ASSESSING OF GENETIC VARIABILITY OF AVENA ACCESSIONS ARTIFICIALLY INOCULATED WITH FUSARIUM SPP.

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ABSTRACT

The pathogenic fungi Fusarium spp. cause yield losses and presence of mycotoxins in grains of many cereals, with potential risk to human health. Relatively less visible infections are found in oats, but even so high levels of T2 and HT2 mycotoxins were reported. The present study reports results on the variability of genetic resistance of modern cultivars and wild oats by artificial inoculation with different Fusarium species and on the role of morphological characters in the manifestation of infection.

Artificial inoculation with Fusarium spp. revealed a high variability of attack intensity between the studied Avena accessions. Infection on grains showed a leptokurtic distribution of the values, the probability of existence of resistance sources being in the cultivars of both classes of infections with a large interval of data dispersion towards the end of the variation curve.

Among the evaluated agronomic characters, there were significantly negative correlations between Fusarium infection on panicles and kernels and days to maturity, and positive significant correlation between Fusarium infection on panicle and 1000 kernel weight, these traits having an important role in the manifestation on panicle and grain infection.

Infestation with Fusarium fungus manifested differently on panicles and grains, genotypes with high 1000 kernel weight showing a higher degree of attack. Both panicle and grain infection levels were smaller in accessions with a longer vegetation period.

Keywords: Avena, Artificial inoculation, Fusarium spp. Attack.

INTRODUCTION

Fusarium spp. are pathogenic fungi which infest during earing and flowering periods, and have a global distribution on a large number of species, especially in cereals, causing yield losses and presence of mycotoxins in grains, with potential risk to human health (Llorens et al., 2006).

Most studies on cereals highlight significant degrees of attack on wheat, barley, rye and less visible infections on oats due to large distance between the spikelets in the panicle (Langevin, 2004).

Even in the absence of this fungus on oat, high levels of T2 and HT2 mycotoxins (Bottalico and Perrone, 2002) were found, with relevance in the quality of grains and their products. Temperature and humidity are climatic factors that influence the production of Fusarium on cereals, their effect being dependent also on the specific environment of the host (Doohan et al., 2003).

After Tekauz et al. (2005) there is a low rate of genetic variability in modern cultivars, a high level of resistance it assumed to be detectable in wild oats.

The present study aims to testing the variability of genetic resistance of modern cultivars and wild oats by artificial inoculation with different Fusarium species and the role of morphological characters in the manifestation of infection, traits that can be very useful in oat breeding.

MATERIAL AND METHODS

Testing was conducted in year 2015, in the experimental field in 12 blocks, each having 36 plots with 8 standards in five inoculated replications and two non-inoculated replications. For the development of Fusarium infection, in each block, corn plots were included.

Inoculation was performed with 5 Fusarium species, such as: 
- Fusarium culmorum
- Fusarium graminearum
- Fusarium langsethiae
- Fusarium sporotrichioides
- Fusarium avenaceum

Panicles infection level with Fusarium sp. was visually estimated using the 1-9 scoring scale (1 - no symptoms ..., 9 - severe symptoms on all panicles).

The percentages of infected seeds with Fusarium spp. were evaluated using magnifying glass. Three evaluation classes were used: 1 - healthy seeds, 2 - suspiciously infected, grey tips, 3 - Fusarium damaged, discoloured, smaller kernels.

Statistically, morpho-physiological descriptors on plants and frequency of attack of Fusarium spp. on panicles and seeds were analysed by calculating the following estimators: average (X), variation amplitude (Xmax, Xmin), variance (S^2), variation coefficient (S%), Kurtosis coefficient (K%) and Pearson correlation coefficients (r%).

RESULTS AND DISCUSSION

Genetic resistance testing of artificially inoculated Avena accessions with Fusarium spp. on panicles and kernels was performed by analysing the interaction between a series of agronomic traits and fungal infection level.

The following agronomic traits were evaluated with relevance to the infestation expression: number of days from sowing to heading, panicle length, number of panicles/m², number of days from sowing to maturity, 1000 kernels weight.

A variation coefficient smaller than 10% was found for the two physiological traits: days to heading and days to maturity, the studied cultivars having similar periods between numbers of days to heading and to maturity (Table 1). However, the variation coefficients ranging between 20 and 30% were found for the following agronomic traits: panicle length, panicle numbers/m² and 1000 kernel weight, which highlight a heterogeneous distribution of these traits in the analysed cultivars.

