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ESTIMATION OF COMBINING ABILITY AND GENETIC ADVANCE IN BREAD WHEAT USING LINE × TESTER ANALYSIS

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ABSTRACT

Fifteen crosses and eight parents were evaluated during wheat growing season 2016-2017. Five lines Punjab-85, MH-97, Chenab-2000, Shakar-95 and Kohistan-2000 and three testers 312, 735 and 481 were crossed in Line × Tester fashion to develop these crosses during 2015-16. Analysis of variance showed significant differences among the lines and testers for all the traits i.e. chlorophyll contents, flag leaf length, flag leaf width, plant height, peduncle length, extrusion length, spike length, awn length, number of spikelets, number of fertile spikelets, days to heading, days to anthesis, days to grain filling, days to physical maturity, number of grains, thousand grain weight, biological yield, grain yield, harvest index. Punjab-85 showed high value of general combining ability for yield related traits and appeared as the best general combiner for yield. Similarly among testers, tester (312) appeared as best general combiner for biological yield. Cross combination between Punjab-85 × 735 showed highest specific combining ability for yield (16.82) and biological yield (26.32). Highest value of genetic advance was observed for grain yield. Results indicated that selection of parents can be done from this study to improve wheat yield.

Keywords: bead wheat, genetic advance, heritability, general combining ability, yield, selection

INTRODUCTION

Wheat is a most important cereal crop which is being used as staple food across the globe. It provides important food constituents like carbohydrates, proteins, fiber and fat for human consumption. It is a chief source of food due to cheap and easy availability to all people of the world. Dwindling climatic conditions and increasing world's population has emerged as the major threats to sustainable food production. Exploration and utilization of existing wheat germplasm is a suitable strategy to combat this menace [1]. Utilization of available germplasm requires complete knowledge of genetic mechanism such as heterosis and combining ability [2]. Therefore, information of heterosis and combining ability are of major concern for improving the yield potential of wheat [3].

Grain yield is a very complex trait which is governed by many genes. Grain yield is mainly depends upon two components which are grain size and number of grains per spike. Therefore, to develop high yielding wheat varieties, parents with desirable traits should be identified [4]. Previously, many researchers noted significant heterotic effects for number of traits in wheat such as flag leaf length, plant height and number of days to flowering. Availability of high value of heterosis increases the chances of producing commercial hybrids on large scale [5]. Hybrid wheat gives more yields as compared to its parents. It shows high response to inputs added in field, uniformity and resistance to many a-biotic stresses. India and china are growing hybrid wheat and it showed considerable increase in yield and has good quality as compared to pure lines.

Genetic advance is an estimation of amount of desired genes present in a genotype controlling a particular trait. Due to polygenic nature of grain yield, plant breeders want to transfer all the genes required for high yield. Genetic advance provides very clear information about the variance due to heritability. Genetic advance is very important for selection of genotypes in breeding programs. It aids selection process especially in segregating populations. Therefore, to improve wheat yield selection of genotypes should be appropriate [6].For improving wheat yield, various crossing schemes have been used in breeding programs. Among these methods, line x tester crossing pattern is suitable for detection of suitable parents and crosses for desired traits. The method is important for genetic improvement of both self and cross pollinated crops. The method can be used effectively for evaluation of combining ability, heterosis and genetic background of wheat crop [7]. The study was carried out to achieve following objectives, i) to develop superior Fi hybrids ii) determination of general and specific combining ability effects of different parents and crosses iii) to determine the value of genetic advance for different yield contributing traits.

