GENETIC VARIABILITY AND INHERITANCE OF GRAIN YIELD AND ITS COMPONENTS IN WHEAT

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Seven F2 populations involving six varieties/lines of wheat (Triticum aestivum L.) were evaluated for genetic variability and inheritance of some yield and related traits. Considerable amount of variability among the genotypes and F2 populations for the traits studied indicated the possibility of selection for these traits in the genetic material studied for further improvement. Broad-sense heritability for flag leaf area, number of tillers per plant, spike length, grains per spike and grain yield per plant ranged from 82.86 to 93.51%, 69.28 to 90.67%, 49.93 to 66.05%, 81.57 to 93.85% and 58.39 to 88.24%, respectively. The respective values of genetic advance for these traits ranged from 8.70 to 16.69, 3.26 to 7.18, 1.28 to 2.25, 16.18 to 32.18 and 1.77 to 4.50. Fairly high estimates of heritability and genetic advance for the plant traits studied in the F2 populations of crosses, 3 WLRG/1-8 × WL-43, 12 WLRG/1-12 × WL-43 and Local White × 3 WLRG/1-8, suggested that selection for these traits could be practiced more effectively.

Key words: Wheat, heritability, genetic variability.

INTRODUCTION

A wide range of heritable variation has been reported in wheat germplasm, which indicates prospects of its improvement through selection following hybridization of superior genotypes. However, effectiveness of the selection depends upon the extent to which a particular trait is heritable. Variations, which prove heritable, are advantageous to the breeders giving opportunity of selection during early segregating generations with high selection efficiency and response to selection. Most of the polygenic traits, like grain yield, are influenced by the environment and have low heritability. Thus, selection of such polygenic traits in early segregating populations becomes difficult. Earlier studies indicate varying inheritance patterns of grain yield and its components in wheat, like high estimates of heritability for flag leaf area were recorded by Ahmad (1991). Collaku (1994) and Dechev (1995) recorded high heritability estimates for spike length. Ravinder et al. (1996) recorded moderate heritability for tillers per plant while Moghaddam et al. (1997) reported 34% heritability for tillers per plant. Chowdhry et al. (1997) estimated moderate heritability with high genetic advance for flag leaf area, tillers per plant, spike length and grains per spike. Similarly, high heritability and genetic advance for grain yield was recorded by Ozkan et al. (1997). Salim et al. (2003) reported high heritability (up to 90%) for grains per spike and grain yield per plant with genetic advance ranging from 7.26 to 30.49 and 4.95 to 11.61, respectively.

Study of statistical parameters like mean, variance, heritability, genetic advance, etc., is helpful to evaluate the performance of any particular genotype and also a measure to determine the effectiveness of selection for a particular trait in that genotype. Thus, the present study was designed to evaluate for genetic variability and inheritance of some yield and related traits and to select desirable genotypes for future breeding strategies.

MATERIALS AND METHODS

Seven F2 populations involving six varieties/lines of wheat (Triticum aestivum L.) viz., Chenab-70, WL-23, 3 WLRG/1-8, 12 WLRG/1-2, Local White and WL-43, were evaluated for variability, heritability and genetic advance during the crop season 2002-03. Seeds of F2 crosses along with their parents were space planted in the experimental area of the Department of Plant Breeding & Genetics, University of Agriculture, Faisalabad, Pakistan. Seeds of each parent were sown in two lines whereas that of each F2 population in six lines of 30 cm apart in holes made with the help of a dibble keeping plant to plant distance of 15 cm. Two seeds per hole were sown, which were later thinned to one healthy seedling per site. Two hundred competitive plants from each F2 population and 50 plants from each of the parental lines were selected randomly. Data from the selected plants were recorded for flag leaf area, tillers per plant, spike length, grains per spike and grain yield per plant. The data were subjected to statistical analysis to calculate mean, variance, heritability and genetic advance at 10% selection intensity. Heritability in broad sense was computed following Mahmud and Kramer (1951).

\[ h^2(B.S.) = \frac{VF_2 - \sqrt{VP_1 \times VP_2} \times 100}{VF_2} \]

Where,

- \( VF_2 \) = variance of F2.
was greater than their respective parents and were higher, indicating transgressive segregation for grain yield. Tiller number ranged from 7.70 in 3 WLRG/1-8 to 10.00 in Chenab-70 and WL-43 among parental genotypes. Tiller number in all the crosses followed by the cross 3 WLRG/1-8 × WL-43 exhibited the lowest (49.93%) estimate of heritability with the lowest value (1.28) of genetic advance. The moderate heritability estimates, indicated that selection for spike length should be practiced with care during early generations which otherwise may not be effective during early generations and should be delayed until some later generations.

These findings get support from those of Chowdhry et al. (1993), Dechev (1995), Chowdhry et al. (1997) and Salim et al. (2003).

4. Grains per spike
Grains per spike is also an important yield trait in wheat. It depends upon various other traits like spike length, spikelets per spike and spike density. However, weight of grains should also be given due consideration while studying grains per spike. A greater number of grains per spike would only be useful if they are healthy and not shrunken having adequate weight. Greater number of shriveled and poor grains will not be required to obtain high yield.
Table 1. Estimates of mean ($\bar{x}$), variance ($\sigma^2$), heritability ($h^2$) and genetic advance (G.A) of F$_2$ populations for studied traits in wheat.

