Spring Wheat Resistance Against Cereal Leaf Beetle (*Oulema Melanopus* Z.) In Relation to Leaf Pubescence

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Abstract: Leaf pubescent in relation to infestation with cereal leaf beetle (*Oulema melanopus* Z.) was studied in different cultivars and genotypes of Kazakhstanian spring wheat. Data obtained clearly indicated that different genetic materials of spring wheat crop varied in the average number of hairs per unit leaf area. The degree of the leaf damage by the beetle depends greatly on the performance of such trait. The results proved that the greater the length of hairs and the number of hairs per unit area of the leaf the smaller the leaf affected by the cereal leaf beetle. Positive percentage of heterosis was obtained in the F₁ produced from the crosses between parents of different genotypes in the number of hairs per unit area and length of hairs in mm.

Key words: wheat resistance, Cereal leaf beetle, leaf pubescence

INTRODUCTION

One of the main goals of the spring wheat breeding is to create varieties resistant to the most common diseases and pests in a particular area.

Winter and spring crops wheat are often damaged by cereal leaf beetle (*Oulema melanopus* Z.). According to international statistics, in some years destruction of agricultural products with pests and diseases on a global scale reduces the total yield of products by 25%. In Kazakhstan, this type of pest is particularly dangerous in the south and south-east of the country. In order to create resistant varieties to cereal leaf beetle, biology of the pest, should be studied on one hand, and at the same time factors that facilitate resistance of plants should be examined. Hairiness of leaf shoots of young wheat plants is a beneficial marker trait. It is well known that thick hairing of leaves has a protective role, reducing their damage with fruit fly, and during the stage of booting-earing- cereal leaf beetle. Cereal leaf beetle refers to the order of *Coleoptera*, family *Christomelidia*. The larvae of the pest eat away parenchyma of the leaves, while leaving intact it epidermis. Some years cereal leaf beetle affects the crop, leaving a massive white marks on the leaves of the wheat. Development of effective methods to control plant pests is associated with applying different insecticides. The side effects of such procedure are: 1) environment is being polluted, 2) beneficial insects die as well as pests, 3) these kinds of activities in large plantings are quite expensive. Some researchers associate non-damage of several spring wheat lines with pubescent leaf surface /1-2/. In this perspective the establishment of wheat varieties with intense pubescent leaf is currently relevant in wheat breeding. Relationship between resistance of plants to damage of cereal leaf beetle and leaf hairiness is established by a number of researchers /3-6/. However, available description of the hairs on the leaves of wheat in the literature is missing. There are limited information about the nature and intensity of pubescence. This research is dedicated to examine the characteristics of pubescence of the leaves of created isogenic and substituted lines of Kazakhstanskaya 4 in the southern areas of the Country in relation to the degree of leaf infestation by cereal leaf beetle.

MATERIALS AND METHODS

The material of the study was varieties or lines of spring wheat Kazakhstanskaya-4 and Saratovskaya-29, isogenic lines, monosomic line and substituted lines of Kazakhstanskaya-4. Grains of plant materials were sown in the agriculture fields of Kazakh Research Institute.

To fulfill the object of the present study, the following parameters were measured on different plant materials: Number of hairs per unit of leaf area, hair distribution and distance between each other in different veins and relationship between degree of damage and hair distribution were clarified.

To explore the nature and hair distribution patterns on the leaf surface dry leaves were immersed into warm mixture alcohol and glycerol (1:1) for several minutes. The sheath or blade, leaf was divided into three parts: base of the sheet, middle part and the top one. Segments from every leaf were placed on a glass slide and droved few times along these segments with a sharp needle. Leaf segments in this way were splitted into narrow
strips of veins. With this method of preparations we were able to observe the structure of the hairs. Under the microscope using microscope MBS-1 leaf segment was examined in 5 fields of view. The number of hairs and the distance between them was counted using ocular micrometer. Using a millimeter ruler the leaf area, the area of the damaged surface by cereal leaf beetle were measured and the degree of damage to the leaf as the percentage of damaged surface was calculated. Crosses among different varieties and lines were carried out to identify the percentage of heterosis in the F₁ produced for the average number of hairs per unit area of the leaf. Percentage of heterosis was calculated using the following formula:

\[
\% \text{ of heterosis} = \frac{F_1 - \text{mid parents}}{\text{mid parents}} \times 100
\]

