaf area; Yield; Bread wheat

INTRODUCTION

Wheat is the most important cereal crop of the world. It is the staple food and chief source of caloric and other valuable nutrients of a great majority of the people. Pakistan has achieved remarkable progress in the development of its wheat-producing sector during the last 30 years. But it is still behind the agriculturally developed countries of the world.

Under these circumstances, the plant breeders are engaged to evolve high yielding, physiologically efficient, agronomically adaptive and genetically superior wheat varieties. For this purpose, combining ability studies give useful information regarding the selection of parents in terms of the performance of their hybrids. Many plant breeders have used this technique in crop improvement and reported useful information on combining ability. In most of the studies on wheat, general combining ability (GCA) and specific combining ability (SCA) effects were high for plant height, yield and yield components (Sharma & Singh, 1979; Chowdhry *et al.*, 1980). Mean squares for GCA and SCA were reported to be significant for all traits (Sharma & Singh, 1979; Dalvir *et al.*, 1982; Bhatti *et al.*, 1984; Zubair *et al.*, 1987; Chowdhry & Ahmad, 1990; Asad *et al.*, 1992; Chowdhry *et al.*, 1992). Additive gene effects were found to be important for plant height, spike length, spikelets per spike, tillers per plant (Dalvir *et al.*, 1982; Munjal & Singh, 1983; Bhatti *et al.*, 1984; Chowdhry & Ahmad, 1990; Asad *et al.*, 1992; Chowdhry *et al.*, 1992) and non-additive for tillers per plant, 1000-grain weight and grain yield per plant (Munjal & Singh, 1983; Bhatti *et al.*, 1984; Zubair *et al.*, 1987; Chowdhry & Ahmad, 1990; Asad *et al.*, 1992)

The present study was undertaken to evaluate four bread wheat varieties/advanced lines with regard to genetic mechanism controlling yield, yield components and plant height in terms of GCA and SCA effects which will be useful for setting a selection criterion in the segregating generations.

MATERIALS AND METHODS

The present study was conducted at University of Agriculture, Faisalabad. Four varieties/advanced lines of bread wheat viz., Pak 81, Pb 85, Chakwal 86 and 4943 were crossed in a diallel fashion in order to obtain all possible combinations. The twelve F_1s including reciprocals and their parents were space planted in the field in November using randomized complete block design with three replications. Each line of five meter length represented as an experimental unit. The plant to plant and row to row distance was 15 and 30 cm, respectively. At maturity, 10 guarded plants were selected from each row and data were recorded for plant parameters like flag leaf area, plant height, tillers per plant, spike length, spikelets per spike, number of kernels per spike, 1000-grain weight and grain yield. The data thus collected were subjected to analysis of variance technique as outlined by Steel and Torrie (1980). The analysis of GCA and SCA was made

according to the procedure given by Griffing (1956) using Method I and Model I.

RESULTS AND DISCUSSION

The differences among the genotypes were significant for all the traits (Table I). The mean squares for GCA were significant for all the traits except flag leaf area and tillers per plant (Table II). The mean squares of GCA for plant height, spike length, spikelets per spike, number of kernels per spike, 1000-grain weight and grain yield per plant were higher than SCA mean squares indicating the predominance of additive type of gene action (Munjal & Singh, 1983; Bhatti *et al.*, 1984; Zubair *et al.*, 1987; Chowdhry & Ahmad, 1990; Asad *et al.*, 1992; Chowdhry *et al.*, 1992) while flag leaf area and number of tillers per plant were mainly under non-additive type of gene action (Munjal & Singh, 1983; Zubair *et al.*, 1987; Chowdhry & Ahmad, 1990; Asad *et al.*, 1992). For flag leaf area, Chakwal 86 showed the highest (1.476) GCA effects followed by Pak 81 and lowest (-1.200) by genotype 4943 (Table III). The estimates of GCA effects showed that highest value of GCA effects was exhibited by Chakwal 86 (4.244) followed by genotype 4943, (1.652) for plant height while Pb 85 showed the poorest performance (-4.076). Chakwal 86 exhibited the highest GCA effects (0.220) followed by Pak 81 (0.030) while lowest (-0.263) by Pb 85 for tillers per plant. In case of spike length, Chakwal 86 showed the highest GCA effects (0.35) followed by genotype 4943 (0.15) and lowest GCA effects (-0.35) were observed by Pak 81. Variety Chakwal 86 again manifested the highest GCA effects (3.495), while lowest effects were noted in genotype 4943, for number of kernels per spike. In case of number of spikelets per spike, Chakwal 86 exhibited the highest GCA effects (1.284) followed by Pb 85 (-0.340). As regards 1000-grain weight GCA effects of 2.061, 1.511 and -2.396 were shown by genotype 4943, chakwal 86 and Pak.81, respectively. Chakwal 86 proved to be the best general combiner for grain yield per plant, showing the maximum GCA effects (0.906), while Pb 85 was the poorest in performance and gave the minimum effects (-1.293).