<table>
<thead>
<tr>
<th>Parents/Crosses</th>
<th>Flag leaf area (cm$^2$)</th>
<th>Tillers per plant</th>
<th>Spike length (cm)</th>
<th>Grains per spike</th>
<th>Grain yield per plant (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>$\bar{x}$</td>
<td>$\sigma^2$</td>
<td>$h^2$</td>
<td>$\bar{x}$</td>
<td>$\sigma^2$</td>
</tr>
<tr>
<td>Chenab 70</td>
<td>44.06</td>
<td>4.94</td>
<td></td>
<td>10.0</td>
<td>2.63</td>
</tr>
<tr>
<td>WL-23</td>
<td>34.57</td>
<td>7.61</td>
<td></td>
<td>9.8</td>
<td>4.38</td>
</tr>
<tr>
<td>3WLRG/1-8</td>
<td>43.54</td>
<td>6.32</td>
<td></td>
<td>7.7</td>
<td>2.85</td>
</tr>
<tr>
<td>12WLRG/1-12</td>
<td>43.07</td>
<td>6.48</td>
<td></td>
<td>8.2</td>
<td>1.71</td>
</tr>
<tr>
<td>Local White</td>
<td>45.02</td>
<td>7.13</td>
<td></td>
<td>9.4</td>
<td>2.34</td>
</tr>
<tr>
<td>WL-43</td>
<td>43.15</td>
<td>7.90</td>
<td></td>
<td>10.0</td>
<td>2.11</td>
</tr>
<tr>
<td>Chenab 70 x WL-23</td>
<td>41.66</td>
<td>35.76</td>
<td>82.86</td>
<td>8.70</td>
<td>11.0</td>
</tr>
<tr>
<td>3WLRG/1-8 x</td>
<td>44.03</td>
<td>55.66</td>
<td>88.50</td>
<td>11.59</td>
<td>10.3</td>
</tr>
<tr>
<td>12WLRG/1-12</td>
<td>42.84</td>
<td>45.39</td>
<td>84.43</td>
<td>9.96</td>
<td>10.8</td>
</tr>
<tr>
<td>3WLRG/1-8 x</td>
<td>38.65</td>
<td>93.22</td>
<td>92.32</td>
<td>15.64</td>
<td>11.8</td>
</tr>
<tr>
<td>12WLRG/1-12</td>
<td>38.42</td>
<td>103.4</td>
<td>93.51</td>
<td>16.69</td>
<td>11.1</td>
</tr>
<tr>
<td>Local White x</td>
<td>45.42</td>
<td>103.4</td>
<td>93.51</td>
<td>16.69</td>
<td>11.1</td>
</tr>
<tr>
<td>3WLRG/1-8</td>
<td>43.27</td>
<td>102.3</td>
<td>93.36</td>
<td>16.57</td>
<td>10.4</td>
</tr>
<tr>
<td>Local White x</td>
<td>48.19</td>
<td>102.9</td>
<td>92.71</td>
<td>16.51</td>
<td>10.0</td>
</tr>
</tbody>
</table>
Mean performance of genotypes (Table 1) indicated that grains per spike was a highly variable character among genotypes and ranged from 39.45 in the cross Local White × 3 WLRG/1-8 to 65.45 in Chenab-70. The maximum grains per spike (60.01) were recorded in the F₂ of the cross Local White × 12 WLRG/1-12. The F₂ from 12 WLRG/1-12 × WL-43 indicated the highest variability (variance = 381.69) for grains per spike. This F₂ also indicated the highest heritability (93.85%) with a maximum genetic advance (32.18) followed by Local White ×12 WLRG/1-12 and Local White × WL-43, which have the respective values of heritability and genetic advance as 93.83%, and 28.14, and 92.89% and 23.86. A fairly high heritability and genetic advance of all the combinations for grains per spike indicated that progenies of these crosses would be useful for improving grains per spike.

The results are in accordance with the findings of Chowdhry et al. (1993), Dechev (1995), Zhao et al. (1995), Katiyar and Ziauddin (1996), Chowdhry (1997), Mehta et al. (1997) and Salim et al. (2003).

5. Grain yield per plant

Grain yield is the prime objective of plant breeders. High estimates of variability, heritability and genetic advance for this trait would be helpful for the breeders to select for the best combinations and to reach at the desirable level of yield potential.

Grain yield per plant among parents ranged from 20.15 g in 3 WLRG/1-8 to 23.25 g in WL-43. In case of F₂ populations it was minimum (21.31 g) in 3 WLRG/1-8 × 12 WLRG/1-12 and maximum (24.84 g) in Local White ×12 WLRG/1-12. Heritability ranged from 58.39% in 3 WLRG/1-8 × 12 WLRG/1-12 to 88.24% in 3 WLRG/1-8 × WL-43. The combinations showing high heritability also showed higher values of genetic advance which were minimum (1.77) in 3 WLRG/1-8 × 12 WLRG/1-12 and maximum (4.50) in Local White × 12 WLRG/1-12. Although selection for grain yield is difficult owing to its polygenic nature but crosses like 3 WLRG/1-8 × WL-43, Local White × 12 WLRG/1-12, 12 WLRG/1-12 × WL-43, Local White × WL-43 and Chenab-70 × WL-23 having fairly high estimates of heritability and genetic advance showed the potential of effective selection for grain yield at early stages.

These results are in conformity with the results of Mahmood and Shahid (1991), Chowdhry et al. (1993), Collaku (1994), Chowdhry et al. (1997), Ozkan et al. (1997) and Salim et al. (2003).

CONCLUSION

The overall results of the study indicated that on account of fairly high estimates of heritability and genetic advance for all the plant traits studied in the F₂ populations of the crosses, 3WLRG/1-8 × WL-43, 12 WLRG/1-12 × WL-43 and Local White × 3 WLRG/1-8, selection for these traits could be practiced to improve grain yield and its components in wheat.

REFERENCES