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RESEARCH ARTICLE

Estimation of Combining Ability Effects for Some Yield Related Metric Traits in Intra-specific Crosses Among Different Spring Wheat (*Triticum aestivum* L.) Genotypes.

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Abstract

Five spring wheat cultivars/lines (BARS-09, AARI-11, Tukuru, WL-01 and Rawal-87) were crossed in half diallel fashion to evaluate their combining ability for yield and its components. The study was conducted at Barani Agricultural Research Station, Fatehjang, during rabi 2011-12. All the genotypes showed significant amount of diversity for all the traits. Both general and specific combining ability variances were highly significant for all the yield related traits. Among all the genotypes BRAS-09 proved best general combiner for traits like grain yield per plant, plant height, number of tillers per plant, spikelets per spike, biological yield per plant and harvest index. The cross Tukuru / WL-01 exhibited highest specific combining ability values for grain yield per plant, 1000-grain weight and flag leaf area. Another cross AARI-11 / Tukuru showed best specific combining ability for plant height and spike length. Maximum specific combining ability values for number of tillers per plant and biological yield was exhibited by the cross BARS-09 / AARI-11. Non additive gene effect was demonstrated by all the characters. The parent BARS-09 was the best general combiner for most of the important yield contributing traits in this particular study and can be helpful in future breeding program.

Introduction

A lot of attempts have been made by past and present breeders for improving grain yield in wheat, which is the ultimate goal of every breeding program or strategy. As to accommodate ever increasing population of Pakistan, breeders must develop those cultivars that can meet the demand of the country. In this regard breeders are attempting to combine different wheat genotypes / lines / cultivars constantly to get some combinations that can enhance the per area yield of wheat. To evaluate the combinations and their combining ability with each other, Griffing proposed a technique in 1956 which is widely used in plant breeding to study the gene action and combination of different genotypes with respect to their general and specific combining ability and ultimately helping the breeders to get the optimum combination for increasing the grain yield.

Scientists already investigated wheat general and specific combining ability at number of occasions. Arshad and Chowdhry (2002) revealed the presence of additive and non additive variability which suggested the utilization of certain genotypes and crosses to evolve new cultivars of wheat. Gorjanović and Balalić (2004) revealed non additive gene effects were more important while selecting on the basis of grain weight per spike and harvest index. Joshi *et al*. (2004) found the predominance of additive gene effects for all the yield traits in ten parent half diallel cross of hexaploid wheat. Siddique *et al.* (2004) also reported non additive gene action for most of the yield attributing traits in a 5x5 diallel cross analysis in wheat. Hassan *et al.* (2007) observed significant differences for GCA and SCA for the parents and crosses respectively. Further more they also find non additive gene effects for yield contributing traits like, number of fertile tillers per plant , 1000-grain weight and grain yield it self. Khan *et al.* (2007) reported both additive and non additive gene effects controlling different plant parameters. Kashif and Khan (2008) observed non additive gene action for all the yield contributing traits while studying combining ability in different wheat genotypes. Similar findings of presence of additive and non additive gene effects are reported by Bao *et al.* (2009). Seboka *et al.* (2009) reported the predominance of non-additive gene effects for plant height, harvest index, grain yield per plant, 1000 kernel weight and maturity traits of eight genotype's half diallel analysis study. Çifci and Yağdi (2010) showed that non-additive gene effects play a major role on the heredity of yield contributing traits like plant height, spike length, number of spikelets/spike, number of grains/spike, grain weight/spike and 1000-grain weight in wheat. Additive and dominance gene action was exhibited by some morphological traits of wheat presented by Kamaluddin *et al.* (2011).

The present experiment was attempted to predict the performance of different cultivars in combinations of each other in half diallel fashion for the evaluation regarding to their gene action and choosing best combinations for further breeding programs.

