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# PHYSIO-MORPHIC RESPONSE OF WHEAT GENOTYPES UNDER RAINFED CONDITIONS

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**Abstract**

Fifteen wheat genotypes were evaluated in the experimental area of the Department of Plant Breeding and Genetics, University of Arid Agriculture, Rawalpindi, during Rabi season 2004-2005. There were highly significant variations among the genotypes for number of tillers per plant, stomatal size, leaf venation, days to heading, days to maturity, spike length, 1000 grain weight and grain yield per hectare. Stomata size and stomatal frequency were negatively correlated. Leaf venation and stomatal frequency were positively correlated it means that high stomatal frequency may result in thick veins per unit leaf area. Stomatal frequency, stomatal size, days to maturity, grain spike$^{-1}$and 1000 grain weight showed small positive correlation with grain yield. These results suggested that plants may tolerate the stress conditions at the cost of yield. To cope with this situation the yield losses should be minimized.

**Keywords**: wheat genotypes, Physio-morphic traits, rainfed condition, yield

## Introduction

Being the staple food, wheat remains the most important cereal in Pakistan. It is the major human consumable commodity in most areas of the world including Pakistan. On world basis wheat ranks second after rice providing protein and caloric requirements to one third of the world population (Bakhsh *et al*., 2003). About 20% area of the wheat is under rainfed conditions, where moisture is the major limiting factor. Water deficit, is one of the major constraint in agricultural production including wheat, which has devastated the economy of many countries. Water is also becoming a scarce commodity and its severity has been forecast further in this area as well, in the years to come. Drought is one of the most important natural features that affect plant growth and limits crop yields.

Drought affects every aspect of the plant growth and the ability to yield well under stress is conditioned by different physiomorphic traits. There have been considerable efforts in the past, in breeding for improved drought tolerance in field crops. Struggle had been made primarily through the use of empirical breeding approaches by concentrating on yield and yield components in wheat. These traits are genetically complex and are not easy to manipulate. So, little success has been achieved to develop drought tolerant wheat varieties over the last 50 years. A number of physiological traits like leaf water potential, stomatal frequency, stomatal size, osmotic adjustments that are associated with drought resistance have been identified in wheat and are relatively simple in inheritance (Ahmad *et al*., 2000*).* Moreover, selection and breeding for drought resistance in crops has been considered to be an economical and efficient means of overcoming drought problem (Blum, 1983).

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Correlation analysis provides information on the correlated response of plant traits and so of their contribution to the final attribute, the grain yield (Bhutta & Chowdhry, 1999).

Keeping in view the importance of drought tolerance in wheat for its yield improvement, the present study was conducted to compare different wheat genotypes for better performance under rainfed condition and to estimate the mutual correlation among various physio-morphic and yield contributing traits. The information obtained may greatly help to improve the wheat breeding in Pakistan.

## Materials and Methods

The experimental material in the present study was comprised of 15 wheat genotypes namely Chakwal-86, Rawal-87, Inqalab-91, Suleman-96, Chakwal-97, margalla-99, Iqbal-2000, Uqab-2000, As-2002, GA-2002, 00C0-01, V-02166, V-02172, 99FJ-016 and 00BT-04. All the genotypes were sown in the experimental area of the Department of Plant Breeding and Genetics, University of Arid Agriculture, Rawalpindi on 11-11-2004 during Rabi 2004-2005. Randomized complete block design was followed with 3 replications keeping row to row distance 30 cm and plant to plant 10 cm and row length was kept 5 meters. There was one meter distance between replications. Plot size was 18x17 meters. Artificial irrigation was not done. Rainfall data is given in table 4. Data were recorded from ten randomly selected plants from each replication for number of tillers per plant, stomatal frequency, stomatal size, leaf venation, days to heading, days to maturity, spike length, number of spikelets per spike, number of grains per spike, 1000 gain weight and grain yield per hectare. Data for physiological traits were recorded in the morning at 0900 hours. The number of stomata per unit area counted from the upper surface of the third nodal leaf of each randomly selected plant. The leaf strips, which were taken from the middle part of the leaf, were dipped in methylated spirit to arrest stomatal movement and removal of chlorophyll from leaf tissues. After 24 hours the leaf strips were removed from solution, peeled off with razor and examined under 40X objective of microscope for counting the number of stomata of selected tissues. The observations were taken from each foliar strip and the average was used for analysis. The leaf strips taken for studying stomatal frequency were also used for measuring the size of the stomata. The leaf strips were examined under the 40X objective of microscope. Three stomata from each sample were measured at random for length and width with the help of ocular micrometer. The stomatal size was calculated by multiplying length and width with standardized value of microscope and average was calculated for analysis. Leaf venation was recorded as number of longitudinal veins falling in low power (10X) microscope field. Strips taken for stomatal counts were used for these observations.

