INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print), 2222-5234 (Online)
http://www.innspub.net
Vol. 11, No. 4, p. 41-47, 2017

RESEARCH PAPER OPEN ACCESS

# Combining ability analysis for morphological traits in wheat

**Hafiz Ghulam Muhu-Din Ahmed*[1], Muhammad Rizwan[1], Hafiz Arslan Anwaar[2], Abdul Qadeer[3], Zikria Zafar[4], Humaira Jamil[1]**

[1]*Department of Plant Breeding and Genetics, University of Agriculture, Faisalabad, Pakistan*

[2]*Department of Plant Pathology, University of Agriculture, Faisalabad, Pakistan*

[3]*Institute of Soil and Environmental Sciences, University of Agriculture, Faisalabad, Pakistan*

[4]*Department of Forestry and Range Management, University of Agriculture, Faisalabad, Pakistan*

**Key words:** Wheat, GCA, Crosses, Bread, Variety

http://dx.doi.org/10.12692/ijb/11.4.41-47 Article published on October 8, 2017

## Abstract

Wheat (*Triticum aestivum* L.) is the most precious staple food and is highly regarded in the world as king of cereals. The present experiment was conducted to determine the combining ability analysis of 30 wheat hybrids and six parents *viz.*, Iqbal-2000, Aas-11, SH-95, 9469, 9481 and 9486 for morphological traits in bread wheat. Data recorded for the traits including flag leaf area, number of spikelet per spike, number of grains per spike, 100-grain weight and grain yield per plant. All the studied traits were highly significant to specific combining ability (SCA)except flag leaf area. The genotype Iqbal-2000 was the best parent out of six parents involved due to its good GCA. So, this parent could be used in hybridization program for obtaining desirable genotypes. The crosses like Iqbal-2000×9469 and 9469×9481 good (SCA) showed their superiority and a cross SH-95×Aas-11 expressed reciprocal superiority for studied traits and could be further used for future breeding program and selecting desirable plants in the subsequent generations which may be useful in the development of varieties.

* **Corresponding Author:** Hafiz Ghulam Muhu-Din Ahmed ✉ ahmedbreeder@gmail.com

## Introduction

Agriculture invariably occupies a significant position in Pakistan's economy and is also the single largest source of foreign exchange earnings. Its share is 21.4 % in gross domestic production (GDP).In Pakistan the largest crop area is devoted to bread wheat (*Triticum aestivum* L.).In2012-13 the wheat yield per hectare was 2787 (Kgs/hec) contributing 10.1%to the value added in agriculture and 2.2 % to the total GDP of the state. Area under wheat cultivation increased to 8693 thousand hectares from 8650 thousand hectares showing an increase of 0.5 % area over the previous year with total production of24.2million tons, showing 3.2%increase over last years and 5.1%decrease over the target. (Pakistan Economic Survey, 2012-13). Population of Pakistan has increased rapidly during the last few years. With the introduction of high yielding varieties production was increased many folds but this increase in wheat production is not sufficient to meet the future needs of continuously increasing population.

Therefore, increasing wheat production is an important goal to reduce the gap between production and consumption. This can be achieved by developing high yielding varieties, application of improved agronomic technique and cultivating wheat in newly reclaimed soils (Awan *et al*., 2005: Adeland Ali. 2013).Many morphological and physiological and developmental events are involved in yield but a few of them like spikelets per spike, grains per spike and grain weight have main role in the grain yield (Nazeer *et al.,* 2013; Ahmed *et al.,* 2015a). The combining ability analysis helps in classifying the parents in terms of their hybrid performance and in gaining greater understanding of the nature of quantitatively inherited trait (Ahmed *et al*., 2 017).

Therefore, the present study was under taken to estimate the general combining ability and specific combining ability for yield and yield contributing traits in some wheat lines/crosses. This information so desired could be of greater value for a successful wheat breeding program to develop high yielding wheat genotypes.

## Materials and methods

The present investigation was performed during 2014/2015 and 2015/2016 seasons at the Experimental Farm, Department of Plant Breeding and Genetics in University of agriculture Faisalabad, Punjab, Pakistan.

