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Gene Action Studies for Some Biometric Traits in a Diallel Cross of Wheat

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Abstract: Four wheat varieties viz. Blue Silver, Pak 81, Inqalab 91 and Kohistan 97 were crossed in a complete diallel fashion for combining ability analysis of five agronomic characters. Significant genetic variability existed for all the traits under study. The variance components attributable to both general combining ability (GCA) and specific combining ability (SCA) for grain yield, plant height and number of nodes per plant were significant. The GCA mean squares were larger than those of SCA for all the characters except grain yield. The relative magnitude of these variances indicated the preponderance of additive gene action for most of the characters. Variety Blue Silver was found to be the best general combiner for grain yield. For plant height and number of spikelets per spike, Pak 81 showed its superiority for general combining ability. Crosses Blue Silver × Kohistan 97 and Kohistan 97 × Pak 81 gave markedly higher SCA values for grain yield. Selection of desirable segregants from these two crosses will be useful for improvement in grain yield.

Key words: Wheat (*Triticum aestivum* L.) genotypes, breeding, combining ability, agronomic characters, Pakistan

Introduction

Yield is a complex character, improvement in which relies maximally upon identification of genetically superior and suitable genotypes and their exploitation through either heterosis breeding or pedigree breeding. Selection of parents and the crosses is based on the knowledge of nature and magnitude of genetic variances present in the base population. Combining ability analysis greatly helps assess the plant material regarding the existence of variability and its genetic basis.

In literature, significant estimates of general and specific combining ability variances for yield and yield related traits have been reported. The manifestation of genetic variation in grain yield of wheat and its components have been indicated under both additive and non-additive gene effects (Chen and Chen, 1987; Malik *et al.,* 1988; Chaudhry *et al.,* 1992a; Sattar *et al.,* 1992). However greater magnitude of GCA variance than SCA variance indicating the predominant role of additive gene action for various plant characters have been reported by Bhatti *et al*. (1984), Khan *et al.* (1991), Chaudhry *et al.* (1992b), Kalwar *et al.* (1993) and Chaudhry *et al*. (1994).

The present study was undertaken to envisage the analysis of plant material to ascertain the inheritance mechanism of grain yield and some other important plant characters from intraspecific crosses of wheat.

Materials and Methods

Present study was conducted in the research area of Department of Plant Breeding and Genetics, University of Arid Agriculture, Rawalpindi. The experimental material was developed by crossing four wheat varieties viz. Blue Silver, Pak 81, Inqalab 91 and Kohistan 97 in all possible combinations during 1997-98. The seed of twelve Fl crosses along with their parents were planted in October 1998 following randomized complete block design in three replications. Each plot consisted of single five-meter long row. Row to row and plant to plant spacings were kept as 30 cm and 15 cm respectively. During the crop season normal agronomic practices were adopted.

At maturity data were noted for plant height, number of nodes, internodal length, number of spikelets per spike and grain yield from well guarded 15 plants per row.

Mean values of the parents and the hybrids for these characters were analyzed by ordinary variance technique to determine the significance of genotypic differences (Steel and Torrie, 1980). For genetic analysis, diallel cross technique method I, model I developed by Griffing (1956) and elaborated by Singh and Chaudhary (1985) was used.

Results and Discussion

The presence of heritable variation in the breeding material provides the basis for improvement in genetic architecture of crop plant. The analysis of variance (Table 1) revealed the existence of highly significant differences among the genotypes for all the characters under study except for plant height where genetic differences were significant at 5% probability level.

The results of the analysis indicated the presence of adequate diversity among parent varieties and their hybrids. Therefore, combining ability analysis was performed in order to partition the components of variation i.e. general combining ability (GCA), specific combining ability (SCA) and reciprocal effects as suggested by Griffing (1956). Combining ability analysis revealed that GCA variances were highly significant in case of grain yield, number of nodes and number of spikelets per spike whereas GCA for plant height was significant ($p = 0.05$). The mean squares due to specific combining ability (SCA) were significant for plant height, number of nodes and grain yield and non-significant for rest of the characters. Table 2 further revealed that variances due to reciprocals were significant for number of nodes, number of spikelets per spike and grain yield.

The magnitude of variances due to GCA and SCA suggested the contribution of both additive and non-additive type of gene action involved in the inheritance of plant height, number of nodes and grain yield.

The results obtained are in agreement with those of Chen and Chen (1987), Malik *et al.* (1988), Chaudhry *et al.* (1992a) and Sattar *et al.* (1992) who reported the role of additive and non additive gene effects in the manifestation of grain yield and various yield components. However, certain other workers Bhatti *et al.* (1984), Khan *et al*. (1991), Chaudhry *et al.* (1992b), Kalwar *et al.* (1993) and Chaudhry *et al.* (1994) found preponderance effect of additive genes for these traits.