**RESULTS AND DISCUSSION**

Comparative analysis of pubescence trait of the parental forms showed that Kazakhstanskaya-4 is intensely affected with cereal leaf beetle. The leaves of this kind have not been covered with hairs except only single hairs in the middle and end part of the leaf. Intensity lesions vary with leaves distribution, the most affected leaves are at the top, leaves at the second and third levels are less damaged, and the fourth level almost is not affected. Apparently, this is due to the fact that the surge of cereal leaf beetle comes at a time when the larvae emerge from the soil and displace out, where they feed on leaves. They develop at a very lower part of the stem it, under the cover of leaf sheath. To reach the fourth leaf the development of larvae is affected by heat, dryness and limited food resources. The developmental cycle of cereal leaf beetle in the southeast takes about fit in 25-30 days, in 12-15 days the larvae pupate, 9-12 days later adult insect comes out of the pupa. The optimum for oviposition in summer grain is the second sheet. In the early winter crops during hot weather a lot of eggs are laid on seedlings in a phase of the first leaf. Saratovskaya-29 is characterized by change in intensity of pubescence along the leaf blade. Leaf base of the number of hairs in an average of 29.50 ± 0.13, in the middle part hairs are unidirectional –25.10 ± 0.69, all leaf veins are haired, leaf and is intensely pubescent – 23.30 ± 0.98. The intensity of hairiness also varies with levels. The most pubescent leaves were of third and fourth tiers. Lesions of cereal leaf beetle were observed in non-haired part of the leaf.

Analysis of leaf pubescence of substituted analogue showed that most pubescence is observed at the base of the leaf. Counting results of number of hairs per unit area is given in Table 1.

Thus, the average number of hairs per unit leaf area of substituted line along the leaf base is 28.20 ± 0.81, in the middle 24.80 ± 1.03, on top – 21.50 ± 1.13 respectively.

Leaf pubescence of “Nadezhda” line is uniform. The average number of hairs per unit area in “red grain” analog follows pattern: the base is 16.50 ± 0.44, in the middle is 15.40 ± 0.88 and, and on top of a sheet 14.10 ± 0.14 respectively.

In isogenic 4 (iso-4) line, the nature of leaf pubescence was similar to the variety Nadezhda. Thus the number of hairs at the base of leaf was 16.20 ± 0.14, in the middle 15.10 ± 0.15, and on top 14.30 ± 0.17.

Comparative analysis of the nature of pubescent leaves showed that the substituted analogue, obtained by transferring 4A chromosome of Saratovskaya-29 with the corresponding chromosome varieties of Kazakhstanskaya-4 leaf surface is more intensely haired than of “Nadezhda” line, created by backcrossing. Apparently, the direction chromosome transfer is more reliable way to improve the economically valuable traits of regionalized and prosperous kinds of wheat widely used in the selection processes.

### Table 1: The average number of hairs per unit area (0.49 mm²) of the leaf in the parental forms, F₁ hybrids and isogenic lines of wheat in addition to percentage of heterosis in the F₁ hybrids.

<table>
<thead>
<tr>
<th>Name of the lines</th>
<th>Number of hairs at the bottom</th>
<th>Number of hairs in the middle</th>
<th>Number of hairs at the top</th>
</tr>
</thead>
<tbody>
<tr>
<td>Substituted analogue</td>
<td>28.20 ± 0.81</td>
<td>24.80 ± 1.03</td>
<td>21.50 ± 1.13</td>
</tr>
<tr>
<td>“Red grains” haired analogue</td>
<td>16.50 ± 0.44</td>
<td>15.40 ± 0.88</td>
<td>14.10 ± 0.14</td>
</tr>
<tr>
<td>Parental forms</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Saratovskaya-29</td>
<td>29.50 ± 0.13</td>
<td>25.10 ± 0.69</td>
<td>23.30 ± 0.98</td>
</tr>
<tr>
<td>Isogenic 4 (iso-4)</td>
<td>16.20 ± 0.14</td>
<td>15.10 ± 0.15</td>
<td>14.30 ± 0.17</td>
</tr>
<tr>
<td>Kazakhstanskaya-4</td>
<td>No pubescence</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hybrids F₁</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kaz.4 x iso.4</td>
<td>17.00 ± 0.62</td>
<td>110</td>
<td>41.3</td>
</tr>
<tr>
<td>Kaz.4 x Sar.29</td>
<td>24.80 ± 0.66</td>
<td>50.3</td>
<td>21.20 ± 1.21</td>
</tr>
</tbody>
</table>

**Het.**: Heterosis

Negative correlation is observed between the degree of leaf damage and the two different traits; hair length and number of hairs per unit area in the two different lines; Nadezhda and Intensivnaya 96 (table 2). Data
obtained clearly indicated that greater the length of hairs and the number of hairs per unit area smaller the leaf area which was affected and damaged by cereal leaf beetle.

