Evaluation of elite bread wheat genotypes for grain yield and other agronomic attributes

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ABSTRACT

An experiment was conducted at Cereal Crops Research Institute (CCRI), Pirsaabak, Nowshera, to identify high yielding and disease resistant bread wheat genotypes for the agro ecological zone of Khyber Pakhtunkhwa. The trial comprised of 12 genotypes, which were selected on the basis of yield performance and other agronomic characteristics under optimum planting conditions from advanced yield trials (B-trials). The experiment was laid out in a randomized complete block design with three replications. Differences among the genotypes for grain yield and biological yield were highly significant while significant results were divulged for days to maturity. The data regarding days to heading, plant height and harvest index revealed non significant results. Out of 12 entries, three lines were selected on the basis of disease resistance, yield and grain color for further investigation in MPT during 2012-13. Entry number 04 was selected to be the best entry with desirable attributes. Furthermore, the selected entry was forwarded for testing in National Uniform Wheat Yield Trial 2012-13 in order to be register as a high yielding and disease resistance new variety for Pakistan.

Keywords: Bread Wheat, Grain Yield, Harvest Index, Biological Yield

INTRODUCTION

Bread wheat (Triticum aestivum) is the most widely grown crop in the world. Approximately one-sixth of the world's total arable land is under wheat production; this is the largest amount of land cultivated for any crop (Slafer and Satorre, 1999). Wheat accounts for more than one-quarter of the total world cereal output and also constitutes the main source of calories for more than 1.5 billion people (Reynolds et al., 1999). In Pakistan, wheat being the staple diet is the most graniferous crop and cultivated on the largest acreages (8666 thousand hectares during 2011-12). It contributes 12.5% to the value added in agriculture and 2.6% to GDP (Pakistan Economic Survey, 2011-12). To meet the ever-increasing demand of food grains for rapidly growing population, it is imperative to develop genotypes having high yield potential per unit area and disease resistance, especially to rusts. Conventional breeding approaches are always the best way to produce superior varieties while molecular breeding has low contribution in developing new varieties. In molecular breeding the germplasm can easily be manipulated via marker assisted selection or transformation of desirable gene/s for a specific trait (Ali and Yan, 2012). The main objective of most conventional breeding program is the production of high yielding wheat lines for commercial utilization. The high yielding varieties with improved traits have been developed throughout the world following different breeding techniques. Apart from generating its own breeding material through hybridization, the institute of CIMMYT and ICARDA has developed an active collaboration with various international and national research institutes for exchange and evaluation of wheat germplasm. The trials/nurseries are tested under local environments for various economic characteristics. Useful selections made from the breeding material are either directly used for development of new varieties or utilized for incorporating their valuable genetic attributes in the locally adapted...
wheat varieties through cross breeding program. A series of improved lines of wheat with high grain yield potential and resistance against abiotic and biotic stresses selected/developed through selection and cross breeding are investigated in this experiment for commercial utilization hand. Out of these tested material, an elite line PR-103 performed well regarding grain yield and resistance to the two rusts (yellow and brown rust) was forwarded to National Agricultural Research Council for testing in uniform wheat yield trials.

MATERIALS AND METHODS

The study was conducted at the experimental field of CCRI, Pirsabak Nowshera during the growing season of 2011-12. Geographically, the experimental area is located at 34°01’ N and 74°02’E longitude at the elevation of above 288 m the sea level. The texture of the soil is sandy loam where 12 advanced genotypes of wheat were used as experimental materials. The detail information and pedigree of the experimental material is given in Table 1. Performance of these lines was evaluated under normal growing environment (sowing at 15th November). The experiment was laid out in randomized complete block design (RCBD) with three replications. Each entry was planted in six rows, five meter long and 30 cm apart. Fertilizers were applied in recommended doses and methods. Whole amount of phosphate fertilizers and two-third of urea were applied during land preparation and the remaining amount applied during first irrigation and second irrigation. The first, second and third irrigation was given 22, 60 and 90 days after sowing. Weeding and other intercultural operations were performed on need basis. Data were recorded on plant parameters viz; days to heading, days to maturity, plant height, biological yield, grain yield and harvest index. Computer software package STATISTIX 8.1 was used for analyses of data.

RESULTS AND DISCUSSION

Days to heading

The number of days taken to 50% heading by the genotype under study showed non significant (Table 1) showing the extent of variability in the germplasm for this specific trait. The genotype No. 04 took minimum days to heading (118 days) while genotype No. 9 took maximum days to heading (125 days) followed by the genotype No. 11 which took 124 days to produce heads. Days to heading is always measured to identify the early maturing genotypes. While this is the most favorable attribute for wheat breeding programs in order to escape late season drought and utilize the land for another crop. In case of late sowing the early maturing genotypes have the ability to perform well and reduce the threat of drastic reduction in yield of wheat crop. Differences among wheat genotype for days to heading are largely governed by their sensitivity to photoperiod and vernalization (Slafer et al., 1995).