### *Studied Germplasm*

The experimental material comprised of six wheat varieties/lines of bread wheat *viz*., Iqbal-2000, Aas-11, SH-95, 9469, 9481 and 9486. These varieties/lines were crossed each other.

The hybrid seeds including reciprocals and their parents were sown in the department field on November 23, 2015, using randomized complete block design with three replications.

### *Sowing Method*

Each replication had 30 crosses and 6 parental lines, each line of 5 meter length. The plant-to-plant and row-to-row distance was 15 and 25 cm, respectively. Each line comprising 30 plants approximately.

The sowing was done by hand. Two seeds per hole (made with the help of dibbler) were sown which were thinned to sole seedling per site after germination to ensure good plant stand. All other treatments were kept constant for the whole experiment.

### *Data Collection*

At the time of maturity, 10 fortified plants from each line were taken at random and data were recorded for various morphological traits including flag leaf area, number of spikelets per spike, number of grains per spike, 100-grain weight and grain yield per plant.

### *Statistical Analysis*

The observed data were subjected to analysis of variance technique (Steel *et al.* 1997). Traits showing significant differences were further analyzed to estimate the GCA, SCA and reciprocal effects by Griffing's (1956) Method I, Model II was used.

**Results and discussions**

The average performances of different genotypes/crosses for morphological traits in bread wheat are presented in table 1.Analysis of variance results, presented in table 2 indicated that there were highly significant genotypic differences for number of grains per spike and 100-grain weight while significant genotypic differences were observed for flag leaf area, number of spikelets per spike and grain yield per plant among $F_1$ progenies and the parental lines.

**Table 1.**Grand mean, Coefficient of variation and Standard errors for morphological traits.

| Parents/crosses | Flag leaf area | No. of spikelets/ spike | Number of grains/spike | 100-grain weight | Grain yield/ plant |
|---|---|---|---|---|---|
| Grand Mean | 35.658 | 21.411 | 55.619 | 4 | 18.281 |
| CV % | 8.14 | 8.54 | 6.54 | 15.79 | 13.95 |
| Standard Error | 1.67 | 1.05 | 2.06 | 0.4 | 1.47 |

**Table 2.** Analysis of variance (ANOVA) for morphological traits.

| Source of variation | d.f | Flag leaf area | No. of spikelets/spike | Number of grains/spike | 100-grain weight | Grain yield per plant |
|---|---|---|---|---|---|---|
| Replication | 2 | 105.619 | 65.801 | 32.62 | 5.675 | 15.675 |
| Genotype | 35 | 14.901* | 5.895* | 123.969** | 0.984** | 11.276* |
| Error | 70 | 8.424 | 3.347 | 12.778 | 0.483 | 6.501 |

*= Significant (P<0.05) **= Highly Significant (P<0.01), N.S= Non-significant.

After performing analysis of variance the analysis was performed to estimate the combining ability effects as indicated in table 3.

*Flag leaf area (cm²)*

In case of cereals, flag leaf plays a major role towards grain yield. Flag leaf being the major site of photosynthetic activity fixes large amount of photosynthates to the grains during grain filling. It was apparent from Table 3combining ability analysis showed that mean squares (M.S) were non-significant for GCA and SCA effects while M.S due to reciprocal effects were significant. Combining ability analysis indicated that mean squares of SCA (13.793) were higher than mean squares of GCA (9.987) effects (Table 3).

**Table 3.**Combining ability analysis for morphological traits.

| Source of variation | df | Flag leaf area(cm²) | No. of spikelets/spike | No. of grains per spike | 100-grain weight | Grain yield per plant |
|---|---|---|---|---|---|---|
| Due to GCA | 5 | 9.987NS | 2.220NS | 101.553NS | 0.599NS | 6.126NS |
| Due to SCA | 15 | 13.793NS | 4.883NS | 119.902** | 0.865** | 15.827** |
| Due to RCA | 15 | 17.648* | 8.135** | 135.498** | 1.233** | 8.438NS |
| Error | 70 | 8.424 | 3.347 | 12.778 | 0.483 | 6.501 |

*= Significant (P<0.05), **= Highly Significant (P<0.01), N.S= Non-significant.