Material and Methods

The present study was carried out while taking five wheat genotypes i.e., BARS-09, AARI-11, Tukuru, WL-01 and Rawal-87. The genotypes were crossed in half diallel fashion during the Rabi 2010-11 at research farm of Barani, Agricultural Research Station, Fatehjang. The F_1 along with parents was planted during Rabi 2011-12 at same location in a randomized complete block design with three replications. Row to row and plant to plant distances were kept at 30 and 20cm respectively. Uniform agronomic and cultural practices were carried out during the growing season. The data was recorded of ten randomly selected plants from each entry for the following parameters. Plant height (cm), spike length (cm), number of spikelets per spike, number of tillers per plant, flag leaf area (cm^2), biological yield (g), 1000 grain weight (g), harvest index (%) and grain yield per plant (g). Analysis of variance was carried out on the means of the traits using the technique provided by Steel *et al.* (1997). Combining ability analysis was performed according to Griffing's (1956), method II and model II.

Results and Discussion

All the parents and their F_1 hybrids showed highly significant differences among each other for plant height, spike length, number of spikelets per spike, number of tillers per plant, flag leaf area, biological yield, 1000 grain weight, harvest index and grain yield per plant depicting adequate diversity among parents and their combinations for these characters (Table 1). The mean square values of both GCA and SCA were highly significant that indicated the presence and importance of epistatic and dominant genes which were controlling all the traits among these genotypes (Table 2). Higher values of variance components of SCA as compared to GCA variance values for plant height, spike length, spikelets per spike, number of tillers per plant, flag leaf area, 1000-grain weight, biological yield per plant, harvest index and grain yield per plant indicates predominance of the non additive gene action for these traits. Confirmatory findings have been reported by a number of researchers (Gorjanović and Balalić, 2004; Hassan *et al*., 2007; Kashif and Khan, 2008 and Çifci and Yağdi, 2010). However our results are in disparity with the findings of Joshi *et al*. (2004) and Kamaluddin *et al.* (2011) who reported the predominance of additive type of gene effects for the yield attributing characters in wheat.

Analysis of general combining ability indicated that parent variety BARS-09 was the best general combiner for spikelets per spike, number of tillers per plant, harvest index and grain yield per plant (Table 3). Rawal-87 proved best general combiner for plant height and biological yield while AARI-11 exhibited its potential as good combiner for spike length. The data showed that Tukuru and WL-01 were best general combiners for flag leaf area and 1000-grain weight, respectively.

Specific combining ability analysis revealed that the cross Tukuru / WL-01 was the best specific combiner for flag leaf area, 1000-grain weight and grain yield per plant (Table 4). BARS-09 / AARI-11 exhibited maximum positive SCA values for number of tillers per plant and biological yield per plant. The cross BARS-09 / Rawal-87 possessed highest SCA effect for harvest index. For spikelets per spike the cross WL-01 / Rawal-87 gained the maximum SCA value. Similarly highest SCA values for plant height and spike length were exhibited by the hybrid AARI-11 / Tukuru.

Higher values of variance components of SCA as compared to that of GCA for grain yield and yield related traits including plant height, spike length, spikelets per spike, number of tillers per plant, flag leaf area, 1000-grain weight, biological yield per plant, harvest index and grain yield per plant indicated the prevalence of the non additive gene affects for these traits (Table 5). These results are in accordance with findings of Siddique *et al*. (2004), Hassan *et al*. (2007), Kashif and Khan (2008) and Seboka *et al.* (2009).

From the above discussion it can be obviously concluded that the plant material have shown ample amount of genetic diversity which can be exploited in subsequent generations for varietal development. In present study the preponderance of non-additive or dominant gene action indicates the presence of epistasis and linked genes for these traits of these genotypes. Therefore selection should be delayed to the subsequent or advance generations for the settlement of the desirable genes. Thus possibility of different breeding approach like diallel hybridization, pedigree selection and recurrent selection can be helpful as an integrated breeding strategy. It is obvious from the results that BARS-09 was the potential general combiner parent for most of the important traits and could be used frequently in hybridization program.

The potential cross for further studying which would produce desirable segregates is Tukuru / WL-01. Careful selection from this cross could enhance the flag leaf area, 1000-grain weight and grain yield per plant.

Table 1. Mean squares of quantitative traits in 5x5 half diallel cross of wheat.