The data collected for various characteristics were subjected to analysis of variance and the means obtained were compared by LSD at 5 percent level of significance (Steel & Torrie, 1980). The correlation coefficient among all the traits was computed according to the method proposed by Kown & Torrie (1964).

## Results and Discussions

Highly significant variation was observed among the genotypes for number of tillers per plant, stomatal size, leaf venation, days to heading, days to maturity, spike length,

Table 1: Mean squares and their significance of the traits for 15 wheat genotypes sown at UAAR during 2004-05 under field conditions.

| SOV | df | No. of tillers plant$^{-1}$ | Stomatal frequency | Stomatal size | Leaf Venation | Days to heading | Days to maturity |
|---|---|---|---|---|---|---|---|
| Genotypes | 14 | 1.80$^{**}$ | 0.610$^{*}$ | 6702.52$^{**}$ | 0.853$^{**}$ | 49.60$^{**}$ | 43.61$^{**}$ |
| Replication | 2 | 0.30 | 0.199 | 1713.10 | 0.430 | 0.822 | 3.26 |
| Error | 28 | 0.06 | 0.282 | 703.68 | 0.173 | 5.013 | 5.67 |
| | | Spike length | Spikelets/spike | No. of Grains/ spike | 1000-grains weight | Grain yield/ha | |
| Genotypes | 14 | 1.07$^{**}$ | 4.99$^{*}$ | 29.89$^{*}$ | 72.00$^{**}$ | 2224554.28$^{**}$ | |
| Replication | 2 | 1.35 | 5.03 | 6.39 | 10.23 | 66729.73 | |
| Error | 28 | 0.31 | 2.07 | 14.28 | 3.78 | 452221.80 | |

$^{*,**}$ Significant at 0.05 and 0.01 probability levels respectively

Table 2: Mean value of various traits of 15 wheat genotypes sown at UAAR during 2004-05 under field conditions

