STUDY ON RESISTANCE OF MAIZE HYBRIDS TO SMUT OF MAIZE (*Ustilago maydis*)

DOI: 10.7904/2068-4738–VI(12)–81

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Abstract. The objective of the work was the degree of attack of smut of maize on a part of the collection of maize hybrids of IASS “Obraztsov chiflik”–Rousse, to be studied under conditions of IASS. The analysis of the damage of the studied pathogens in the latest hybrids of IASS “Obraztsov chiflik”–Rousse showed that some of them manifest resistance. The highest resistance is in Eks 24–I, Eks 1–I, Eks 16–I hybrids. They could be used as sources of resistance. Eks 12–I, Eks 15–I, Eks 11–I, Eks 8–I, Eks 10–I, Eks 23–I are susceptible.


Introduction

The introduction of the latest achievements of the local selection in agriculture, directed to the creation of new varieties with increased resistance and early maturity has an important influence on the development of agriculture in perspective. [PAVLOV and VALCHEV, 2013, BUTNARIU and SAMFIRA, 2012].

It is known that the most efficient method of control of the diseases of economic importance is the breeding of resistant varieties.

Different breeding–genetic methods characterized with a higher or less efficiency in this direction have been used till now for this purpose. [POPOV and POPOVA 1976, BUTNARIU, al et., 2014].

As a source of breeding material the local populations are often used, being formed under different ecological conditions with various valuable traits which are inherited. [POPOV 1970, BUTNARIU and CAUNII, 2013].

Annual losses of maize production as a result of the attacks of various diseases account to 7–17%, as in some regions these percentages are even higher [HRISTOVA and MOMCHILOVA, 2002, RASHED and BUTNARIU, 2014]. Diseases reduce yield and lower the quality of production [PAYAK and Shama, 1985; MIR et al., 2015].

The main causes of diseases of maize are fungal–maize helminthosporisis (*Helminthosporium turcicum*), smut of maize (*Ustilago maydis*), *Fusarium* (*Fusarium moniliforme*). Smut of maize is distributed wherever maize is grown. Degree of attack and yield reduction vary widely, depending on the climatic conditions, the applied agrotechnics, variety susceptibility, etc. [IVANOVA 1985; PAVLOV and VALCHEV, 2013, IVANOVA1988; POPOV 1970].


They determined the resistance of more than 1500 local and synthetic populations, varieties, inbred lines and maize hybrids. As a result, the development of genotypes with desired level of resistance leads to higher productivity [MIR et al., 2015, BUTNARIU, 2014].

The objective of the study was the degree of attack of smut of maize (*Ustilago maydis*) on 22 hybrids and 4 maize standards to be determined under conditions favorable to the development of the pathogen.

Material and methods

The study was conducted in the Experimental fields of the Institute of Agriculture and Seed Science “Obraztsov chiflik”–Rousse during the period 2012–2014. 26 germplasms in total were
included of a PVT (preliminary variety trial).

The experiment started after the block method in three replications, harvesting plot being 10 m², on natural infectious background under conditions without irrigation, in density of 5500 plants/da.

Field phytopathological readings were made in July and August in phases tasseling of maize and milky–wax ripeness of maize, counting the main plants giving each of them relevant ball, depending on the degree of damage from 0 to 5, according to the five–point scale of Popov [POPOV 1970,1972, SAMFIRA al et., 2013].

Results and discussion
IASS “Obraztsov chiflik is situated in the northern climatic region of the Danube plain. The climate is continental. Summer is droughty, with low relative humidity and high daily temperatures in July and August.

During the period of study, the agro–meteorological conditions were favorable for the growth and development of maize.

According to the agro–meteorological characteristics month by month for 2012 and 2013, April in the first year was with an average temperature of 14.2°C which was 2.8°C higher than the average norm.

Precipitation during the same month was 19.0 mm less than the norm.

In the second year during the same month, the average temperature was 13.4°C which was 2.0°C higher than average norm and the precipitation–4.2 mm below the average norm.

In the last ten days of April and the first ten days of May, in both years, the increase in average daily temperature continued and despite of the lower quantity of precipitation in 2013–8.8 mm below the norm, the conditions were favorable for rapid initial growth of maize.

In June the precipitation in 2012 was 16.9 mm, at a norm of 80.5 mm, and the average daily temperature–nearly 3°C above the norm.

July was characterized with average daily temperature of 27.18°C, and precipitation–only 0.9 mm.

As a result of the average temperature higher than the norm by 4.7°C and almost without any precipitation during the month, the drought was severe.

That coincided with the phases tasseling of maize, flowering and inbreeding of maize, which took place in shorter period, than the normal.

In June of 2013 the precipitation was 34.9 mm above the norm and the average daily temperature–higher than the norm by 1.0°C.

