Evaluation and selection of bread wheat genotypes grown under different environments

Soomro A. Zahoor¹, Simair A. Altaf²,³, Mangrio G. Sughra¹ and Tunio H. Tanveer¹

¹Department of Biotechnology and Department of Plant Breeding and Genetics, Sindh Agriculture University, Tando Jam.
²Institute of Biotechnology & Genetic Engineering, University of Sindh, Jamshoro, Sindh, Pakistan.
³Corresponding Author: E-mail: altafsimair@hotmail.com, phone: +923003183582

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ABSTRACT

A randomized complete block design with three replications was used in Sakrand and Tando Jam, Sindh, Pakistan, to assess the simple correlation, coefficient of determination and regression coefficient of ten commercial wheat genotypes (Mehran-89, Moomal-2002, Anmol-91, Pavon, Maxi-Pak, Abadgar-93, Tj-83, Yecora, Z.A-77 and T.D-1). The characteristics studied were plant height (cm), tillers per plant, spike length (cm), spikelets per spike, grains per spike, seed index (g) and grain yield per plant (g). A highly significant positive correlation was observed between tillers per plant and grain yield per plant (r = 0.57 **), and the highest positive regression value (byx=2.01) was recorded between spike length and grain yield per plant in Tando Jam. In the Sakrand environment, the highest positive correlation coefficients were found between tillers per plant and grain yield per plant (r=0.78 **), tillers per plant and seed index (r=0.77 **), spike length and spikelets per spike (r=0.81 **) and spike length and grains per spike (r=0.70 **); the highest positive regression coefficient value (byx=3.67) was recorded between seed index and grain yield per plant.

¹Corresponding author’s contact address: Institute of Biotechnology & Genetic Engineering, University of Sindh, Jamshoro, Sindh, Pakistan.
E-mail: altafsimair@hotmail.com,
Phone: +9230031835825

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INTRODUCTION

Wheat (Triticum aestivum L.) is the most important food grain for more than one third of the world population. Since earliest times, wheat has played a vital role in the development of civilization; this principal source of food is extensively grown and consumed in Pakistan (Bhatti and Soomro 1996). Wheat breeding programs worldwide have achieved significant genetic gains in yield potential without the aid of physiological selection tools (Rajaram and VanGinkel, 1996). Plant breeders and physiologists generally agree that future success will be realized through a greater integration of interdisciplinary research (Jackson et al., 1996). Thus, an urgent need exists to develop new and more efficient wheat breeding methodologies to complement existing breeding techniques and to identify new traits that will drive higher-yielding grains.

Breeding approaches have become increasingly successful in recent years as knowledge of the behavior of yield components has become available. Recently, efforts have been made to assess the contribution of various characteristics that affect yields and the associations among these characteristics under irrigated conditions. This problem has been approached using correlation analysis, which can be helpful in isolating potential genotypes under different environmental conditions. The genetic variability of yield and its components are important parameters in this respect.

MATERIALS AND METHODS

A field experiment was conducted to analyze the genotype x environment interaction for several economically important traits in bread wheat. Ten commercial wheat varieties (Mehran-89, Moomal-2002, Anmol-91, Pavon, Maxi-Pak, Abadgar-93, TJ-83, Yekora, ZA-77 and TD-1) were grown at two locations (Southern Wheat Research Station, Tando Jam and the Wheat Research Institute, Sakrand, Sindh, Pakistan) during the period 2010-11. The grain was sown in the field with three replicates in a randomized complete block design (RCBD) using a plot size of 1.2 m x 2.5 m (3.0 m²). The sowing was conducted using a single counter hand-driven drill, and a spacing of 30 cm between rows and 15 cm between plants was maintained. At both locations, ten plants of each genotype in each replication were selected at random and tagged to record the data in the field and in the laboratory as follows: days to 75% flowering, days to 90% maturity, plant height, number of tillers/plant, spike length, number of spikelets/spike, number of grains/spike, seed index and grain yield/plant. A standard fertilizer dose of 134-77 kg N-P /hecat was applied as follows: a full dose of phosphorus and a half dose of nitrogen was applied at the time of sowing, and the remaining half of nitrogen was divided into two and used as top dressings at the tillering and earhead emergence stages. Standard cultural practices including the use of herbicides etc. were adopted uniformly in all plots throughout the growing period. Statistical parameters including variances of means, coefficients of determination and regression coefficients were calculated for grain yield/plant at both locations.