These results are in accordance with the finding of Ahmed and Mustafa. (2017). In table 4 revealed that genotype 9469 exhibited the highest positive general combining effects 0.397 and the genotypes Aas-11 and Iqbal-2000 showed the negative general combining effects which were -0.997 and -0.125, respectively. Likewise, in table 4 the cross Aas-11 × 9481 exhibited the highest positive SCA effects which was 1.861 followed by 9469 × 9486 showed negative SCA effects which was -2.425.And 9486 × Iqbal-2000showed the highest positive reciprocal effects which was of 1.467 and cross 9469 × Aas-11 with value of -3.067 showed

highest negative reciprocal effects. The best general combiner for the flag leaf character is 9469, the best specific combiner for this trait are Aas-11 × 9481. These results are in agreement with the finding of Ahmed *et al.* (2015a).

**Table 4-8.** General combining ability (diagonal), specific combining ability (above diagonal) and reciprocal effects (below diagonal) for studied characters.

**Table 4.**Flag leaf area.

| PARENTS | Iqbal-2000 | Aas-11 | SH-95 | 9469 | 9481 | 9486 |
|---|---|---|---|---|---|---|
| Iqbal-2000 | -0.125 | -2.169 | -1.911 | 0.703 | -0.211 | 1.797 |
| Aas-11 | -0.833 | -0.997 | -0.706 | 1.075 | 1.861 | -0.597 |
| SH-95 | -0.5 | -0.833 | 0.078 | -0.117 | -1.381 | 1.728 |
| 9469 | 1.433 | -3.067 | 1.05 | 0.397 | 0.983 | -2.425 |
| 9481 | -1.9 | -1.367 | -1.533 | -1.217 | 0.311 | -0.439 |
| 9486 | 1.467 | -3.8 | -1.267 | 0.9 | 1.267 | 0.336 |

**Table 5.**No.ofspikelets/spike.

| PARENTS | Iqbal-2000 | Aas-11 | SH-95 | 9469 | 9481 | 9486 |
|---|---|---|---|---|---|---|
| Iqbal-2000 | -0.036 | 0.336 | -0.694 | -0.714 | -1.472 | 0.683 |
| Aas-11 | 0.5 | -0.011 | -0.219 | -0.072 | 0.586 | -0.442 |
| SH-95 | 1.933 | -1.567 | 0.453 | 0.647 | 0.139 | 1.211 |
| 9469 | -1.317 | 0.017 | 0.833 | -0.278 | 1.369 | -1.275 |
| 9481 | 0.55 | 1.3 | 0.117 | 0.783 | -0.153 | -0.15 |
| 9486 | 1.05 | 1.783 | 0.033 | 0.75 | 2 | 0.025 |

*Number of spikelet's per spike*

In table 3 analysis of variance for combining ability revealed that mean squares were non-significant for GCA and SCA effects, while mean square due to reciprocal effects were highly significant. These results were supported with findings of Ahmed and Mustafa, (2017). The highest positive GCA effects for spikelets on main spike was exhibited by the genotype SH-95 with the value of 0.453 (table 5) and the highest negative effects was shown by the genotype 9469 with value -0.278. SCA effects displayed in table 5 showed the cross combination 9469 × 9481possessed the highest positive SCA value of 1.369 and highest negative value was exhibited by the cross 9469 × 9486 (-1.275).

**Table 6.** Number of grains per spike.

| Parents | Iqbal-2000 | Aas-11 | SH-95 | 9469 | 9481 | 9486 |
|---|---|---|---|---|---|---|
| Iqbal-2000 | -0.228 | 1.461 | 2.786 | -0.019 | 7.025 | -5.289 |
| Aas-11 | 2.5 | 1.847 | -2.372 | 3.356 | 0.1 | 3.136 |
| SH-95 | -4.033 | 5.917 | -0.978 | -2.853 | 4.808 | 4.261 |
| 9469 | 1.417 | -0.9 | -8 | 2.244 | -3.331 | 5.122 |
| 9481 | -1.433 | -7.583 | 5.633 | 8.55 | -0.95 | -6.05 |
| 9486 | 2.967 | 5.467 | -2.733 | 1.883 | 0.55 | -1.936 |

The crosses namely 9486 × 9481 (2.0) and SH-95 ×Aas-11 (-1.567) exhibited the highest positive and negative reciprocal effects, respectively displayed in table 5. The above results are supported by the findings of Kumar *et al.* (2011); Adel and Ali (2013).