July was characterized with average daily temperature of 22.2°C–very close to the norm and significant precipitation, exceeding the norm by 95.0 mm.

In the second and third ten days of the month, values of the temperatures were close to the norm, allowing a good head start of filling the grain.

In August of 2012 the precipitation was above the norm during the second and third ten days, and without economic significance, because the hybrids in the trial since the end of the first ten days have been already in technical maturity.

The same month of 2013 was unfavorable in regard to the precipitation–by 42.1 mm below the norm, which did not allow the crop to show its full yield potential embedded at the beginning of vegetation.

In conclusion it should be noteded that both years of study were with temperatures close to the norm with the exception of July, 2012, and in regard to the precipitation–with very large differences–both in quantity and month by month.

In 2014 the precipitation in June and July was about the norm, but was distributed in 17 and 13 days, respectively.

The water logging negatively affected yield and quality of crops attacked by fungal diseases.

In 2012, in PVT 7 of 26 observed numbers were infected with smut of maize and 5–with Fusarium.
We found that there were significant differences in resistance between the variants studied during the three years of conducting the experiment (Table 1).

### Table 1.
Evaluation of the resistance of perspective hybrids of IASS “Obraztsov chiflik” to smut of maize (*Ustilago maydis*).

<table>
<thead>
<tr>
<th>No</th>
<th>Germplasm</th>
<th><em>Ustilago maydis</em></th>
<th>Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>2012</td>
<td>2013</td>
</tr>
<tr>
<td>1.</td>
<td>St. 20</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>2.</td>
<td>Eks. 12–I</td>
<td>1</td>
<td>0</td>
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<tr>
<td>3.</td>
<td>Eks. 15–I</td>
<td>0</td>
<td>1</td>
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<tr>
<td>4.</td>
<td>Eks. 11–I</td>
<td>1</td>
<td>1</td>
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<tr>
<td>5.</td>
<td>Eks. 8–I</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>6.</td>
<td>Eks. 10–I</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>7.</td>
<td>Eks. 24–I</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>8.</td>
<td>Eks. 23–I</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>9.</td>
<td>Eks. 1–I</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>10.</td>
<td>Eks. 16–I</td>
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<tr>
<td>11.</td>
<td>Eks. 2–I</td>
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<tr>
<td>12.</td>
<td>Eks. 3–I</td>
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<td>0</td>
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<tr>
<td>13.</td>
<td>Eks. 4–I</td>
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<td>0</td>
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<tr>
<td>14.</td>
<td>Eks. 5–I</td>
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<tr>
<td>15.</td>
<td>Eks. 6–I</td>
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<tr>
<td>16.</td>
<td>St. 7</td>
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<tr>
<td>17.</td>
<td>Eks. 9–I</td>
<td>0</td>
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<tr>
<td>18.</td>
<td>St. 13</td>
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<td>0</td>
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<tr>
<td>19.</td>
<td>Eks. 14–I</td>
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<td>0</td>
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<tr>
<td>20.</td>
<td>Eks. 17–I</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>21.</td>
<td>Eks. 18–I</td>
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<tr>
<td>22.</td>
<td>Eks. 19–I</td>
<td>0</td>
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<tr>
<td>23.</td>
<td>Eks. 20–I</td>
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<tr>
<td>24.</td>
<td>Eks. 21–I</td>
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<tr>
<td>25.</td>
<td>Eks. 25–I</td>
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<td>0</td>
</tr>
<tr>
<td>26.</td>
<td>St. 26</td>
<td>0</td>
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</table>

As a whole, the hybrids manifested resistance to the pathogen. It was the highest in hybrids: St 20, Eks 24–I, Eks 1–I, Eks 16–I.

Those hybrids could be used as sources of resistance to smut of maize (*Ustilago maydis*). Eks 12–I, Eks 15–I, Eks 11–I, Eks 8–I, Eks 10–I, Eks 23–I were susceptible.

The reason is the genetic diversity among hybrids, which hybrids in genetic terms were complex heterozygous material.

The analysis of damage of smut of maize in 26 germplasms observed (Table 1 and 2), including 4 standards and 22 hybrids of IASS “Obraztsov chiflik”–Rousse showed that 15 were resistant and 7–susceptible (figure 1 and 2).
They should be grown very carefully because of the risks of possible losses, caused by the disease in Bulgaria.

Conclusions
A total of 15 germplasms showed resistance to *Ustilago maydis* and can be used in breeding, in order inbred lines and hybrids, resistant to smut of maize to be created.

During the process of selection, the germplasms manifesting high susceptibility to *Ustilago maydis*, have to be gradually eliminated.

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Received: July 3, 2015
Article in Press: October 26, 2015
Accepted: Last modified on: November 20, 2015

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