Correlation and regression coefficients were determined as described by Snedecor (1956). The significance of correlation coefficients was ascertained using the Fisher “r” table.

RESULTS AND DISCUSSION

An experiment was conducted at the Wheat Research Institute, Sakrand and at the Southern Wheat Research Station, Tando Jam to assess the genotypes that are best suited for each region. The experiments used a Randomized Complete Block Design with three replications to determine the following quantitative traits: plant height, tillers per plant, spike length, spikelets per spike, grains per spike, seed index and grain yield per plant for the following ten commercial cultivars: Mehran-89, Moomal-2002, Anmol-91, Pavon, Maxi Pak, Abadgar-93, TJ-83, Yekora, ZA-77 and TD-1.

The analysis of variance presented in Table 1 shows that genotypes are highly significant (P<0.01) for all the studied characteristics. The effect of location over yielding was highly significant (P<0.01) for spikelets per spike, grains per spike, and seed index; moderately significant (P<0.05) for tillers per plant and spike length; and non-significant for plant height and grain yield per plant. The interaction of location with genotype was highly significant at the 0.01 level for tillers per plant, grains per spike and grain yield per plant; significant at the 0.05 level for spike length and seed index; and non-significant for plant height and spikelets per spike.

The mean performances of the genotypes are presented in Table 1 and reveal that the tallest plant (98.02 cm) and the longest spike (12.16 cm) was produced by Pavon, maximum tillers (13.20) were produced by TD-1, the maximum number of spikelets per spike (22.66) was produced by Yekora, the maximum number of grains per spike (73.46) was produced by Maxi Pak, the maximum seed index (3.72 g) was produced by Abadgar-93 and that the variety TD-1 out-yielded all other tested varieties, producing 15.33 grams of grain yield per plant.
at the Tando Jam site.

The mean performances of the genotypes are presented in Table 1 and reveal that the tallest plant (98.00) was produced by A badgar-93; maximum tillers, seed index and grain yield per plant (13.27, 4.33 g and 16.06 g, respectively) were produced by TD-1; the longest spike (12.55 cm) was produced by Pavon; the maximum number of spikelets per spike (23.06) was produced by Yekora; and the maximum number of grains per spike (79.33) was produced by M axi Pak at the Sakrand site.

Highly significant values of interaction between genotype and environment were recorded in the wheat varieties Mehran-89, M oomal-2002, A nnmol-91, Pavon, M axi-Pak, A badgar-93, T J-83, Yekora, Z A-77 and T D-1. These findings are consistent with results reported by Mondal and Khajuria (2002), Budak et al. (2003), Reynolds et al. (2004), Baric and Pecina (2004 b), and Yong et al. (2004). The named authors all studied genotype (G) x environment (E) interactions in wheat; the results obtained were broadly similar to those found here. The results for A badgar-93 found here are consistent with the findings recorded by Sial et al. (2003), who studied environments (E), genotypes (G), and G x E interactions in terms of grain yield and observed that E and G x E interactions were highly significant. Our results showed that Mehran-89, A nnmol-91, T J-83, and Yekora performed better at the Tando Jam site whereas M oomal-2002, Pavon, M axi-Pak, A badgar-93, Z A-77 and T D-1 performed better at the Sakrand location. The performance of the genotypes reveals an interaction between genotype and environment.

### Table 1. Average performance of the ten genotypes for the observed characteristics of *Triticum aestivum* L. (Tando Jam & Sakrand).

