Line x Tester Analysis for some Morpho-Physiological Traits in Bread Wheat

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ABSTRACT

Six wheat genotypes (three each females and males) were crossed for the study of some morpho-physiological traits. Kohistan-97 and MH-97 showed the highest negative GCA effects for epidermal cell size and stomata size, respectively. Highest positive GCA estimates for number of tillers per plant, number of grains per spike and grain yield per plant were obtained in Chakwal-86, while Barani-83 showed highest positive GCA effects for flag leaf area. Hybrid Kohistan-97 x MH-97 exhibited negative SCA effects for stomata size and epidermal cell size. Cross combination Kohistan-97 x Pasban-90 showed highest positive SCA effects for number of tillers per plant, number of grains per spike and grain yield per plant. About 55% of the hybrids showed positive SCA effects for number of grains per spike, grain yield per plant and 67% for flag leaf area and number of tillers per plant. While 44% hybrids exhibited positive SCA effects for stomata size and epidermal cell size. These crosses may prove useful in future breeding programme.

Key Words: Wheat genotypes; Drought; Line x tester analysis; GCA; SCA

INTRODUCTION

The common bread wheat (*Triticum aestivum* L.), one of the major crops is widely grown not only Pakistan but also through out the world as a prime food cereal. In Pakistan, it is used as the staple food of the people and occupies a pivotal position in our economy because it covers the largest area with the highest production. The situation of wheat production in Pakistan is much better than before but still consistent effects are required to keep the pace with the ever increasing population. About one third of our wheat growing area is perpetually devoid of supplemental irrigation. In these areas, per unit grain yields are miserably low. Irrigation water supplies cannot be increased due to many reasons. Under such conditions the wheat breeders are working hard to evolve new genotypes that have efficient plant mechanism so that they can either escape, avoid or better tolerate the conditions of drought.

To evolve high yielding, drought resistant varieties better understanding of various morpho-physiological characters like flag leaf area, stomata size, epidermal cell size, number of tillers per plant, number of grains per spike and grain yield per plant will need special attention. Equally significant would be the proper choice of parents. They should not only manifest the requisite traits but should also be capable of producing hybrids with superior performance when crossed with other parents. Combining ability analysis provides useful information in this respect. Significant value of general and specific combining ability effects for flag leaf area (Prabhu & Sharma, 1987), tillers per plant, (Chowdhry *et al*., 1996) number of grains per spike (Yadav & Singh, 1988) and grain yield per plant (Malik *et al.,* 1988; Yadav & Singh, 1988) have been reported. The diallel analysis approach (Griffing, 1956) is not practicable unless the number of parents involved is limited. So line x tester analysis is used here in order to evaluate six parents for general and specific combining ability.

MATERIALS AND METHODS

Three lines of wheat *viz.,* Barani-83, Chakwal-86, Kohistan-97 (female parents) and three testers Pasban-90, Punjab-96, MH-97 (male parents) were crossed in Feb-March, 1999. Necessary precautions were taken to avoid the contamination of genetic material at the time of crossing. Emasculation of spikes was done and sufficient hybrid seed for each cross was produced by hand pollination.

The F1 seeds of the nine crosses (3 x 3) alongwith their parents were planted in the filed in randomized complete block design with three replications during 2nd week of November, 1999. The genotypes were assigned at random to experimental unit in each block and each row contained 20 plants. Each replication consisted of six varieties and nine F1 crosses with a five meter long single row for each treatment. Inter-plant and inter-row distances were as 15 and 30 cms, respectively. Two seeds per hole were sown with the help of a dibble and later thinned to one seedling per site after germination. The experimental population was kept under normal agronomic care from sowing to maturity. At maturity, 10 guarded plants from each plot were taken randomly and data were recorded on some morpho-physiological traits like leaf area (cm^2), stomata size (μm^2), epidermal cell size (μm^2), number of tillers per plant, number of grains per spike and grain yield per plant (g).

