Field evaluation of specimens from a corn collection for resistance to Helminthosporium turcicum Pass and Fusarium moniliforme Scheldon

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Abstract. The paper presents research data on the spread and development of the main fungal pathogens of corn. Corn holds a prominent place among the other grain crops grown in Primorsky kray. Corn is susceptible to more than 120 different pathogens. Helminthosporium turcicum Pass and Fusarium moniliforme Scheldon cause significant damage to zea mays plants under the conditions of the south of the Russian Far East. The research evaluated 148 corn genotypes. The progression degree of northern leaf blight ranged from 8 to 70% at the kernel milk stage depending on the specimen (the prevalence was 38-100%); the occurrence frequency of Fusarium ear rot varied within 0-90%. The conducted research resulted in the identification of genotypes with resistance to these pathogens. The following genotypes might be valuable for further breeding: S-1847, k-23428 B, k-24825, R-nj purple, k-22077, k-21477, S-430 V, MP-162-B, and varieties Sakharnaya and Indeiskaya krakhmalistaya.

1 Introduction

Corn in one of the leading crops in Russia. High yield and low production cost add to the popularity of this crop all around the globe [1-2]. For over fifty years, corn has been the main crop in the south of the Far Eastern Federal District. Its versatility is well known [3-4]. This is the main fodder crop, which is used for producing highly nutritional forage. One hundred grams of corn grain contain up to 1.4 MJ of metabolizable energy, one kilogram of corn grain equals 1.34 Russian feed units. Additionally, unique properties of zea mays allow its use as raw material in food industry and manufacturing. This crop plays an important agronomical and environmental role as well.

However, corn is susceptible to different fungal pathogens, which significantly reduce its yield [5-10]. Northern leaf blight is a common corn disease in Primorsky kray [11]. The infectious agent is the imperfect fungus species Helminthosporium turcicum Pass from the

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order Hyphomycetales. This disease develops at high humidity levels and temperatures. At advanced stages, it leads to the premature withering of plants reducing grain yield.

Fusarium ear rot (Fusarium moniliforme) causes the most damage in comparison with other corn ear diseases. The infectious agent is the imperfect fungus species Fusarium moniliforme Scheldon. Fusarium ear rot similarly to northern leaf blight is widespread in regions with moderately to extremely wet conditions. The progression degree of Fusarium ear rot might reach 40-50% in warm and humid years.

For this reason, it is key important to study the genetic diversity of zea mays to identify genotypes with resistance to fungal pathogens for the creation of new highly resistant starting material.

2 Material and methods

The research evaluated 148 corn genotypes from our collection nursery for susceptibility to Helminthosporium turcicum Pass and Fusarium moniliforme Scheldon. Records on the development of the diseases were made according to the methodology of G.V. Grisenko and E.L. Dudka [12].

The prevalence of a disease was calculated by the formula (1):

\[ \frac{n}{N} = P \]  

(1)

Where P – disease prevalence (%), n – number of infected plants, N – total number of studied plants.

The progression of a disease was calculated by the formula (2):

\[ \frac{\sum (ab)100}{NK} = R \]  

(2)

Where R – progression of a disease (%), \( \sum (ab) \) – sum of the products of the diseased plant number (a) and the corresponding damage score (b), N – total number of the studied plants, K – the highest score on the rating scale.

Growing degree days (above 10°C) from May to September amounted to 2926.9°C in 2023 while the total precipitation was 833.5 mm, which was by 368.5 mm higher than the long term annual average (Table 1). The growing period was excessively wet (the hydrothermal coefficient of Selyaninov was 2.9).

Table 1. Meteorological conditions during the growing period of 2023.

<table>
<thead>
<tr>
<th>Month</th>
<th>Temperature (°C)</th>
<th>Total precipitation (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>monthly</td>
<td>long term</td>
</tr>
<tr>
<td>May</td>
<td>13.9</td>
<td>11.2</td>
</tr>
<tr>
<td>June</td>
<td>18.6</td>
<td>15.7</td>
</tr>
<tr>
<td>July</td>
<td>22.5</td>
<td>20.0</td>
</tr>
<tr>
<td>August</td>
<td>22.5</td>
<td>20.8</td>
</tr>
<tr>
<td>September</td>
<td>18.1</td>
<td>16.8</td>
</tr>
</tbody>
</table>

The terrain of the experimental field plots was flat with slightly sloping low hills. The soil was heavy meadow brown bleached soil with a plough layer of 22-25 cm and a pH 5.1±0.1, containing 3.55±0.51% humus, 58±12 mg/kg of labile phosphorous, 63±11 mg/kg of exchangeable potassium, and 60±5 mg/kg of nitrogen.
3 Results and Discussion

Northern leaf blight is widespread in Primorsky kray. The disease starts to develop from the lower leaves and continues until the plant withers naturally. The progression of *Helminthosporium turcicum* (Figure 1) was facilitated by high temperature and humidity levels in 2023 including abundant precipitation in the second part of the corn growing period.

The degree of disease progression ranged from 8 to 70 % at the kernel milk stage (the prevalence was 38-100%).

According to our data, the lowest progression degree of northern leaf blight (0-10%) was characteristic of twelve genotypes from the collection nursery, which accounted for 8.1% of the total number of the studied specimens (Figure 2). Specimen S-1847 stood out from the other studied genotypes for a low degree of disease progression (8%) (the prevalence was 38%). Specimen k-5550 was observed to have a high degree of disease progression (70%). The degree of disease progression varied within 31-40% in most of the studied genotypes (40.5%).

![Figure 1. Corn plants damaged by *Helminthosporium turcicum* (photo by the author).](image)

![Figure 2. Progression degree of *Helminthosporium turcicum* in corn plans, %](image)

*Fusarium moniliforme* causes significant damage to corn plants. Damaged grains loose brightness, turn brownish, crumble easily, and eventually begin to rot. The conditions of 2023 were favorable for the development of this disease. The frequency of occurrence varied from 0 to 90% depending on the genotype. The highest prevalence (90%) was observed in six specimens.
The research revealed that a low degree of disease progression (0-10%) was characteristic of eighty specimens (Figure 3). The following nine genotypes (6.1%) had immunity (the frequency of occurrence and the progression degree were 0%) to this disease: k-23428 B, k-24825, k-22077, k-21477, S-430 V, MP-162-B, R-nj purple, and varieties Sakharinyaya and Indeiskaya krakhmalistaya. A progression degree of 11-20% was observed in forty-eight (32.4%) genotypes, of 21-30% in eighteen (12.2%) genotypes, and of 31-40% and 41-50% in one genotype each (0.7%). Disease progression over 50% was not registered.

Figure 3. Corn ears damaged by *Fusarium moniliforme* (photo by the author).

4 Conclusion

Thus, studying different corn genotypes under the conditions of the south of the Russian Far East allowed us to select sources of resistance to two plant pathogens (*Fusarium moniliforme* Scheldon, *Helminthosporium turcicum* Pass). The following genotypes were determined to be valuable starting material for further breeding: S-1847, k-23428 B, k-24825, k-22077, k-21477, S-430 V, MP-162-B, R-nj purple, and varieties Sakhalinskaya and Indeiskaya krakhmalistaya.

References

11. O. Telichko, T. Belova, O. Sirmolot, Y. Lastushkina, JAE, 10, 38 (2023)