<table>
<thead>
<tr>
<th>Genotypes</th>
<th>Plant Height</th>
<th>Tillers / Plant</th>
<th>Spike Length</th>
<th>Spikelets / Spike</th>
<th>Grains / Spike</th>
<th>Seed Index</th>
<th>Grains Yield/Plant</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tando Jam</td>
<td>Sakrand</td>
<td>Tando Jam</td>
<td>Sakrand</td>
<td>Tando Jam</td>
<td>Sakrand</td>
<td>Tando Jam</td>
</tr>
<tr>
<td>Mehran-89</td>
<td>97.25 gh</td>
<td>95.55 h</td>
<td>5.46 ab</td>
<td>6.63 h</td>
<td>11.16 gh</td>
<td>11.00 ef</td>
<td>22.00 ef</td>
</tr>
<tr>
<td>Moomal-2002</td>
<td>97.22 gh</td>
<td>92.58 fh</td>
<td>5.09 h</td>
<td>6.13 g</td>
<td>10.80 fh</td>
<td>10.03 ef</td>
<td>20.06 ab</td>
</tr>
<tr>
<td>A nnmol-91</td>
<td>95.52 fh</td>
<td>93.78 gh</td>
<td>5.73 h</td>
<td>5.57 ab</td>
<td>10.48 ab</td>
<td>9.95 h</td>
<td>20.26 ab</td>
</tr>
<tr>
<td>Pavon</td>
<td>98.02 h</td>
<td>95.38 h</td>
<td>5.96e</td>
<td>6.30 f</td>
<td>12.16 gh</td>
<td>12.55 gh</td>
<td>21.73 de</td>
</tr>
<tr>
<td>M axi-Pak</td>
<td>97.30 bc</td>
<td>87.03 c</td>
<td>5.83 bc</td>
<td>6.07 ac</td>
<td>10.52 de</td>
<td>11.83 g</td>
<td>21.53 de</td>
</tr>
<tr>
<td>A badgar-93</td>
<td>95.77 g</td>
<td>98.01 e</td>
<td>4.89 a</td>
<td>5.90 d</td>
<td>10.58 e</td>
<td>16.74 d</td>
<td>20.80 d</td>
</tr>
<tr>
<td>T J-83</td>
<td>85.52 c</td>
<td>88.75 ed</td>
<td>6.20 f</td>
<td>4.67 n</td>
<td>11.20 gh</td>
<td>16.72 ac</td>
<td>20.80 d</td>
</tr>
<tr>
<td>Yekora</td>
<td>69.45 bh</td>
<td>68.03 a</td>
<td>8.30 h</td>
<td>6.91 i</td>
<td>11.31 i</td>
<td>12.52 gh</td>
<td>22.26 gh</td>
</tr>
<tr>
<td>Z A-77</td>
<td>93.25 e</td>
<td>90.02 c</td>
<td>6.56 gh</td>
<td>6.10 c</td>
<td>9.32 a</td>
<td>10.72 ab</td>
<td>21.73 de</td>
</tr>
<tr>
<td>T D-1</td>
<td>86.29 a</td>
<td>68.48 bh</td>
<td>12.20 big</td>
<td>13.27 j</td>
<td>10.42 abc</td>
<td>10.08 bc</td>
<td>19.4e</td>
</tr>
</tbody>
</table>

### Plant height

Plant height exhibited a positive but non-significant correlation (r=0.04) with spike length, spikelets per spike (r=0.15) and seed index (r=0.046) at the Tando Jam site and negative but non-significant correlations (r=-0.06, r=-0.04 and r=-0.16, respectively) at the Sakrand site. On the other hand, plant height exhibited negative, non-significant correlations with tillers per plant (r=-0.80) and grains per spike (r=-0.03) at the Tando Jam site and negative, non-significant correlations with tillers per plant (r=-0.66) and grains per spike (r=-0.17) at the Sakrand site.

