Influence of Stripe Rust of Wheat Upon Plant Development and Grain Quality of Closely Related Lemhi Derivatives

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IN 1963 stripe rust, incited by Puccinia striiformis West, seriously reduced the yield and weight per bushel of soft white spring wheat, Triticum aestivum ssp. vulgare (Vill., Host) Mac Key, grown in the Snake River Valley of Idaho. The principal variety grown was 'Lemhi 53'.

The purpose of this study was to determine the components involved in yield reduction and if other aspects of grain quality are affected by stripe rust.

MATERIALS AND METHODS

Ninety-two F2 plants obtained from 13 crosses of Lemhi 53 X (Lee' X Chinese-Aegilops umbellulata) were planted in 13 field rows. Rows were spaced one foot apart. Plant spacing within rows ranged from 2 to 12 inches.

Data were taken in the field on stripe rust infection type, severity of infection, plant height, and number of heads per plant. Number of seeds per head, weight per 100 kernels, and yield per plant were obtained after the grain was threshed.

Samples for quality tests were 15-gram composites made by combining equal amounts of seed from 2 or 3 resistant plants in each row for the resistant composite and from a like number of seeds from susceptible plants for the susceptible composite. When a sufficient number of plants were available 2 resistant and 2 susceptible composites were made for each row.

The sedimentation test was used to determine differences in flour-protein quality. Flour for the sedimentation test was ground on a Quadrumat Junior mill. The Udy protein analyzer was used to determine protein content of samples. Samples for protein tests were ground in a hammer mill with a screen size of 0.024 inch.

Significant differences between means of the resistant and susceptible groups were determined by the t test. The absence of differences in number of tillers per plant was expected because tiller initiation had occurred before flowering.

Resistant and susceptible plants did not differ significantly in height and number of heads per plant (Table 1).

EXPERIMENTAL RESULTS

Fifty-one plants had a type 2 stripe rust reaction—moderate chlorosis and a few small rust pustules. Forty-one were very susceptible. All susceptible plants had 100% severity of leaf blade infection at flowering and many of them had head infections beginning to appear two weeks after flowering.

Resistant and susceptible plants did not differ significantly in height and number of heads per plant (Table 1).

Differences between the two groups in the number of seeds per head, kernel weight, and, consequently, total yield were highly significant. The average yield of susceptible plants was reduced by 37.9%. Lower kernel weight caused 19.9% of the reduction and fewer seeds per head caused the remaining 17.6%.

The 1.7% lower protein content of grain from susceptible plants was highly significant. Flour from resistant and susceptible plants had a highly significant difference in the actual sedimentation value. The difference was still highly significant when the sedimentation value was corrected by the Barmore method to that which would have been obtained if flour from all plants had had the same protein.

DISCUSSION

Differences in genotype of resistant and susceptible F2 plants used in this study should have been limited to the effects of a short segment of one of the pair of chromosomes carrying the dominant allele for stripe rust resistance, since rust resistance appears to be governed by a single gene. Therefore, differences between groups of plants were probably caused by the stripe rust infection and not by linkage of the rust gene with those for the other characters considered. Differences caused by unequal plant spacing within rows should have affected both groups equally.

The absence of differences in number of tillers per plant was expected because tiller initiation had occurred before rust became a problem. Allen et al. reported that susceptible groups of closely related resistant and susceptible lines grown under a stripe rust epiphytotic had reduced yields and test weights. The components responsible were probably those reported here, because they found that susceptible plants had a stripe rust infection of 100% severity by flowering.

Table 1. Plant development and grain quality of near-isogenic stripe rust resistant and susceptible wheat plants.

<table>
<thead>
<tr>
<th>Plant character</th>
<th>Plant reaction</th>
<th>Difference</th>
<th>t value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Height, inches</td>
<td>35.6 35.9</td>
<td>0.3</td>
<td>4.45</td>
</tr>
<tr>
<td>Heads per plant</td>
<td>11.40 11.15</td>
<td>0.28</td>
<td>8.39</td>
</tr>
<tr>
<td>Seeds per head</td>
<td>36.9 30.4</td>
<td>6.5</td>
<td>8.75**</td>
</tr>
<tr>
<td>100 kernel weight, g.</td>
<td>9.55 9.13</td>
<td>0.42</td>
<td>10.70**</td>
</tr>
<tr>
<td>Yield per plant</td>
<td>10.5 10.0</td>
<td>0.5</td>
<td>3.42**</td>
</tr>
<tr>
<td>Grain protein, %</td>
<td>12.7 12.0</td>
<td>0.7</td>
<td>7.35**</td>
</tr>
<tr>
<td>Sedimentation value</td>
<td>18.4 16.8</td>
<td>1.6</td>
<td>1.76</td>
</tr>
<tr>
<td>Sedimentation value, corrected to 13% protein</td>
<td>20.2 18.6</td>
<td>1.6</td>
<td>1.76</td>
</tr>
</tbody>
</table>

1 Mention of trade names is for identification only and does not imply endorsement by the U. S. Department of Agriculture.


4 Sedimentation test was used to determine differences in protein content of samples. Samples for protein tests were ground in a hammer mill with a screen size of 0.024 inch.

5 Significant differences between means of the resistant and susceptible groups were determined by the t test. The absence of differences in number of tillers per plant was expected because tiller initiation had occurred before flowering.

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