MATERIALS AND METHODS

The experiment was conducted during 2015-16 and 2016-17 at the experimental area of the department of Plant Breeding and Genetics, Bahauddin Zakariya University, Multan, Pakistan.. Fifteen crosses were developed by line × tester method during 2015-2016. Five lines Punjab-85, MH-97, Chenab-2000, Shakar-95 and Kohistan-2000 and three testers were used for making crosses. Hybrid seed of crosses were harvested at maturity. Collected seeds of crosses and parental lines were sown in randomized complete block design in three replications on 15 November 2016. Row to Row distance was maintained 9 inches with the help of scale. Sowing was done with the manual drill. Soil was given with required amount of fertilizers and irrigation. Total 23 lines were used to evaluate the following plant parameters chlorophyll contents (Chl%), flag leaf length (FLL), flag leaf width (FLW), plant height (PH), peduncle length (PL), extrusion length (EL), spike length (SL), awn length (AL), Number of spikelets per spike (SPS), number of fertile spikelets per spike (FSPS), days to 50% heading (DTH), days to 50% anthesis (DTA), days to 50% grain filling (DTG), days to 50% physiological maturity (DTPM), grain yield (GY), thousand grain weight (TGW), number of grain per spike (GPS), biological yield (BM) and harvest index (HI). For taking the measurements, five plants from each genotype were tagged. At the maturity data of different traits was recorded from selected plants. Analysis was done to determine the variance among the genotypes used in experiment. After phenotyping, the data was subjected to analysis of variance to determine the level of variation among studied genotype [8]. Analysis for combining ability effects and genetic advance were determined using the line × tester analysis [7].

Table 1: List of parents and crosses used in this experiment

Sr. No.	Genotypes	Sr. No.	Genotypes
1	Punjab-85	13	Kohistan-97×735
2	MH-97	14	Kohistan-97×312
3	Chenab-2000	15	MH-97×312
4	Kohistan-97	16	MH-97×481
5	Shahkar-95	17	MH-97×735
6	312	18	Punjab-85×481
7	735	19	Punjab-85×735
8	481	20	Punjab-85×312
9	Chenab-97×312	21	Shakar-95 ×312
10	Chenab-97×481	22	Shakar-95×735
11	Chenab-2000 ×735	23	Shakar-95×481
12	Kohistan-97×481		

RESULTS AND DISCUSSION

Analysis of variance revealed significant differences among genotypes for all the traits viz., chlorophyll contents, flag leaf length, flag leaf width, plant height, peduncle length, extrusion length, spike length, awn length, number of spikelets, number of fertile spikelets, days to heading, days to anthesis, days to grain filling, days to physical maturity, number of grains, thousand grain weight, biological yield, grain yield, harvest index (Table 2). In Line × Tester analysis general combining ability was determined for all the lines and testers (Table 3). Among lines, line Punjab-85 exhibited highest positive GCA for grain yield (2.91) followed by flag leaf length (1.66) and minimum GCA for number of grains (-1.43). MNH-97 showed maximum GCA for number of grains (2.9) followed by harvest index (2.59) and lowest value of GCA for awn length (-4.64). Chenab-2000 had maximum general combining ability effects for trait plant height (5.12) followed by biological yield (3.42) and revealed minimum value for chlorophyll content (-2.76). General combining ability for Kohistan-97 exhibited maximum GCA for days to grain filling (2.47) followed by days to heading (2.38), and grain yield showed minimum GCA (-4.91). Shahkar-95 showed highest general combining ability for biological yield (2.84) followed by days to physical maturity (1.98) and lowest GCA was observed for trait number of grains per spike (-3.16).

Among testers, the tester 312 showed maximum GCA for biological yield (2.54) followed by number of grains per spike (2.43) whereas, plant height showed minimum value (-4.22) for general combining ability. The tester 735 indicated maximum GCA for grain yield (1.2) followed by harvest index (0.97) and minimum GCA was recorded for peduncle length (-3.18). Tester 481 revealed highest GCA values for plant height (6.67), extrusion length (6.07) whereas, biological yield showed minimum value of GCA (-2.35) (Table 3). The cross Shahkar-95 × 312 showed maximum positive specific combining ability for grain yield (7.64) and for thousand grain weight 6.72. This showed minimum value of specific combining ability for flag leaf length (-1.99). Cross Punjab-85×481 showed highest value of specific combining ability for trait spike length (1.9) followed by awn length (0.23) and minimum value of SCA was observed for grain yield (-12.1). The value of SCA was observed maximum for trait biological yield (9.23) for cross combination Kohistan-97×481 followed by grain yield (4.45) and lowest value of SCA was noted for trait thousand grain weight (-4.21). The cross Shahkar-95×735 showed highest value of specific combining ability for trait chlorophyll contents (3.61) and minimum value of SCA was observed for trait thousand grain weight (-3.94). The cross Kohistan-97×735 offered highest value of SCA for days to heading (3.47) followed by days to physical maturity (3.13) and minimum value of SCA for trait grain yield(-5.14). Maximum SCA was observed for trait biological yield (7.26) followed by grain yield (5.45) in cross MN-97×735 and minimum value of SCA was observed for days to grain filling (-2.33). Values of specific combining ability for rest of the traits are depicted in Table 4. Combining ability analysis was studied by various researchers in wheat. The above cited results are in agreement with [9-12].