Table I. Mean squares for plant height, yield and its components in a set of diallel crosses among four wheat varieties

		MEAN SQUARES							
Sorces of variation	**df**	**Flag leaf area (cm^2)**	**Plant height (cm)**	**No. of tillers per plant**	**Spike length (cm)**	**No. of spikelets per spike**	**No. of kernals per spike**	**1000-grain weight (g)**	**Grain yield per plant (g)**
Replications	2	85.60	21.9	1.04	0.16	3.28	149.13	45.9	2.87
Genotypes	15	26.76*	91.99**	12.28**	.89**	4.83**	77.33**	30.06**	53.82**
Error	30	11.19	8.65	1.04	0.21	0.74	27.31	3.35	5.35

*, ** = Significant at 5 and 1% level of probability, respectively

Table II. Combining ability analysis of variance for plant height, yield and its components in a set of diallel crosses among four wheat varieties

		MEAN SQUARES							
Sources of variation	**df**	**Flag leaf area (cm^2)**	**Plant height (cm)**	**No. of tillers per plant**	**Spike length (cm)**	**No. of spikelets per spike**	**No. of kernals per spike**	**1000-grain weight (g)**	**Grain yield per plant (g)**
GCA	3	10.17	108.44**	0.32	0.79**	5.90**	48.47**	36.42**	9.36**
SCA	6	10.26*	18.36**	4.02**	0.24*	0.81*	24.95**	5.63*	3.88
Reci. eff.	6	6.98	4.02	6.06	0.11	0.33	15.26	1.19	36.27
Error	30	3.73	2.88	0.35	0.07	0.25	9.10	1.12	1.78

*, ** = Significant at 5 and 1% level of probability, respectively; Reci. eff.= Reciprocal effects

Table III. Estimates of general, specific combining ability and reciprocal effects for plant height, yield and components in a set of diallel crosses among four wheat varieties

				MEAN SQUARES				
Sources of variation	**Flag leaf area (cm^2)**	**Plant height (cm)**	**No. of tillers per plant**	**Spike length (cm)**	**No. of spikelets per spike**	**No. of kernals per spike**	**1000-grain weight (g)**	**Grain yield per plant (g)**
		General	**Combining**	**Abilitiy**	**Effects**			
Pak.81	+0.140	-1.817	+0.030	-0.350	-0.520	-0.165	-2.396	-0.490
Pb.85	-0.410	-4.076	-0.263	-0.413	-0.340	-1.225	-1.176	-1.293
Chakwal.86	+1.476	+4.244	+0.220	+0.350	+1.284	+3.495	+1.551	+0.906
4943	-1.200	+1.652	+0.013	+0.150	-0.431	-2.104	+2.061	+0.870
SE (gi-gj)	0.965	0.848	0.294	0.132	0.247	1.508	0.528	0.667
		Specific	**Combining**	**Ability**	**Effects**			
Pak.81 x Pb.85	-1.038	-0.474	+2.445	+0.125	-0.143	+2.101	-0.438	+0.311
Pak.81 x Chak.86	-2.190	-2.625	-0.55	-0.300	-0.235	-2.619	-1.053	+1.081
Pak.81 x 4943	-1.158	-1.768	-1.400	-0.360	-0.720	-3.454	+1.061	-1.900
Pb.85 x Chak.86	+1.860	+1.134	-0.515	+0.240	+0.380	+3.576	+0.616	-1.196
Pb.85 x 4943	+1.990	+3.812	-0.620	+0.185	+0.230	+0.311	+1.041	+1.496
Chak.86 x 4943	+0.880	+1.275	+1.400	+0.250	+0.410	+2.054	+1.986	0.960
SE (Sij-Sik)	1.672	1.470	0.509	0.229	0.429	2.612	0.914	1.155
SE (Sij-Skl)	1.360	1.200	0.416	0.187	0.350	2.133	0.746	0.943
			Reciprocal	**Effects**				
Pb.85 x Pak.81	-2.835	+3.200	+0.365	-0.070	-0.265	+0.170	+1.335	+3.385
Chak.86 x Pak.81	-0.500	-0.230	-0.665	-0.065	-0.800	+3.00	-0.730	-4.550
4943 x Pak.81	-1.335	+1.165	+1.200	+0.200	+0.135	+0.935	+0.135	+0.795
Chak.86 x Pb.85	-0.600	-0.200	-0.135	-0.430	+0.465	-0.965	0.400	-4.700
4943 x Pb.85	+0.135	-0.085	+0.365	+0.300	+0.600	+5.900	+0.135	+4.465
4943 x Chak.86	-3.235	+0.600	+4.00	-0.065	+0.470	+0.360	-1.030	-5.830
SE (rij-rkl)	1.930	1.697	0.588	0.264	0.495	3.017	1.056	1.334