| Entries | No of tillers per plant | Stomatal frequency | Stomatal size | Leaf venation | Days to heading | Days to maturity | Spike length | No. of spikelets/ spike | No. of grains/ spike | 1000 grain weight | Grain yield /hec. |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Chakwal-86 | 6.23 | 9.27 | 758.30 | 10.59 | 125.30 | 170.70 | 10.90 | 21.67 | 61.23 | 43.07 | 5163.00 |
| Rawal-87 | 5.45 | 9.27 | 707.60 | 10.68 | 122.00 | 169.00 | 11.63 | 22.13 | 63.27 | 45.93 | 4993.00 |
| Inqlab-91 | 5.15 | 8.87 | 778.90 | 10.76 | 116.70 | 163.00 | 11.73 | 19.80 | 53.53 | 38.77 | 4947.00 |
| Suleman-96 | 6.33 | 8.45 | 777.50 | 11.23 | 118.70 | 168.70 | 11.30 | 19.70 | 56.67 | 46.87 | 5389.00 |
| Chakwal-97 | 5.63 | 9.51 | 757.70 | 10.30 | 118.30 | 168.00 | 11.60 | 21.07 | 62.60 | 41.67 | 5607.00 |
| Margalla-99 | 6.30 | 8.01 | 767.30 | 10.42 | 125.70 | 169.30 | 11.73 | 22.33 | 57.40 | 49.27 | 4320.00 |
| Iqbal-2000 | 5.46 | 9.45 | 739.50 | 10.69 | 114.00 | 164.00 | 11.97 | 21.00 | 60.90 | 43.93 | 4787.00 |
| Uqab-2000 | 6.36 | 9.62 | 740.70 | 11.09 | 119.30 | 158.00 | 11.73 | 20.40 | 63.20 | 46.17 | 4783.00 |
| AS-2002 | 6.84 | 8.99 | 793.30 | 10.70 | 112.30 | 167.00 | 11.53 | 18.67 | 66.20 | 46.13 | 6650.00 |
| GA-2002 | 7.07 | 9.17 | 786.20 | 11.42 | 116.30 | 165.70 | 11.47 | 18.73 | 55.34 | 42.40 | 5593.00 |
| 00C0-01 | 7.45 | 9.23 | 663.60 | 10.82 | 125.30 | 167.70 | 11.30 | 19.27 | 54.28 | 30.03 | 3333.00 |
| V-02166 | 6.17 | 8.50 | 838.70 | 11.29 | 115.30 | 166.30 | 9.97 | 19.60 | 56.33 | 35.63 | 3800.00 |
| V-02172 | 5.63 | 8.68 | 823.00 | 10.65 | 119.70 | 161.00 | 10.27 | 20.73 | 53.87 | 42.53 | 5806.00 |
| 99FJ-016 | 6.44 | 9.30 | 834.30 | 12.47 | 118.00 | 159.30 | 11.77 | 21.90 | 60.40 | 46.13 | 3989.00 |
| 00BT-004 | 4.47 | 9.23 | 807.70 | 11.22 | 119.70 | 167.30 | 10.60 | 22.40 | 58.61 | 41.80 | 5565.00 |
| LSD at 0.05 % | 0.4329 | 0.882 | 44.37 | 0.695 | 3.7 | 3.983 | 0.9417 | 2.409 | 3.85 | 3.252 | 1125 |

Table 3: Correlation coefficient among various traits of 15 wheat genotypes sown at UAAR during 2004-05

| | Stomatal frequency | Stomatal size ($\mu m^2$) | Leaf venation | Days to heading | Days to maturity | Spike length | No. of spikelets/ spike | No. of grains/ spike | 1000 grain weight | Grain yield/hec. |
|---|---|---|---|---|---|---|---|---|---|---|
| No. of tillers | -.076 | -.234 | .192 | .110 | .038 | .151 | -.580* | -.029 | -.152 | -.253 |
| Stomatal frequency | | -.359 | .104 | -.139 | -.284 | .323 | .065 | .487 | -.122 | .085 |
| Stomatal size | | | .468 | -.474 | -.304 | -.466 | .019 | -.133 | .235 | .264 |
| Leaf venation | | | | -.253 | -.477 | -.036 | -.041 | -.109 | .042 | -.294 |
| Days to heading | | | | | .374 | -.053 | .489 | -.199 | -.074 | -.401 |
| Days to maturity | | | | | | -.128 | .090 | .061 | -.075 | .103 |
| Spike length | | | | | | | .055 | .377 | .406 | -.008 |
| No. of | | | | | | | | .233 | .408 | -.138 |
| No. of grains/spike | | | | | | | | | .515* | .350 |
| 1000-grain weight | | | | | | | | | | .452 |