Genetic advance values were recorded for all traits used in study. Genetic advance value ranged from 0.866 to 26.408. Highest value of genetic advance were observed for traits biological yield, harvest index, plant height, grain yield and number of grains per spike (26.408, 19.156, 17.065, 16.01 and 15.731), respectively. Moderate value of genetic advance was observed for traits like awn length (5.293), days to heading (5.165), days to grain filling (5.482), flag leaf length (6.287), chlorophyll content (6.545), thousand grain weight (7.028), extrusion length (12.125) and peduncle length (12.304). Lowest value of genetic advance was observed for flag leaf width (0.866), number of fertile spikelets (2.321), number of spikelets (2.622), days to physical maturity (3.726) and spike length (4.941). Maximum genetic advance mean was observed for traits such as awn length (74.908) followed by the extrusion length (65.035), flag leaf width (50.629) biological yield (33.924) and harvest index (33.424). Moderate value of heterosis was observed for traits like peduncle length, grain yield and number of grains per spike (30.011, 23.442 and 26.19), respectively. Minimum genetic advance was noted for traits days to physical maturity (2.855), days to heading (5.748), days to anthesis (4.419) and number of fertile spikelets (10.615).

Kumar *et al.,* [13] estimated the high value of genetic advance for trait number of days to maturity, number of tillers and 1000 grain weight. Moderate value of genetic advance was observed in plant height and number of spikelets. Lowest value of genetic advance was shown by number of grains per spike. Saleem *et al.,* [14] observed high value of genetic advance for plant height, grain yield, number of grains per spike and flag leaf length. Basavaraja *et al.,* [15] determined the high value of genetic advance for grain yield, number of kernal per plant, number of spikelets per spike and plant height. From above mentioned results it is evident that most of the lines and testers showed highest values of GCA for yield related traits. Among lines, Punjab-85 appeared as best general combiner for yield. Similarly among testers, tester (312) appeared as best general combiner for biological yield. Cross combination between Punjab-85 × 735 showed highest specific combining ability for yield (16.82) and biological yield (26.32). Conclusively, selection parents and F_1 hybrids for increasing wheat yield can be executed from the wheat germplasm used in this study. The parent Punjab-85 appeared as best general combiner as well it showed high value of specific combining ability in number of crosses. Therefore, this parent should be given due importance while breeding for high yields. The gene action helps plant breeders to select higher yield crop genotypes under varying environmental conditions [16-18].

Table 2: Mean Square value of studied traits

SOV	DF	Chl %	FLL	FLW	PH	PL	EL	SL	AL	NS	NFS	DTH	DTA	DGF	DTPM	NG	TGW	BM	GY	HI
Rep	2	1.27	1.37	0.01	2.15*	0.13	3.59	0.01	0.02	0.37	0.1	0.23	0.52	1.57	6.2*	10.3	0.26	5.39*	0.37	0.08
Gen	22	77**	70.9*	0.2*	162*	107**	82.4*	21.8*	14.50*	4.4*	5*	23.2**	17.6*	22.9*	15.3*	172.6**	39.8*	465.6*	328.4*	180.4*
Parents	7	30.6**	8.59**	0.07*	45*	13.6*	12.1*	14.9*	8.95*	0.88*	1.37*	15*	13.0*	19.7	16.8*	197.85**	45.7*	463**	322**	297**
P×C	1	1038**	1051**	1.2	310**	713**	186*	125*	5.11	14*	35	72*	88**	60*	0.62	975**	68**	338**	1222**	462**
Crosses	14	32*	32*	0.14	209**	110**	110**	18*	18*	5.5**	4.7**	23.8*	14.8**	22**	15.7**	102.7**	34.8**	475.6**	267.4**	102*
Lines	4	28.5	23.2	0.1	99.5**	16.7*	8.8*	11.3	61.1*	5.9	2.07	25*	18.7*	22.35	21.7**	50.5*	27.2*	105.5**	92**	27.9*
Testers	2	14.4	46.9	0.22	512.2	446.2**	434.5**	53.1	1.4*	3.33	1.40	30.4	23.5*	5.5	0.46	67.31	14.9*	90**	20.8*	62.9**
Line × Testers	8	37.5*	32.8	0.13	188.4**	73.7*	79.8*	12.2	0.51*	5.75	6.84	21.4*	10.7	25.9*	16.5**	137.7**	348.4**	6057.3**	3333.7**	1191.7**
Error	44	0.53	0.67	0.003	0.95	0.63	1.08	0.2	0.08	0.2	0.1	1.62	0.71	0.6	2.11	1.73	0.86	2.07	1.57	0.66