Plant height exhibited a negative but non-significant correlation with grain yield per plant (r=-0.54). The coefficient of determination (r²=0.29) for this correlation suggests that 29% of the variation in grain yield per plant is due to plant height under Tando Jam conditions; for every centimeter of increase in plant height, grain yield decreases by 0.15 grams (Table 2). At Sakrand (Table 3), plant height exhibited a negative but non-significant correlation with grain yield per plant (-0.71). The coefficient of determination for this correlation explains that...
50% of the variation in grain yield is due to plant height \( (r^2 = 0.50) \), and the regression coefficient \( (b=-0.17) \) reveals that for every centimeter of plant height increase, grain yield decreases by 0.17 grams.

For these character combinations, the results found by the author in this investigation are completely consistent with the variation in grain yield per plant was due to the tillers per plant under Tando Jam conditions; for every increase of one tiller per plant, grain yield increased by 0.80 grams (Table 2). In contrast, at the Sakrand sit (Table 3), tillers per plant exhibited a positive but highly significant correlation with grain yield per plant \( (0.78) \). The coefficient of determination explains that 60% of the

<table>
<thead>
<tr>
<th>Characters</th>
<th>Plant Height</th>
<th>Tillers / Plant</th>
<th>Spike Length</th>
<th>Spikelets/ Spike</th>
<th>Grains / Spike</th>
<th>Seed Index</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Tando Jam</td>
<td>Sakrand</td>
<td>Tando Jam</td>
<td>Sakrand</td>
<td>Tando Jam</td>
<td>Sakrand</td>
</tr>
<tr>
<td>Plant height</td>
<td>1.00</td>
<td>1.00</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Tillers / plant</td>
<td>-0.80 ns</td>
<td>-0.66 ns</td>
<td>1.00</td>
<td>1.00</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spike length</td>
<td>0.04 ns</td>
<td>-0.06 ns</td>
<td>-0.18 ns</td>
<td>-0.27 ns</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Spikelets/ spike</td>
<td>0.15 ns</td>
<td>-0.04 ns</td>
<td>-0.50 ns</td>
<td>-0.36 ns</td>
<td>0.28 ns</td>
<td>0.81 **</td>
</tr>
<tr>
<td>Grains/ spike</td>
<td>-0.03 ns</td>
<td>0.17 ns</td>
<td>-0.13 ns</td>
<td>-0.52 ns</td>
<td>0.37 ns</td>
<td>0.70 **</td>
</tr>
<tr>
<td>Seed index</td>
<td>0.046 ns</td>
<td>-0.16 ns</td>
<td>0.004 ns</td>
<td>0.77 **</td>
<td>-0.02 ns</td>
<td>0.59 ns</td>
</tr>
<tr>
<td>Grain yield/plant</td>
<td>-0.54 ns</td>
<td>-0.71 ns</td>
<td>0.57 **</td>
<td>0.78 **</td>
<td>0.37 ns</td>
<td>0.34 ns</td>
</tr>
</tbody>
</table>
seed index at the Tando Jam site, whereas a value of \( r = -0.59 \) was found for the Sakrand site.

Spike length exhibited a positive but non-significant correlation with grain yield per plant \( (r=0.37) \). The coefficient of determination \( (r^2=0.13) \) explains that 13% of the variation in grain yield per plant was due to spike length under Tando Jam conditions and that every increase of one centimeter in spike length produces 2.01 grams of grain yield increase. In contrast, under the Sakrand environment, spike length exhibited a positive but non-significant correlation \( (0.34) \) with grain yield per plant. The coefficient of determination exhibited that 11% of the variation in grain yield was due to spike length \( (r^2=0.11) \), and the regression coefficient \( (b=1.22) \) revealed that every increase of one centimeter in spike length produces 1.22 grams of grain yield increase.

