

Genetic Architecture of Yield Components Accessed Through Line \times Tester Analysis in Wheat (*Triticum Aestivum* L.)

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Abstract Line \times tester analysis is one of breeding strategy to evaluate combining ability effects of genotypes and also to provide information regarding genetic mechanisms controlling certain traits. Three elite wheat lines were used as female parents viz. 9436, 9444 and 9452 and three wheat varieties viz. SH-2002, Sehar 2006 and Lasani 2008 as male parents to produce 9 F1 crosses. Parent line 9452 and tester SH-2002 were found good general combiner for yield and its components which are important in grain yield improvement. 9436 \times SH-2002, 9444 \times SH-2002, 9452 \times Sehar 2006 and 9452 \times Lasani 2008 were more promising hybrids for grain yield components. The combining ability studies indicate the existence of both additive and non-additive gene effects in genetic material. Thus selection should be practiced either for hybrid breeding or pure line wheat varieties after achieving desired homozygosity in succeeding generations (F₅, F₆).

Keywords Genetic Evaluation, Line \times Tester Analysis, General Combining Ability, Specific Combining Ability

1. Introduction

Wheat (*Triticum aestivum* L.) is one of the most important food crop of the world. It is the main cereal grain crop in terms of production, nutritional value, consumption, storage qualities and trade. In Pakistan, more or less all the commercial wheat varieties developed today are pure lines (Chowdhry *et al.*, [6]).

One of the most important advances in plant improvement is the discovery of heterosis/ hybrid vigor and its utilization in breeding programs. Superiority of hybrids over pureline, mid parents and better parents is related with heterotic effects of yield contributing traits (Alghamdi [3]). But efforts to evolve hybrid wheat cultivars in Pakistan are scanty (Chowdhry *et al.*, [6]).

Improvement in wheat plant depends upon the amount of

genetic variability present any other breeding method. Combining or incorporated through hybridization or GCA and SCA ability studies are frequently used by plant breeders to evaluate newly developed cultivars for their parental usefulness and to assess the gene action involved in various characters, so as to design an efficient breeding plan for further genetic upgrading of the existing material. Line \times tester analysis is a simple and efficient statistical approach that has been very commonly used for combining ability analysis in plant breeding.

A knowledge of general and specific combining abilities (GCA, SCA) influencing yield and its components has become increasingly important to plant breeders in the choice of suitable parents for developing potential hybrids in many crop plants (Kruvadi [14]). Assessment of GCA effects for yield components has considerable importance in selecting parents for yield improvement (Kinanci [12]). It has been further reported that number of tillers per plant and spikelets per spike were controlled by additive type of gene action (Akbar *et al.*, [2]). Both non additive gene action (Lariket *et al.*, [15], Süleyman and Akgüni [26] and additive gene action (Ahmadiet *et al.*, [1], Joshi *et al.*, [9]) has been reported for yield components in wheat.

The main objective of present study was to identify the best parents and specific combining ability of crosses for yield and its components to determine the potential of hybrid production in wheat.

2. Materials and Methods

The present study was carried out in the research area of Plant Breeding and Genetics, University of Agriculture, Faisalabad, under normal conditions. Lines viz., 9436, 9444 and 9452 were used as female parents while varieties viz. SH-2002, Sehar 2006 and Lasani 2008 were used as male parents and their 9 F1 crosses were made through manual crossing. Seeds of F1s along with their parents were sown in triplicated randomized complete block design. Spacing

between plants and rows was maintained as 15 and 30 cm, respectively. At maturity ten guarded plants were randomly selected from each plot and data were collected for plant height (cm), number of tillers per plant, number of grains per spike, 1000-grain weight (g) and grain yield per plant (g). The data was subjected to analysis of variance (Steel *et al.*, [25]). Data for the traits depicting significant difference were further analyzed by using line × tester analysis (Kempthorne [10]).

3. Results and Discussions

All genotype used as parents showed significant differences for plant height, number of tillers per plant, number of grains per spike, 1000-grain weight and grain yield per plant. All nine crosses also showed significant variation for all the traits. Variance due to Parents vs crosses was significant only for number of grains per spike and 1000-grain weight. Female parents (lines) and male parents (testers) differ significantly for all the traits except for plant height in case of testers i.e. male parents. (Table 1).

Table 1. Analysis of variance of yield and yield components in bread wheat

SOV	d.f	PH	T/P	G/S	TGW	GY/P
Replications	2	35.42 ^{NS}	0.26 ^{NS}	2.38 ^{NS}	8.54**	0.11 ^{NS}
Genotypes	14	58.18**	10.07**	90.45**	100.86**	60.53**
Parents	5	76.89**	9.92**	111.43**	136.34**	72.38**
Parents vs crosses	1	10.92 ^{NS}	0.72 ^{NS}	316.44**	182.10**	0.74 ^{NS}
Crosses	8	52.39**	11.33**	49.10**	68.52**	60.28**
Lines	2	148.72**	38.05**	5.11**	58.62**	99.95**
Testers	2	17.35 ^{NS}	3.70**	114.82**	145.86**	91.18**
Lines Testers	4	21.75 ^{NS}	1.79 ^{NS}	38.23**	34.80**	25.61**
Error	28	14.87	0.06	3.88	1.72	0.38

***= Significant at 0.1 and 0.05 alpha value respectively, ^{NS}= Non significant, PH = Plant height, T/P = Number of tillers per plant, G/S = Number of grains per spike, TGW = 1000 grain weight, GY/P = Grain yield per plant

3.1. General Combining Ability Studies

Estimates of variation due to general combining ability were distributed for both male (Testers) and female (Lines) parents for the characters under study to search out the potential parents for future breeding program and the results are presented in Table 2. Regarding plant height, 9436 among female parents and SH-2002 among male parents were potential parents (desirable negative value i.e. reduction of plant height). These findings are in accordance with the results of Corral [7], Palve *et al.*, [20], Zubair *et al.*, [27] and Malik *et al.*, [18].