Days to maturity

Development of early maturing variety is one of the prime objectives of this breeding program. Physiological maturity is usually taken as the time when the flag leaf and spikes turn yellow (Hanft and Wych, 1982). Significant differences were observed among these genotypes for day to maturity (Table 1). Days to maturity among wheat genotypes ranged from 156 to 163 days. Genotype No. 07 was the late among the these genotypes taking 163 days to mature while the early maturing genotype was No. 2 accomplishing physiological maturity in 156 days. Anwar et al. (2009) also observed significant differences among the genotypes for days to maturity. Genotype No. 4 took 161 days to maturity among the genotypes, and was considered best for agro-climatic condition of Khyber Pakhtunkhwa. The selected genotypes among these lines are best suited in the exiting cropping pattern to meet the food demand of ever growing population in the target region. These results showed that selection in introduce germplasm can decrease the amount of days required for physiological maturity and early maturing genotypes can be identified via this method as suggested by Inamullah et al. (2007). Early maturity in wheat is normally accomplished by screening germplasm for identification of physiological maturing lines or accessions, and then utilizing the selected entries in different breeding scheme (Ali et al., 2011) to pinpoint superior genotypes. The selected entries can also be utilized in back crossing to introgress desirable traits from the donor parent into an agronomical superior, adapted line or inbred (Ali et al., 2013)

Plant height

Statistical analysis of the data revealed non significant differences among genotypes for plant height (Table 1). The genotype No. 04, 11 and 05 achieved maximum plant height of 119, 116 and 113 cm, whereas minimum plant height of 85, 97 and 98 cm was recorded for genotypes No. 12, 01 and 02 and 03 respectively (Table 1). In Pakistan tall varieties are mostly grown by farmers to meet the straw demand for their livestock (Byerle et al., 1993). The genotype No. 04 gave the maximum plant height and higher grain yield.

Grain yield

Grain yield is the most important parameter in variety
Table 1. Mean Table for Days to Heading (DH), Days to Maturity (DM), Plant Height (PH), Grain Yield (GY), Biological yield (BY), Harvest Index (HI) and Yellow Rust (Yr) of MPT Normal planted at CCR, Pirsabak during 2011-12.

<table>
<thead>
<tr>
<th>Genotypes</th>
<th>Pedigree</th>
<th>DH (Days)</th>
<th>DM (Days)</th>
<th>PH (cm)</th>
<th>GY (kg/ha)</th>
<th>BY (kg/ha)</th>
<th>HI (%)</th>
<th>Rust (Yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>SKH8/4/RRV/WW15/3/BY&quot;S&quot;/ON2*/BON/5/RBS/ANZA/3</td>
<td>119</td>
<td>157</td>
<td>97</td>
<td>4409</td>
<td>12074</td>
<td>37</td>
<td>0*</td>
</tr>
<tr>
<td>2</td>
<td>MILAN/S87230//BABAX</td>
<td>119</td>
<td>156</td>
<td>98</td>
<td>4743</td>
<td>12759</td>
<td>37</td>
<td>5 MRMS*</td>
</tr>
<tr>
<td>3</td>
<td>PRINIA/PASTOR</td>
<td>122</td>
<td>161</td>
<td>98</td>
<td>5404*</td>
<td>14093</td>
<td>38</td>
<td>10 MRMS</td>
</tr>
<tr>
<td>4</td>
<td>WBLL1<em>2/4/YACO/PBW65/3/KAUZ</em>2/TRAP//KAUZ</td>
<td>118</td>
<td>161</td>
<td>119</td>
<td>6257</td>
<td>14333</td>
<td>44</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>SONORA 64</td>
<td>122</td>
<td>162</td>
<td>113</td>
<td>5014*</td>
<td>13093</td>
<td>38</td>
<td>10 MRMS</td>
</tr>
<tr>
<td>6</td>
<td>AGA/5<em>TI//2</em>GEN//3/KHYBER-87</td>
<td>124</td>
<td>163</td>
<td>107</td>
<td>5619*</td>
<td>14870</td>
<td>38</td>
<td>5 MR</td>
</tr>
<tr>
<td>7</td>
<td>P?N/BOW//OPATA/3/HXL7573/2*BAY</td>
<td>124</td>
<td>161</td>
<td>112</td>
<td>4913</td>
<td>13870</td>
<td>35</td>
<td>10 MR*</td>
</tr>
<tr>
<td>8</td>
<td>SARA/THB//VEE/3/BY/COC//PRL/BOW</td>
<td>121</td>
<td>157</td>
<td>109</td>
<td>4719</td>
<td>12648</td>
<td>37</td>
<td>5 MR</td>
</tr>
<tr>
<td>9</td>
<td>PASTOR/FILIN//PASTOR</td>
<td>125</td>
<td>161</td>
<td>112</td>
<td>4791</td>
<td>12704</td>
<td>38</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>CROC_1/AS.SQUARROSA (224)//OPATA/3/BY/COC//...</td>
<td>120</td>
<td>157</td>
<td>104</td>
<td>4757</td>
<td>12611</td>
<td>38</td>
<td>0</td>
</tr>
<tr>
<td>12</td>
<td>Check (Pirsabak-08)</td>
<td>123</td>
<td>159</td>
<td>85</td>
<td>4556</td>
<td>11222</td>
<td>41</td>
<td>20 MSS*</td>
</tr>
<tr>
<td>Grand Mean</td>
<td></td>
<td>121.92</td>
<td>159.22</td>
<td>105.36</td>
<td>5039.2</td>
<td>13298</td>
<td>37.972</td>
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</tr>
<tr>
<td>CV %</td>
<td></td>
<td>0.45</td>
<td>1.13</td>
<td>3.17</td>
<td>11.23</td>
<td>10.84</td>
<td>8.83</td>
<td></td>
</tr>
<tr>
<td>LSD</td>
<td></td>
<td>0.9321</td>
<td>3.0443</td>
<td>5.6540</td>
<td>958.11</td>
<td>1219.9</td>
<td>2.8385</td>
<td></td>
</tr>
<tr>
<td>Probability</td>
<td></td>
<td>0.35</td>
<td>0.05</td>
<td>0.76</td>
<td>0.01</td>
<td>0.00</td>
<td>0.66</td>
<td></td>
</tr>
</tbody>
</table>