The data recorded were subjected to analysis of variance according to Steel and Torrie (1980) to determine significant differences among genotypes. Combining ability

studies were made by using line x tester analysis as described by Kempthrone (1957).

RESULTS AND DISCUSSION

The perusal of the results Table I, shows that the female parents (lines) revealed non-significant differences for all traits studied; whereas, male parents (testers) accounted significant differences for stomata size and non-significant differences for flag lea area, epidermal cell size, number of tillers per plant, number of grains per spike and grain yield per plant. Interaction of line x tester was highly significant for all the traits except stomata size for which, it was significant. Male and female parents used in the present study provided broad range of expression for various characters (Table II). Flag leaf area was highest in Kohistan-97 and minimum in Barani-83. Maximum size of stomata was found in Punjab-96 and minimum in Pasban-90. Epidermal cell size was maximum in Punjab-96 and minimum in Chakwal-86. MH-97 produced maximum number of tillers per plant while minimum were recorded in Chakwal-86. In case of number of grains per spike and grain yield per plant MH-97 showed the maximum value while Barani-83 exhibited the minimum values.

Mean performance of nine crosses is presented in (Table II) which revealed a considerable degree of hybrid vigour existed in most of the crosses for majority of the characters studied. In case of flag leaf area maximum value (38.83 cm^2) and minimum value (32.11 cm^2) was found in crosses Kohistan-97 x Pasban-90 and Barani-83 x MH-97, respectively. Hybrids Chakwal-86 x MH-97 showed the maximum value (3899.2 μ^2) minimum value was found in Kohistan-97 x MH-97 (3199.3 μ^2). Stomata size was less variable in hybrids. However, increase in vigour was observed in some cases. Maximum value (2729.7 μ^2) was observed in Chakwal-86 x Pb-96 which also exceeded its better parent Pb-96 (2682.5 μ^2). Minimum stomsta size was observed in Kohistan-97 x Pb-96 (2036.9 μ^2). Number of tillers per plant ranged from 10.72 (Barani-83 x Pb-96) to 13.01 (Koh-97 x Psb-90). Maximum number of grains per spike (61.31) was observed in the cross Kohistan-97 x Pasban-90 whereas, Barani-83 x Pb-96 showed the minimum value for the same trait. In case of grain yield per plant a fair degree of variation was observed. The minimum (20.88 g) and maximum (25.83 g) value were recorded in the crosses Barani-83 x Pb-96 and Kohistan-97 x Pasban-90 respectively.

General combining ability studies. Estimates of variation

Table I. Analysis of variance for line x tester experiment for various morpho-physiological traits in bread wheat

Crosses	df	Flag leaf area	Stomata size	Epidermal cell size	Number of tillers per plant	Number of grains per spike	Grain yield per plant
Replication	2	1.6680N.S	14098N.S	131584**	14.9996**	32.2813**	11.8340**
Genotype	14	22.4972**	207496**	212480**	4.5700**	16.9129**	12.3856**
Parents	5	26.3035**	381298**	329702**	8.5476**	25.1914**	19.3568**
P.Vs.C.	1	2.1367N.S	40672*	234560**	11.0283**	16.6562**	14.6016**
Crosses	8	22.2626**	119710**	136456**	1.2764**	11.7686**	7.7505**
Lines	2	6.9316N.S	119784N.S	117616N.S	1.8485N.S	12.1562N.S	10.5958N.S
Testers	2	1.1680N.S	283288*	140720N.S	0.6797N.S	3.3008N.S	2.1006N.S
L x T	4	41.2754**	37884*	143744**	1.2893**	15.8086**	9.1543**
Error	28	2.2379N.S	9708N.S	846N.S	0.0001 N.S	0.2656N.S	0.0877N.S

** Highly significant; * Significant; N.S = Non-significant

Table II. Mean values of parents and crosses for various morpho-physiological traits in bread wheat