Number of tillers per plant also plays an important role in

grain yield as more number of tillers are expected to result in better yielding ability. Positive GCA effects for number of tillers per plant were observed for female parents viz; 9436 and 9452 and male parent Lasani-2008. These results are in accordance with those of Qari *et al.*, [21], Sarkar *et al.*, [24], Zubair *et al.*, [27] and Chowdhry *et al.*, [5].

Table 2. Estimates of general combining ability effects for yield components in three lines (female parents) and three testers (male parents) of wheat

Parents	PH	T/P	G/S	TGW	GY/P
Female Parents (lines)					
9436	-4.48	1.23	0.17	1.75	-2.48
9444	3.44	-2.37	-0.83	1.17	-1.30
9452	1.03	1.15	0.65	-2.93	3.78
Male Parents (Testers)					
Sehar 2006	1.20	-0.12	3.99	1.73	-2.14
Lasani 2008	0.31	0.69	-1.11	-4.60	-1.51
SH-2002	-1.51	-0.57	-2.88	2.87	3.65

Number of grains per spike is one of the major components of grain yield. Grains per spike shows positive association towards grain yield. Among females 9452 with (0.65) and 9436 with (0.17), among male Sehar-2006 with (3.99) were found the best general combiner parents. Similar findings have also been reported by Qari *et al.*, [21], Palve *et al.*, [20], Sarkar *et al.*, [24] and Zubair *et al.*, [27]. Two female parents viz; 9436 and 9444 along with two male viz., Sehar 2006 and SH-2002 showed positive general combining ability for 1000 grain weight. These results are in agreement with the findings of Fedin *et al.*, [8] and Zubair *et al.*, [27]. For grain yield per plant, one female parent and one male parent showed positive GCA effects. These results are in conformity with the findings of Khurana *et al.*, [11] and Sarkar *et al.*, [24]. These parents could be used for genetic improvement of respective yield component.

3.2. Specific Combining Ability Studies

Results for specific combining ability effects of various yield related characters are presented in Table 3.

9436 × SH-2002 (-3.07), 9444 × Sehar 2006 (-1.99), 9444 × Lasani 2008 (-1.04) and 9452 × Sehar 2006 (-0.02) showed desirable negative specific combining ability effects for plant height (Liu *et al.*, [16] and Rajara and Maheshwari [22]). Maximum positive specific combining ability effects were found in the crosses viz., 9436 × Sehar 2006, 9452 × SH-2002, 9452 × Lasani 2008 and 9444 × SH-2002 (Sarkar *et al.*, [24], Majumdar and Bhowal [17] and Chowdhry *et al.*, [5]). For number of grains per spike, about 55% crosses showed positive specific combining ability. These crosses were 9444 × SH-2002, 9436 × Sehar 2006, 9452 × Lasani

2008, 9436 × Lasani 2008 and 9452 × SH-2002 (Kraljevic-Balalic *et al.*[13], Rasal *et al.*[23] and Chandrakar *et al.* [4]. For 1000-grain weight, highest positive SCA effects were recorded in 3 out of 9 crosses. The best specific combiner were found to be 9452 × SH-2002 and 9436 × Lasani 2008 possessing values 3.73 and 2.69 respectively(Sarkar *et al.* [24] and Chowdhry *et al.*[5]. SCA effects were found much variable among crosses for grain yield per plant.9436 × SH-2002 (2.75) exhibited the highest positive SCA effects for grain yield per plant (Corral [7], Khurana *et al.* [11], Mishra *et al.* [19] and Chowdhry *et al.*[5].

Table 3. Estimates of specific combining ability for yield components of wheat crosses through line × tester analysis

Crosses	PH	T/P	G/S	TGW	GY/P
1.9436 × Sehar 2006	2.02	0.85	3.25	-1.51	-1.68
2.9436 ×Lasani 2008	1.04	-0.09	0.89	2.69	-1.07
3.9436 × SH-2002	-3.07	-0.76	-4.14	-1.18	2.75
4.9444 ×Sehar 2006	-1.99	-0.05	-1.22	2.65	-0.17
5.9444 ×Lasani 2008	-1.04	-0.16	-2.04	-0.09	-0.80
6.9444 × SH-2002	3.04	0.21	3.26	-2.55	0.97
7.9452 ×Sehar 2006	-0.02	-0.80	-2.03	-1.14	1.85
8.9452 ×Lasani 2008	0.07	0.25	1.15	-2.59	1.87
9.9452 × SH-2002	0.02	0.55	0.88	3.73	-3.73

4. Conclusion

Considerable genetic variation exists in wheat genotypes for improving basic yield components. Both additive and non additive gene action governs expression of quantitative yield traits. Selection for parents with high GCA effects and crosses with high SCA effects would be a suitable strategy for yield improvement in wheat.

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