LSD = Least significant difference, CV= coefficient of variation, 0*= Resistant, MRMS*= moderately resistant to moderately susceptible, MR*= moderately resistant, MSS*= moderately susceptible to susceptible.

Selection and is the primary objective of most breeding schemes. Highly Significant differences (P≤0.01) were observed for grain yield showing the amount of genetic variability in the germplasm. Maximum grain yield of 6257 kg/ha was produced by genotype No. 04 followed by genotype No. 07 (5619 kg/ha) and genotype No. 03 (5404 kg/ha) while genotype No. 01 yielded minimum grain yield of 4409 kg/ha. Muhammad et al. (1992) also observed highly significant variation among the genotypes for grain yield. Grain yield can also be enhanced by incorporating CIMMYT germplasm in wheat Breeding Program (Smale et al., 1998). High yielding varieties is usually achieved by testing lines or accessions from different countries and research institutes. Once a superior genotype is observed in evaluation phase then a target oriented breeding program is worth increasing the capacity of adapted varieties (Ali et al., 2012). In breeding for wide adaptation, genotypes must have the genetic potential for superior performance under ideal growing conditions, and yet must also produce acceptable yields under less favorable environments (Koemel et al., 2004). Favoring the cultivation of specially adapted germplasm is generally expedient for maximizing regional yields and increasing the biodiversity of cultivated material. Our results demonstrated that genotype No. 04 having maximum yield adapted well to the climatic condition of the province.

**Biological yield**

Maximum biological yield of 15574, 14870 and 14333 kg/ha was recorded for genotype No. 05, 07 and 04 whereas minimum biological yield of 1122 kg/ha was recorded for check (Table 1). Highly
significant differences were found among the genotype this trait. Our results was contrary to that of Koler and Khristov (1984) who reported that biological yield was not significantly (P<0.05) affected by the various genotypes of wheat.

Harvest index

Harvest index of genotypes ranged from 33 to 44% (Table 1). The highest harvest index was recorded for genotype No 04 (44%) followed by genotype No. 11 and Pirzabak 2008 (41%). With highest harvest index genotype No. 04 showed maximum grain yield. Donmez et al. (2001) reported that the harvest index in wheat is mostly associated with increases in grain yield. Our results showed non-significant differences among wheat genotypes for harvest index (Table 1). Ihsanullah and Mohammad (2000) and Shah et al., (2003) who also reported non-significant differences in wheat whose are in agreement with us. The findings of Khan et al. (2001) are contradictory to our results.

Conclusion and Recommendations

The comparison of adaptation studies plays a key role in genotype/variety recommendation for a specific environment and of general cultivation in agro-climatic condition of the region. On the basis of various studied, morphological and yield parameters it was concluded that genotype No 04 (PR-103) performed best in comparison with Check and other genotypes and was also found resistant to prevailing yellow rusts.

It is recommended that PR-103 will be forwarded to National Agricultural Research Center (NARC) for further testing in National Uniform Wheat Yield Trials (NUWYT) thereby to release a new high yielding and disease resistant variety for general cultivation in agro-ecological zone of Khyber Pakhtunkhwa, Pakistan.

REFERENCES


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