Source of variance	d.f	Plant height	Spike length	Spikelets per spike	Tillers per plant	Flag leaf area	Biological yield per plant	1000-grain weight	Harvest index	Grain yield per plant
Replication	2	5.26	0.27	0.63	1.45	4.97	1.53	3.16	0.04	0.09
Genotypes	14	88.37**	4.12**	7.70**	82.98**	172.40**	2132.46**	12.01**	67.86**	411.36**
Error	28	4.243	0.790	1.097	1.038	7.393	7.241	1.462	0.354	0.286

** Highly significant at P<0.01

Table 2. Combining ability analysis for quantitative traits in 5x5 half diallel cross of wheat.

Source of variance	d.f	Plant height	Spike length	Spikelets per spike	Tillers per plant	Flag leaf area	Biological yield per plant	1000-grain weight	Harvest Index	Grain yield per plant
GCA	4	24.55**	1.34**	2.09**	27.76**	26.54**	216.43**	3.85**	3.12**	13.29**
SCA	10	31.42**	1.38**	2.76**	27.62**	69.84**	908.58**	4.06**	30.42**	186.65**
Error	28	1.41	0.26	0.36	0.34	2.46	2.41	0.15	0.12	0.09

** Highly significant at P<0.01

Table 3. Estimates of general combining ability for some quantitative traits in 5x5 half diallel cross of wheat.

Parents	Plant height	Spike length	Spikelets per spike	Tillers per plant	Flag leaf area	Biological yield per plant	1000-grain weight	Harvest index	Grain yield per plant
BARS-09	-1.62	-0.07	0.83	2.81	-1.97	3.27	-1.19	0.90	2.33
AARI-11	-2.26	0.63	-0.39	0.63	-1.58	-0.19	0.32	-0.05	-0.28
Tukuru	1.22	0.21	0.27	-0.75	2.91	-3.59	-0.22	-0.53	-1.15
WL-01	0.54	-0.30	-0.45	-2.64	0.51	-6.80	0.68	0.40	-0.88
Rawal-87	2.11	-0.47	-0.25	-0.04	0.12	7.32	0.41	-0.72	-0.01

Table 4. Estimates of specific combining ability for quantitative traits in a 5x5 half diallel cross of wheat.

Crosses	Plant height	Spike length	Spikelets per spike	Tillers per plant	Flag leaf area	Biological yield per plant	1000-grain weight	Harvest index	Grain yield per plant
BARS-09 / AARI-11	4.63	-0.58	1.17	6.33	7.73	39.95	0.41	5.20	17.04
BARS-09 / Tukuru	-6.39	-1.59	0.74	2.37	-6.62	8.83	-2.21	4.50	7.21
BARS-09 / WL-01	5.83	-0.41	-0.69	3.20	4.48	-10.62	-2.72	-4.55	-9.42
BARS-09 / Rawal-87	1.75	0.36	1.27	5.59	8.77	16.31	1.95	8.26	16.77
AARI-11 / Tukuru	7.68	2.10	0.06	3.40	5.29	0.75	0.65	-0.87	-2.15
AARI-11 / WL-01	1.11	-0.44	1.86	-0.28	-1.04	14.83	1.33	3.03	7.05
AARI-11 / Rawal-87	-3.30	-1.15	-0.14	-1.55	-3.67	12.29	2.01	-2.31	-1.92
Tukuru / WL-01	-2.65	0.91	0.20	4.03	13.68	38.24	2.51	7.36	19.28
Tukuru / Rawal-87	-1.42	0.17	1.26	2.15	4.80	22.24	-0.41	-0.04	3.15
WL-01 / Rawal-87	-8.04	1.29	2.19	0.38	0.31	8.25	-2.05	-0.04	1.18

Table 5. Estimates of variance components of general and specific combining ability and error of quantitative traits of 5x5 half diallel crosses of wheat.

Components of variation	Plant height	Spike length	Spikelets per spike	Tillers per plant	Flag leaf area	Biological yield per plant	1000-grain weight	Harvest index	Grain yield per plant
vg	-1.96	-0.01	-0.19	0.04	-12.37	-197.75	-0.06	-7.79	-49.53
vs	30.00	1.12	2.39	27.27	67.37	906.16	3.91	30.30	186.56
ve	1.41	0.26	0.36	0.34	2.46	2.41	0.15	0.12	0.09

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