Gupta et al. (2002), Singh et al. (2002a), Naeem et al. (2004) and Deshtaki et al. (2004) studied the correlations and regressions among the number of tillers per plant, spike length, spikelets per spike, grains per spike and seed index with grain yield per plant for various genotypes of wheat under various environments and reported results that are similar to those found in the present research work.

### Spikelets per spike

Spikelets per spike exhibited a positive but non-significant correlation with grains per spike \( (r=0.07) \) at the Tando Jam site but a significant positive correlation \( (r=0.54) \) at the Sakrand site. A negative but non-significant correlation \( (r=-0.03) \) was observed between spikelets per spike and seed index at Tando Jam site, whereas a value of \( r = -0.50 \) was found for the Sakrand site.

Spikelets per spike exhibited a positive but non-significant correlation with grain yield per plant \( (r=0.02) \). The coefficient of determination \( (r^2=0.0004) \) explains that 0.04% of the variation in grain yield per plant was due to the spikelets per spike under Tando Jam conditions and that for every increase of one spikelet per spike, grain yield increases by 0.30 grams (Table 2). In the Sakrand environment (Table 3), spikelets per

### Grains per spike

Negative but non-significant correlation \( (r=-0.08) \) between grains per spike and seed index at Tando Jam site, whereas a value of \( r = -0.80 \) was found for the Sakrand site.

Grains per spike exhibited a positive but non-significant correlation with grain yield per plant \( (r=0.28) \). The coefficient of determination \( (r^2=0.07) \) explains that 7% of the variation in grain yield per plant was due to grains per spike under Tando Jam conditions and that for every increase of one grain per spike, grain yield increases by 0.15 grams (Table 2).
Sakrand environment (Table-3), grains per spike exhibited a positive but non-significant correlation with grain yield per plant (0.04). The coefficient of determination explains that 0.16% of the variation in grain yield is due to grains per spike ($r^2=0.0016$), and the regression coefficient ($b=0.02$) revealed that for every increase of one grain per spike, grain yield increased by 0.02 grams.

Deswal et al. (1996), Gupta et al. (2002), Singh et al. (2002a), Ibrahim (2004), Yaday and Choudhary (2004), Najeeb et al. (2004), Deshtaki et al. (2004), and Safeer-ul-Hassan et al. (2005) studied the correlations and regressions among the number of tillers per plant, spike length, spikelets per spike, grains per spike and seed index with grain yield per plant for various genotypes of wheat under various environments and reported results that are similar to those found in the present research work.

### Seed index

Seed index exhibited a positive but non-significant correlation with grain yield per plant ($r=0.006$). The coefficient of determination ($r^2=0.0003$) explains that 0.003% of the variation in grain yield per plant was due to seed index under Tando Jam conditions and that for every increase of one grain in seed index, grain yield increased by 0.02 grams (Table 2). In the Sakrand environment (Table 3), seed index exhibited a positive but non-significant correlation with grain yield per plant ($r=0.31$). The coefficient of determination explains that 9% of the variation in grain yield was due to seed index ($r^2=0.09$), and the regression coefficient ($b=3.67$) revealed that for every one grain of seed index increase, grain yield increased by 3.67 grams.

Deswal et al. (1996), Gupta et al. (2002), Singh et al. (2002a), Ibrahim (2004), Yaday and Choudhary (2004), Najeeb et al. (2004), Deshtaki et al. (2004), and Safeer-ul-Hassan et al. (2005) studied the correlations and regressions among the number of tillers per plant, spike length, spikelets per spike, grains per spike and seed index with grain yield per plant for various genotypes of wheat under various environments and reported results that are similar to those found in the present research work.

### Conclusion

It is concluded that the variety T.D-1 out-yielded all other varieties at both sites (Tando Jam and Sakrand). The outstanding grain yield produced by T.D-1 demonstrated it is a better genotype. Yekora and Pavon performed better at Tando Jam, whereas Pavon and Maxi-Pak performed better at Sakrand. Hence, these genotypes are recommended for use in cultivation.

### References


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