### Table 2: The relationship between the density of hairs, long hairs, and the degree of damage leaf cereal leaf beetle.

<table>
<thead>
<tr>
<th>Name of the lines</th>
<th>The total loss, %</th>
<th>length of hairs, mm</th>
<th>number of hairs per unit area</th>
<th>correlation coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>X</td>
<td>Y</td>
<td>Z</td>
<td>Rxy+mr</td>
</tr>
<tr>
<td>Nadezhda</td>
<td>2.6</td>
<td>1.4</td>
<td>14.1</td>
<td>-0.71+0.25</td>
</tr>
<tr>
<td>Intensivnaya 96</td>
<td>3.9</td>
<td>1.4</td>
<td>13.8</td>
<td>-0.94+0.15</td>
</tr>
</tbody>
</table>

To establish the relationship between cereal leaf beetle damage and the nature of leaf hairing, we measured width and length of the leaf, as well as damaged parts of the leaf. Percentage of total damage was measured as ratio of damaged leaf area to the total area of the leaf. The analysis showed that damage with cereal leaf beetle affected mostly the first leaf, then in descending manner - the second leaf, but the fourth leaf is almost not affected.

In isogenic lines derived from Kazakhstanskaya-4 type a great variety in degree of pubescence, and hair distribution along the leaf blade was seen. The following types of pubescence were identified: 1. the hairs are arranged in order of increasing length in some veins and in descending manner on the other veins. 2. hairs are arranged unidirectionally and have the same length along the entire length of the blade. 3. the hairs are arranged in order of increasing length from the base to the end of the leaf, all the veins are equally pubescent. 4. Veins are pubescent through one alternating long and short hairs. 5. hairs are directed in different directions and randomly along the length of stems, all veins are pubescent. The hair length varies greatly. 6. Hairs are arranged in pairs along the veins, pubescence of the veins is the same. 7. hairs are unidirectional along the veins. Veins alternate with small and large hairs. 8. The leaves are not hairy. There are single hairs in the field of view. 9. The leaves are completely uncovered with hair.

In the course of the material study it was found out that the degree of damage depends on hair the length and direction of hair distribution along the veins. With regards, to this all the types of hairing were grouped as following: 1) unidirectional long hairiness, long, 2) unidirectional rare hairing, 3) hairs were along the veins are distributed randomly throughout the length of the blade, 4) hairs were arranged in pairs on veins, and 5) the hairs are unidirectional, alternating with long and short hairs, and 6) the leaves are not hairy, single hairs are seen in the field of view. The most common type is the first one, which protects plants from damage with cereal leaf beetle. This type exists in substituted line. All the leaves with this type of pubescence are not affected with cereal leaf beetle. Leaves of the second type of pubescence - all are compromised with the beetle. This type is characterized by isogenic line with waxy coating. Diversity of pubescence is observed not only within a line, but also within a single plant. Leaf pubescence pattern along the tiers of “Nadezhda” line and substituted lin-31 is similar to those of the Saratovskaya-29.

Thus, there is a strong correlation between the types of pubescence and leaf lesions caused by cereal leaf beetle. As the length and number of hairs increase, degree of leaf damage decreases. Obtained from intervarietal chromosome substitution analogues of Kazakhstanskaya-4 are different at intensity hairing along leaf tiers. The most damaged leaves were of the first tier, less damaged leaves were of the second and third tiers, and the fourth was not damaged at all. Along the change in hairing of leaf blade from the base to the end (non-haired leaf base, pubescent middle and intensely haired end of the leaf); with the type of leaf pubescence 3-5 leaves were affected by cereal leaf beetle regardless of tier; degree of leaf damage depends on hair length. Leaves with long hairs (0.154 mm) are not affected with cereal leaf beetle.

**REFERENCES**