*Number of grains per spike*

Analysis of combining ability showed that the mean squares due to general combining ability effects were non-significant while mean squares due to specific combining ability and reciprocal effects were highly significant (Table 3). As estimates of GCA studied revealed that genotype 9469 possessed highest positive effects (2.244) whereas highest negative values of -1.936 possessed by 9481 genotype (Table 6). Estimates for the SCA effects were studied and the value of 7.025was the highest positive value displayed by the cross namely Iqbal- 2000 × 9481 and the highest negative value -6.05 exhibited by the cross 9481 × 9486 (Table 9). Highest positive reciprocal effects were shown by the cross 9481 × 9469with 8.55 value and highest negative value was exhibited by the cross named as 9469 × SH-95 with -8.00 (Table 6). Variance components for the GCA, SCA and reciprocal effects in table 6 displayed the estimates were -1.241, 62.202 and 61.361 respectively. These results are in agreement with the results of Seboka *et al.* (2009) and Ahmed *et al.* (2015b).

**Table 7.**100-grain weight.

| Parents | Iqbal-2000 | Aas-11 | SH-95 | 9469 | 9481 | 9486 |
|---|---|---|---|---|---|---|
| Iqbal-2000 | 0.171 | 0.651 | -0.285 | -0.474 | -0.230 | -0.019 |
| Aas-11 | -0.117 | -0.006 | -0.407 | -0.463 | 0.115 | -0.407 |
| SH-95 | -0.267 | -0.267 | -0.054 | -0.066 | 0.162 | 0.056 |
| 9469 | -0.983 | -0.517 | 0.067 | 0.119 | 0.406 | 0.434 |
| 9481 | -0.500 | 0.200 | 0.100 | 0.383 | -0.043 | -0.071 |
| 9486 | -0.233 | 0.133 | -0.283 | 0.467 | 0.933 | -0.187 |

*100-grain weight (g)*

Mean square to general combining ability was non-significant as stated by Iqbal and Khan. (2006) while specific and reciprocal effects mean squares were highly significant for this trait (Table 3). Mean square of SCA (0.865) was greater than GCA (0.599) effect. The genotype Iqbal-2000 proved to be a good general combiner as it exhibited the highest positive GCA value of 0.171 and the genotype 9486 exhibited the highest negative GCA with -0.187 values (Table 7).The highest positive value in reciprocal effects was 0.933 observed in 9486 × 9481crosswhile highest negative reciprocal effects were observed in 9469 × Iqbal-2000 cross which was -0.983. For 100-grain weight the estimates of genetic components of variance due to general, specific and reciprocal effects were studied and the values of variance were -0.021, 0.221 and 0.375 respectively as displayed in Table 3. These findings are in agreements with the results of Rashid *et al.* (2012) and Nazeer *et al.* (2013).

**Table 8.**Grain yield per plant.

| PARENTS | Iqbal-2000 | Aas-11 | SH-95 | 9469 | 9481 | 9486 |
|---|---|---|---|---|---|---|
| Iqbal-2000 | 0.469 | -2.363 | 0.476 | 0.234 | 0.665 | -1.027 |
| Aas-11 | 1 | -0.154 | -1.419 | 2.723 | 2.604 | -1.838 |
| SH-95 | 0.233 | 2.083 | -0.393 | -0.871 | -0.407 | 1.151 |
| 9469 | -0.7 | -0.167 | -3.167 | 0.216 | -0.732 | 1.293 |
| 9481 | 0.333 | 0.15 | -1.2 | -0.817 | -0.515 | -0.31 |
| 9486 | 1.133 | 0.1 | 0.35 | -0.6 | -1.067 | 0.377 |