Parents	Flag leaf area (cm^2)	Stomata size (μm^2)	Epidermal cell size (μm^2)	Number of tillers per plant	Number of grains per spike	Grain yield per plant (g)
Females						
Barani-83	32.17	2295.6	3820.4	11.66	54.56	19.43
Chakwal-86	37.12	2438.3	3035.4	8.92	58.71	24.16
Koh-97	38.30	2302.2	3657.3	11.89	55.39	21.85
Males						
Pasban-90	33.03	1647.7	3259.2	12.66	60.52	25.68
Punjab-96	38.14	2682.5	3836.2	9.31	55.01	21.66
MH-97	32.37	2513.4	3308.6	12.83	60.98	25.81
Crosses						
Barani-83 x Psb-90	35.46	2308.4	3554.4	12.59	59.97	25.37
Barani-83 x Pb-96	38.08	2563.6	3878.6	10.72	54.98	20.88
Barani-83 x MH-97	32.11	2407.2	3510.4	12.32	59.00	24.80
Chakwal-86 x Psb-90	37.36	2265.4	3721.9	12.63	60.03	25.43
Chakwal-86 x Pb-96	35.52	2729.7	3552.7	11.99	58.00	23.47
Chakwal-86 x MH-97	32.57	2421.4	3899.2	12.43	59.81	24.98
Koh-97 x Psb-90	38.83	2414.0	3666.8	13.01	61.31	25.83
Koh-97 x Pb-96	38.49	2036.9	3720.7	11.92	56.44	22.72
Koh-97 x MH-97	32.28	2225.4	3199.3	12.39	59.39	24.87

due to GCA were partioned for both male and female parents for various morpho-physiological traits to search out the potential parents for further breeding and results are given in Table III. In case of flag leaf area, positive GCA effects are more important because flag leaf has much contribution in grain yield. From this point of view female parent Barani-83 and male parent MH-97 showed the positive GCA value 0.90 and 0.41, respectively. These results are in accordance with the results of Joshi (1990), Chowdhry *et al.* (1992) and Usman (1998). Plants with higher number and small size of stomata can better tolerate the moisture deficiency as they efficiently and economically regulate the supply of water. In case of stomata size, negative effects are given due importance. So keeping that in view, Barani-83 and Chakwal-86 were found to be the potential parent among females. Whereas, highest negative GCA effects among males were recorded in case of MH-97. Negative GCA effects are desirable for epidermal cell size. Chawkal-86 x Kohistan-97 among females while Pb-96 and MH-97 among males were the best general combiner for this traits. Productive tillers per plant is a major yield component. Therefore, parents such as Chakwal-86, Barani-83 and Pb-96 seemed to be good combiner for increasing tillering ability. The findings of Qari *et al.* (1986), Sarkar *et al.* (1987), Zubair *et al.* (1987) and Usman (1998) supported the results reported in this write up. Similarly number of grains per spike is also an important trait. The useful parents having positive GCA effects were Barani-83, Chakwal-86 and Pb-96. These results are in agreement with those of Qari *et al.* (1986), Palve *et al.* (1987), Sarkar *et al.* (1987) and Usman (1998). In case of grain yield per plant, the suitable parents were Chawkal-86, Barani-83, Pb-96 and MH-97 as they indicate positive GCA effects. These finding

are in conformity with the results of Sarkar *et al.* (1987) and Usman (1998).