Table 1: Mean squares for plant height, number of nodes, internodal length, spikelets per spike and gain yield from a 4×4 diallel cross of wheat

Source	Df	Plant height	No. of nodes	Internodal length	No. of spikelets per spike	Grain yield
Genotypes	15	52.40*	0.52**	3.52**	8.21**	162234.33**
Replications	2	14.22	0.03	1.66	5.15	8429.32
Error	30	21.61	0.16	0.60	2.54	18781.85

**Highly significant *Significant

Table 2: Combining ability analysis for different plant characters from 4×4 diallel cross of wheat

Source	Df	Plant height	No. of nodes	Internodal length.	No. of spikelets per spike	Grain yield
GCA	3	25.03*	0.33**	2.25	6.95**	160022.05**
SCA	6	24.54*	0.15*	0.98	1.25	31347.23**
Reciprocal	6	6.61	0.13*	0.82	2.09*	17838.27*
Error	30	7.20	0.05	5.99	0.85	6260.62

**Highly significant *Significant

Table 3: Estimates of general combining ability effects of four parental lines for different plant characters from 4×4 diallel cross of wheat

Parents	Plant height	No. of nodes	Internodal length	No. of spikelets per spike	Grain yield
Blue Silver	1.98	-0.08	0.43	-0.50	195.08
Kohistan 97	-0.37	0.003	-0.01	0.30	-21.21
Ingalab 91	0.81	-0.20	0.32	-0.96	-21.62
Pak 81	-2.22	0.28	-0.74	1.16	-152.25

Table 4: Estimates of specific combining ability effect for different plant characters from 4×4 diallel cross of wheat

Crosses	Plant height	No. of nodes	Internodal length	No. of spikelets per spike	Grain yield
Blue silver×Kohistan 97	1.06	-0.24	0.51	-0.40	198.08
Blue silver×Ingalab 91	-2.27	-0.13	-0.14	0.59	-59.04
Blue silver×Pak 81	-4.60	2.10	-1.07	-0.14	-128.42
Kohistan 97×Ingalab 91	2.96	0.26	-1.00	0.51	41.92
Kohistan 97×Pak 81	-1.37	1.98	-0.50	0.71	2.88
Ingalab 91×Pak 81	1.80	-0.34	0.64	-0.13	-50.04

The SCA effects for four wheat varieties with regard to five plant characters are presented in Table 3. Blue Silver proved to be the best general combiner for grain yield with considerably high GCA value of 195.08. All other parent varieties showed negative GCA effects for this trait. The same cultivar Blue Silver possessed higher values for internodal length and plant height as well. As far as number of nodes and number of spikelets are concerned, Pak 81 gave the greater values i.e. 0.28 and 1.16 respectively. Though Pak 81 had lowest and negative GCA for grain yield but this cultivar could be used in hybridization programme for selecting dwarf plants with other desirable characters. In general Kohistan 97 and Inqalab 91 behaved as poor combiners.

Estimates of specific combining ability effects were made for five plant characters. An overall review of SCA effects presented in Table 4 indicated that cross combination Blue Silver×Kohistan 97 performed exceptionally well and exhibited as good specific combiner for grain yield and internodal length with values of 198.08 and 0.51 respectively. This cross involves the best general combiner Blue Silver and a poor combiner Kohistan 97 and it would be possible to isolate desirable segregates with better yield potential. Utilization of poor general combiner in hybridization for exploitation of yield and other traits has also been emphasized by Bhatti *et al.* (1984) and Chaudhry *et al.* (1992a). Chaudhry *et al.* (1994) has further elaborated that in case crosses showing higher SCA involve good and poor combiners, such combinations may yield desirable transgressive segregants, if the additive genetic system present in the good combiner and complementary epistatic effect in poor combiner are present in the same direction so as to maximize the desirable attributes. Pak 81, which showed remarkably negative GCA effects for plant height and internodal length also proved similar behaviour in SCA analysis when crossed with Blue Silver and Kohistan 97. It suggested the strong relationship between these two traits. Maximum negative SCA effect was observed in cross Blue Silver×Pak 81 followed by Kohistan 97×Pak 81. Former cross exhibited negative effects for plant height, number of spikelets per spike and yield whereas in case of latter, SCA effect was negative for plant height but positive for number of spikelets per spike and grain yield. Therefore, from the cross Kohistan 97×Pak 8 lit would be possible to select segregants of desirable height coupled with yield potential.

It is quite clear from the analysis that SCA effects in case of plant height, number of nodes, number of spikelets per spike and grain yield were obtained on the exploitation of best general combiner as one of the parents for these characters While other parent may be the poor combiner.

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