*Grain yield per plant (g)*

Mean squares of general and reciprocal combining ability were non-significant for this trait according to the analysis of variance for combining ability. While mean Squares due to SCA was highly significant as showed in table 3. The genotype Iqbal-2000 was considered to be a good general combiner as it exhibited the highest positive GCA which was 0.469 (table 8), and the genotype 9481exhibited the highest negative GCA with -0.515 value. Similarly in case of SCA the cross Aas-11 × 9469exhibited the highest positive SCA with 2.723 and cross Iqbal-2000 ×Aas-11 showed the highest negative value of -2.363 (Table 8). The highest positive value in reciprocal effects was 2.083 observed in SH-95 × Aas-11 cross, while highest negative reciprocal effects were observed in 9481 × SH-95 cross which was -1.20. For grain yield per plant the estimates of genetic components of variance due to general, specific and reciprocal effects were studied and the values of variance were -0.783, 5.415 and 0.969 as displayed in table 5. These results get support from the finding of Rashid *et al.* (2012) and Ahmed *et al.* (2015a).

**References**

**Adel MM, Ali EA.** 2013. Gene action and combining ability in a six parents diallel cross of wheat. Asian Journal of Crop Science **5**, 14-23.

**Ahmed HGMD, Khan AS, Kashif M, Khan SH**. 2017. Genetic mechanism of leaf venation and stomatal traits for breeding drought tolerant lines in wheat. Bangladesh Journal of Botany **46,** 35-41.

**Ahmed HGMD, Khan AS, Sadam MS, Yasir MH, Zahid S, Benish M, Khan A**. 2015a. Designate the gene dose for yield related indices in spring wheat. International Journal of Biosciences **6,** 396-401.
http://dx.doi.org/10.12692/ijb/6.3.396-401

**Ahmed HGMD, Mustafa S.** 2017. Designate the Inheritance Pattern of Yield Related Indices in Spring Wheat. Journal of Agriculture and Basic Sciences **2,** 50-57.

**Ahmed HGMD, Saddam MS, Khan A, Fatima A, Saleem S, Hassan M, Zahid S, Benish M.** 2015b. Genetic mechanisms of yield related morphological markers response to increase grain yield in different environment of hexaploid wheat. Journal of Biodiversity and Environmental Sciences **6,** 158-166.

**Awan SI, Malik MFA, Siddique M.** 2005. Combining ability analysis in intervarietal crosses for component traits in hexaploid wheat. Journal of Agriculture and Social Sciences **1,** 316-317.

**Economic Survey of Pakistan.**2011-12. Ministry of Food and Agriculture, Economic Affairs Division, Govt. of Pakistan, Islamabad.

**Griffing B**. 1956. Concept of general and specific combining ability in relation to diallelcrossing systems. Australian Journal Biological Science **9,** 463-493.

**Iqbal M, Khan AA.** 2006. Analysis of combining ability for spike characteristics in wheat (*Triticum aestivum* L.). International Journal of Agriculture and Biology**8,** 684-687.

**Kumar A, Mishra VK, Vyas RP, Singh V.** 2011. Heterosis and combining ability analysis in bread wheat (*Triticum aestivum* L.). Journal of Plant Breeding and Crop Science **3,** 209-217.

**Nazeer W, Hussain T, Khan MA, Naeem M, Amjid MW, Hussain K.** 2013. Mechanism of inheritance for quantitative traits in intera-specific crosses of *Triticum aestivum* L. World Applied Science Journal **22,** 1440-1448.
http://dx.doi.org/10.5829/idosi.wasj.2013.22.10.649

**Rashid MAR, Khan AS, Iftikhar R.** 2012. Genetic studies of yield and yield related parameters in bread wheat. American-Eurasian. Journal of Agriculture and Environmental Science.**12,** 1579-1583.
www.dx.doi.org/10.5829/idosi.aejaes.2012.12.12.1911

**Seboka H, Ayana A, Zelleke H.** 2009. Combining ability analysis for bread wheat (*Triticum aestivum* L.). East African Journal Science **3,** 87-94. http://dx.doi.org/10.4314/eajsci.v3i1.42792

**Steel RGD, Torrie JH, Dickey DA.** 1997. Principles and procedures of statistics. A biometrical approach. 3rd Ed. Mc Graw Hill Book Co., New York.