SOV= Source of Variation, DF= Degree of Freedom, *=Significant, **= Highly Significant, Chl%= Chlorophyll Contents, FLL= Flag Leaf Length, FLW= Flag Leaf Width, PH= Plant Height, PL= Peduncle Length, EL= Extrusion Length, SL= Spike Length, AL= Awn Length, NS= Number of Spikelets per spike, NFS= Number of Fertile Spikelets, DTH= Days to Heading, DTA= Days to Anthesis, DGF= Days to Grain Filling, DTPM= Days to physical maturity, NG= Number of Grains, TGW= Thousand Grain Weight, BM=Biological yield, GY= Grain Yield, HI= Harvest Index

Table 3: Values of General Combining Ability and Genetic Advance

SOV	Chl%	FLL	FLW	PH	PL	EL	SL	AL	NS	NFS	DTH	DTA	DGF	DTPM	NG	TGW	BM	GY	HI
Lines																			
Punjab-85	-0.16	1.66	0.12	0.62	0.01	-0.79	0.67	1	-0.07	0.08	1.04	0.49	0.47	-0.24	-1.43	1.58	0.75	2.91	0.59
MN-97	0.52	-0.92	-0.04	-3.92	-0.3	-0.34	-0.04	-2.64	1.32	0.47	-1.73	-0.51	-0.87	-0.24	2.9	-2.09	-2.48	0.05	2.59
Chenab-2000	-2.76	-1.6	-0.19	5.12	2	0.27	1.48	1.57	-0.46	-0.56	-0.73	-0.84	-0.42	-2.24	0.29	1.41	3.42	2.76	-1.3
Kohistan-97	2.17	1.81	0.08	-1.43	0.13	-0.73	-0.73	1.21	-0.81	-0.43	2.38	2.27	2.47	0.76	1.4	-1.64	-4.52	-4.91	0.02
Shahkar-95	0.23	-0.94	0.02	-0.4	-1.82	1.6	-1.37	0.86	0.02	0.44	-0.96	-1.4	-1.64	1.98	-3.16	0.74	2.84	-0.81	-1.91
Testers																			
312	1.12	1.59	0.14	-4.22	-3.1	-4.2	2.15	0.21	0.08	-0.2	1.56	1.44	0.24	0.2	2.43	-1.11	2.54	-0.04	-2.3
735	-0.41	-1.9	-0.1	-2.44	-3.18	-1.87	-1.33	0.14	0.43	0.35	-1.24	-0.69	-0.69	-0.07	-1	0.29	-0.19	1.2	0.97
481	-0.71	0.31	-0.04	6.67	6.3	6.07	-0.82	-0.35	-0.51	-0.15	-0.31	-0.76	0.44	-0.13	-1.43	0.82	-2.35	-1.16	1.38
G.A	6.54	6.28	0.86	17.0	12.3	12.1	4.94	5.29	2.622	5.16	4.15	5.48	3.72	15.73	7.02	26.40	16.01	19.15	6.54
GAM%	12.79	23.91	50.62	17.02	30.01	65.03	24.40	74.90	11.47	5.74	4.41	5.49	2.85	26.19	15.78	33.92	23.44	33.42	12.79

Chl%= Chlorophyll Contents, FLL= Flag Leaf Length, FLW= Flag Leaf Width, PH= Plant Height, PL= Peduncle Length, EL= Extrusion Length, SL= Spike Length, AL= Awn Length, NS= Number of Spikelets per spike, NFS= Number of Fertile Spikelets, DTH= Days to Heading, DTA= Days to Anthesis, DGF= Days to Grain Filling, DTPM= Days to physical maturity, NG= Number of Grains, TGW= Thousand Grain Weight, BM=Biological yield, GY= Grain Yield, HI= Harvest Index, G.A=Genetic Advance,