Specific combining ability studies. Results for SCA effects of various morpho-physiological traits are presented in Table IV. The cross Kohistan-97 x Pasban-90 showed the highest value of SCA effects for flag leaf area, if more flag leaf area is required, then the crosses Barani-83 x Pb-96, Chakwal-86 x MH-97, Barani-83 x MH-97 and Kohistan-97 x Pasban-90 may be used in further breeding programme. These results confirm the findings of Sarkar *et al.* (1987), Chowdhry *et al.* (1992) and Usman (1998). In case of stomata size, negative SCA effects are more important. It is obvious that crosses namely Kokistan-97 and MH-97, Chakwal-86 x Pasban-90, Chakwal-86 x Pb-96 and Barani-83 and MH-97 are more suitable. For epidermal cell size 55% crosses showed negative SCA effects. If smaller cell size is required then the crosses Kohistan-97 x MH-97, Chakwal-86 x Pasban-90, Barani83 x Pb-96, Chakwal-86 x Pb-96 and Barani-83 x Pasban-90 may be more suitable. Number of tillers per plant is an important yield contributing character. The crosses viz., Kohistan-97 x MH-97, Chakwal-86 x Pasban-90 and Barani-83 x Pb-96 proved to be good specific combiners. These results are in agreement with those of Sarkar *et al.* (1987), Chowdhry *et al.* (1992) and Usman (1998). In case of number of grains per spike 55% of the crosses showed positive SCA effects. Potential crosses showing higher values of SCA effects were Kohistan-97 x MH-97, Barnai-83 x Pb-96 and Barani-83 x Pasban-90. These findings are in line with the results of Sarkar *et al.* (1987) and Usman (1998). As regards the grain yield per plant, five crosses out of nine showed positive SCA effects. The prominent crosses were Barani-83 x Pasban-90, Barani-83 x Pb-96 and Kohistan-97 x MH-97.

Table III. Estimates of GCA for various morpho-physiological traits in bread wheat

Parents	Flag leaf area (cm²)	Stomata size (μm²)	Epidermal cell size (μm²)	Number of tillers per plant	Number of grains per spike	Grain yield per plant (g)
Females						
Barani-83	0.99	-83.92	128.58	0.23	0.42	0.25
Chakwal-86	-0.65	-47.63	-38.43	0.29	0.90	0.94
Koh-97	-0.34	131.55	-90.15	-0.52	-0.31	-0.88
Males						
Pasban-90	-0.26	56.47	143.40	-0.31	-0.52	-0.52
Punjab-96	-0.15	142.30	-57.03	0.22	0.67	0.44
MH-97	0.41	-198.77	-86.37	0.09	-0.15	0.79

Table IV. Estimates of SCA for various morpho-physiological traits in bread wheat

Crosses	Flag leaf area (cm²)	Stomata size (μm²)	Epidermal cell size (μm²)	Number of tillers per plant	Number of grains per spike	Grain yield per plant (g)
Barani-83 x Psb-90	-3.80	74.16	-6.45	0.29	1.14	0.99
Barani-83 x Pb-96	2.35	-19.07	-38.42	0.34	1.46	0.88
Barani-83 x MH-97	1.45	-55.09	44.86	-0.62	-2.60	-1.87
Chakwal-86 x Psb-90	0.75	-75.06	-185.25	0.39	0.80	0.69
Chakwal-86 x Pb-96	-2.72	-62.09	-27.79	-0.41	-1.33	-0.84
Chakwal-86 x MH-97	1.97	137.15	213.04	0.03	0.51	0.15
Koh-97 x Psb-90	3.05	0.90	191.70	-0.67	-1.96	-1.68
Koh-97 x Pb-96	0.37	81.16	66.21	0.07	-0.12	-0.04
Koh-97 x MH-97	-3.42	-82.06	-257.90	0.60	2.08	1.71

Similar results have also been reported by Corral (1983), Sarkar *et al*. (1987) and Usman (1998). From the results of the experiment, it is suggested that among females Barani-83 and Chakwal-86 were the best lines because they have desired GCA effects for the traits under study except epidermal cell size and flag leaf area, respectively.

Similar MH-97 among males exhibited the desired GCA effects for all the traits except number of grains per spike. Pb-96 also showed GCA effects for all the characters except flag lea area and stomata size. Among crosses, Barani-83 x Pb-96 and Chakwal86 x Pasban-90 proved to be the best specific combiners. Cross Kohistan-97 x MH-97 also showed desired SCA effects for all the traits except flag leaf area.

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