*= Significant at 0.05 probability level

1000 grain weight and grain yield per hectare (Table 1). Where as differences were significant for stomatal frequency, spikelets per spike and number of grains per spike. The genotype 00C0-01 had maximum number of tillers per plant (7.45) where as genotype 00BT-004 exhibited minimum number of tillers per plant i.e. 4.470 (Table 2). Maximum stomatal frequency was exhibited by the genotype UQAB-2000 i.e. (9.617) and minimum by MARGALLA-99 i.e. (8.010). The genotype V-02166 had maximum stomatal size (838.7 $\mu m^2$) and minimum stomatal size was exhibited by 00C0-01 i.e. (663.6 $\mu m^2$). The genotype 99FJ-016 exhibited maximum leaf venation (12.47) and minimum leaf venation was possessed by CHAKWAL-97 (10.30). The genotype MARGALLA-99 took maximum days to heading i.e. (125.7) where as genotype AS-2002 took minimum days to heading (112.3). The genotype CHAKWAL 86 took maximum days to maturity (170.7) and genotype UQAB-2000 took minimum days to maturity (158.0). The genotype IQBAL-2000 exhibited maximum spike length (11.97) and genotype V-02166 possessed minimum spike length (9.967). The genotype 00BT-004 possessed maximum spikelets per spike (22.40) and genotype AS-2002 had minimum spikelets per spike (18.67). The genotype AS-2002 had maximum number of grains per spike (66.20) and genotype INQLAB-91 had minimum number of grains per spike (53.53). The genotype MARGALLA-99 possessed maximum 1000 grain weight (49.27) and genotype 00C0-01 possessed minimum 1000 grain weight (30.03). The genotype AS-2002 exhibited maximum yield per hectare (6650) and genotype 00C0-01 exhibit minimum yield per hectare (3333). These differences among genotypes are due to their genetic make up and environment. Genotypes performing better on the basis of their physiological traits can be used for crop improvement under low moisture conditions.

**Table 4: Rainfall data of UAAR during Rabi season 2004-2005.**

| Sr. No. | Months | Rainfall (mm) |
|---|---|---|
| 1. | November | 3.4 |
| 2. | December | 0.0 |
| 3. | January | 14.3 |
| 4. | February | 23.9 |
| 5. | March | 55.5 |
| 6. | April | 08.4 |
| 7. | May | 16.4 |

The correlation coefficients among all the traits are shown in Table 3. The calculated correlation indicated that stomata size and stomatal frequency were negatively correlated (-0.359). The increase in transpiration area in stress conditions cannot be obtained by selecting for high stomatal frequency because of negative correlations between these parameters. Similar findings were reported by Venora *et al*. (1991) and Rajendra (1979) who found that as the level of ploidy increased, stomatal frequency decreased but stomatal size increased. Leaf venation and stomatal frequency were positively correlated with small magnitude (0.104) it indicated that high stomatal frequency may result in thick veins per unit leaf area. These results are similar those reported by Chowdhry *et al.* (1995).

Stomatal frequency, stomatal size, days to maturity, grain spike$^{-1}$and 1000 grain weight showed small positive correlation with grain yield (Table 3). Li (1989) also reported similar findings. These traits play an important role in increasing the grain yield and by improving these traits grain yield could be increased. Days to heading, days to

maturity, spike length, spikelets, grain spike$^{-1}$ and gain yield showed negative but non significant correlation with leaf venation

No. of tillers plant$^{-1}$, leaf venation, spike length, days to heading and days to maturity showed negative and non-significant correlation with 1000 gain weight. It is obvious from Table 3 that 1000 grain weight had positive and non significant correlation with grain yield hec$^{-2}$ (0.452). Grains spike$^{-1}$ showed non significant correlation with all traits. (Table 3). Ayyaz *et al.* (2001) has reported same results. Positive but non significant correlation (0.452) between 1000 grain weight and grain yield indicated that limited increase in yield is possible if grain weight is increased through breeding. These results are similar to those reported by Bhullar *et al.* (1985)

These results suggested that plants may tolerate the stress conditions at the cost of yield. To cope with this situation the yield losses should be minimized.

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