Table 4: Values of Specific Combining Ability of crosses

Crosses	Chl%	FLL	FLW	PH	PL	EL	SL	AL	NS	NFS	DTH	DTA	DGF	DTPM	NG	TGW	BM	GY	HI
Shahkar-95 ×312	1.03	-1.99	-0.1	2.84	-1.15	1.09	-0.49	0.06	1.04	0.88	1.56	0.44	1.87	-0.42	-2.43	6.72	2.11	7.64	2.91
Punjab-85×481	-2.15	-1.55	0.01	-3.28	-2.52	-1.24	1.9	0.23	-1.34	-0.62	-2.98	-1.09	-2.87	-2.16	-4.67	-2.51	-11.33	-12.1	-0.58
Kohistan-97×481	1.12	3.54	0.09	0.44	3.67	0.16	-1.41	-0.29	0.3	-0.26	1.42	0.64	1	2.58	7.1	-4.21	9.23	4.45	-2.32
Shahkar-95×735	3.61	-1.33	-0.01	2.25	1.95	0.98	-0.24	-0.4	-1.51	-2.3	-2.67	-0.89	-0.8	-2.42	2.9	-3.94	-2.79	-0.31	1.74
Kohistan-97×735	-4.68	2.35	0.09	-3.9	-1.78	-2.69	-0.06	-0.08	1.07	1.71	3.47	2.24	3.13	1.18	-3.33	1.32	-4.47	-5.14	-0.08
MN-97×735	1.07	-1.02	-0.08	1.65	-0.16	1.71	0.3	0.48	0.44	0.58	-0.8	-1.36	-2.33	1.24	0.43	2.62	7.26	5.45	-1.66
Shahkar-95×481	-3.11	-2.81	0.04	1.34	0.78	1.03	-2.1	-0.21	-0.97	-0.13	-1.33	-1.22	-3.58	1.24	4.18	-2.11	-3.58	1.71	7.8
Punjab-85×735	5.5	0.51	-0.09	12.39	7.78	7.87	-0.74	-0.11	-0.25	-1.02	-1.53	-1.76	-0.64	-0.82	5.94	0.16	26.32	16.82	-11.7
Kohistan-97×312	-2.38	2.3	0.05	-13.72	-8.56	-8.9	2.84	0.31	1.22	1.15	2.87	2.98	4.22	-0.42	-10.12	1.96	-22.75	-18.53	3.9
Chenab-2000 ×735	-2.5	1.28	-0.27	-4.78	-2.05	0.37	3.01	0.21	-0.28	-0.3	0.89	0.67	0.53	-0.76	-5.93	1.78	-8.52	-8.44	-4.36
Chenab-97×481	1.8	-1	0.11	-3.22	-2.62	-1.47	-1.33	0.32	0.97	0.81	0.02	-0.2	0.13	0.51	6.67	-0.79	4.33	6.56	5.12
Chenab-97×312	0.69	-0.28	0.16	8	4.67	1.1	-1.68	-0.53	-0.69	-0.52	-0.91	-0.47	-0.67	0.24	-0.73	-0.99	4.19	1.88	-0.76
MN-97×481	0.97	4.85	0.35	-1.64	0.47	-3.47	-0.19	0.34	1.72	1.84	1.56	1	1.98	2.36	1.29	-2.44	12.78	-0.61	-8.09
Punjab-85×312	-0.46	-0.32	-0.12	-1.99	-0.86	-2.47	0.23	-0.36	-0.46	-0.89	1.02	0.8	0.24	1.29	-4.61	1.82	-14.86	-6.14	7.25
MN-97×312	-0.51	-4.54	-0.23	3.63	0.39	5.93	-0.05	0.02	-1.26	-0.95	-2.58	-1.8	-2.22	-3.64	3.32	0.62	2.07	6.75	0.84

Chl%= Chlorophyll Contents, FLL= Flag Leaf Length, FLW= Flag Leaf Width, PH= Plant Height, PL= Peduncle Length, EL= Extrusion Length, SL= Spike Length, AL= Awn Length, NS= Number of Spikelets per spike, NFS= Number of Fertile Spikelets, DTH= Days to Heading, DTA= Days to Anthesis, DGF= Days to Grain Filling, DTPM= Days to physical maturity, NG= Number of Grains, TGW= Thousand Grain Weight, BM=Biological yield, GY= Grain Yield, HI= Harvest Index

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