Since the Chakwal 86 showed the best general combiner for most of the yield components except 1000-grain weight, so it might be exploited as best yielding parent for varietal improvement in different cross combinations. Although Pb 85 had negative GCA effects for all the traits but, this variety could be used in hybridization programme for selecting short stature plants with other desirable traits such as yield and its components in the subsequent generations (Dalvir *et al.*, 1982; Bhatti *et al.*, 1984; Zubair *et al.*, 1987).

It is evident from the results (Table III) that the cross combination, Pb 85 x 4943 exhibited the larger SCA effects (1.990) for flag leaf area followed by Pb 85 x Chakwal 86 (1.860). The hybrid, Pb 85 x 4943 was also best specific combiner for plant height (3.812) followed by Chakwal 86 x 4943 (1.275) and Pb 85 x Chakwal 86 (1.134). As far as number of tillers per plant is concerned the cross combination, Pak.81 x Pb 85 (2.445) manifested the excellent performance followed by hybrid Chakwal 86 x 4943 (1.40). The hybrid Chakwal 86 x 4943 was the best specific combination for spike length (0.25) closely followed by hybrid Pb 85 x Chakwal 86 (0.24). In case of spikelets per spike the highest SCA effects were obtained from cross combination, Chakwal 86 x 4943 (0.410) followed by Pb 85 x Chakwal 86 (0.380). In case of number of kernels per spike SCA effects of 3.576 and 2.101 were recorded in cross combinations, Pb 85 x Chakwal 86 and Pak.81 x Pb 85, respectively. The highest SCA effects for 1000-grain weight were observed in the hybrid, Chakwal 86 x 4943 (1.986) followed by Pak.81 x 4943 (1.061). The hybrid Pb 85 x 4943 gave the highest specific combining ability (1.496) for grain yield per plant followed by cross Pak 81 x Chakwal 86. It is obvious from Table III that the parents with best GCA on their utilization in hybridization programmme as one of the parent produced good hybrid combinations for spike length, spikelets per spike, number of kernels per

spike, 1000-grain weight and grain yield per plant (Dalvir *et al.*, 1982; Munjal & Singh, 1983).

The hybrid combination 4943 x Pb 85 showed highest reciprocal effects being 0.135, 0.30, 0.60, 5.9 and 4.465 for flag area, spike length, spikelets per spike, number of kernels per spike and grain yield per plant, respectively (Table III). Cross Pb 85 x Pak 81 exhibited highest values of 3.2 and 1.335 for plant height and 1000-grain weight, respectively. Hybrid 4943 x Chakwal 86 reflected highest reciprocal effects (4.00) for tillers per plant. It can be argued on the basis of these results that single cross performance could be coupled with their reciprocal effects if yield and its components are to be kept in view.

CONCLUSIONS

Additive genetic effects were found to be more important for all traits than non-additive effects with the exception of tillers per plant which appeared to be more closely linked to non-additive genetic effects. The parent, Chakwal 86 had better GCA for all the traits except for 1000-grain weight, for which genotype 4943 was the best combiner. These two parents can be used in hybridization programme for obtaining desirable segregants. The cross combinations, Pb 85 x 4943 and Chakwal 86 x 4943 showed their superiority for yield and its components and can further be studied for selection of desirable plants in the subsequent generations.

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(Received 04 February 1999; Accepted 10 March 1999)