Infection level with Fusarium spp. on panicles and seeds in tested cultivars emphasized a high variability, the variation coefficients being between 31.48 and 131.8% (Table 1).
Table 1. Statistical parameter values for agronomic characters and Fusarium spp. infection on panicle and kernels in artificially inoculated Avena accessions cultivars

<table>
<thead>
<tr>
<th>Estimators</th>
<th>Days to heading</th>
<th>Panicle length (cm)</th>
<th>Panicle numbers / m²</th>
<th>Days to maturity</th>
<th>Weight of one thousand grains (g)</th>
<th>Fusarium infection level on panicle (FHB %)</th>
<th>Fusarium infection level on kernels (FDK 2 %)</th>
<th>Fusarium infection level on kernels (FDK 3 %)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average</td>
<td>72.87</td>
<td>19.74</td>
<td>146.71</td>
<td>121.79</td>
<td>24.53</td>
<td>2.16</td>
<td>0.91</td>
<td>1.84</td>
</tr>
<tr>
<td>Min.</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>115.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Max.</td>
<td>89.00</td>
<td>36.00</td>
<td>282.00</td>
<td>127.00</td>
<td>38.70</td>
<td>5.00</td>
<td>8.00</td>
<td>36.60</td>
</tr>
<tr>
<td>K%</td>
<td>24.41</td>
<td>1.06</td>
<td>-0.14</td>
<td>-0.59</td>
<td>1.73</td>
<td>0.41</td>
<td>9.80</td>
<td>29.75</td>
</tr>
<tr>
<td>S²</td>
<td>52.61</td>
<td>22.11</td>
<td>2666.52</td>
<td>7.92</td>
<td>28.18</td>
<td>0.46</td>
<td>1.44</td>
<td>16.62</td>
</tr>
<tr>
<td>S%</td>
<td>9.95</td>
<td>23.80</td>
<td>35.19</td>
<td>2.30</td>
<td>21.60</td>
<td>31.48</td>
<td>131.80</td>
<td>221.19</td>
</tr>
</tbody>
</table>

In the histograms shown in Figure 1, a leptokurtic distribution (K>3) in Fusarium spp. class 2 of infection (FDK 2) and class 3 of infection (FDK 3) can be observed, the values being scattered over a much larger interval to the final curve of variation for both classes of seeds infection, which indicate an increased probability of resistance sources existence in tested Avena accessions.

Significant correlation coefficients were found between Fusarium spp. infection on panicles (FHB) or on seeds (FDK2, FDK3) and some morpho-physiological traits (Table 2). Thus, we obtained a distinctly significant correlation between Fusarium spp. infection on panicle and 1000 kernels weight (0.169**) and days to maturity (-0.160*). Also, there was a distinctly significant correlation between Fusarium infection on kernels (FDK3%) and days to maturity (0.136**). Significant correlations were found between Fusarium infection level on kernels (FDK2%) and panicle numbers/m² (0.115*), 1000 kernels weight (0.108*) and days to maturity (-0.106*).
**Table 2.** Correlation coefficients (SPSS Statistics 20) between the incidence of *Fusarium* spp. and morpho-physiological traits in the *Avena* accessions tested by artificial inoculation

<table>
<thead>
<tr>
<th>Estimators</th>
<th><em>Fusarium</em> infection level on panicle (FHB %)</th>
<th>Significance of Pearson correlation coefficient</th>
<th><em>Fusarium</em> infection level on kernels (FDK 3 %)</th>
<th>Significance of Pearson correlation coefficient</th>
<th><em>Fusarium</em> infection level on kernels (FDK 2 %)</th>
<th>Significance of Pearson correlation coefficient</th>
</tr>
</thead>
<tbody>
<tr>
<td>Days to earing</td>
<td>-0.075</td>
<td>-0.116</td>
<td>*</td>
<td>-0.076</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panicle length (cm)</td>
<td>-0.092</td>
<td>-0.099</td>
<td>*</td>
<td>-0.021</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Panicle numbers/ m²</td>
<td>-0.027</td>
<td>-0.052</td>
<td>0.115</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Weight of one thousand grains (g)</td>
<td>0.169</td>
<td>**</td>
<td>-0.012</td>
<td>0.108</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Days to maturity</td>
<td>-0.160</td>
<td>oo</td>
<td>0.136</td>
<td>**</td>
<td>-0.106</td>
<td>O</td>
</tr>
</tbody>
</table>

(Pearson correlation coefficient significance * for p<0.05; ** for p<0.01)

In Figures 2 and 3, the regression lines reveal the distinctly significant negative correlations between *Fusarium* infection level on panicles (FHB%), respectively the *Fusarium* infection level on kernels (FDK 3) and days to maturity, the attack degree being lower in oat cultivars with a longer vegetation period.

![Figure 2](image1.png)  
**Figure 2.** Relationships between days to maturity and *Fusarium* infection level on panicles

![Figure 3](image2.png)  
**Figure 3.** Relationships between days to maturity and *Fusarium* infection level on kernels (FDK3%)

In Figure 4, the regression line reveals a distinctly significant positive correlation between panicles infection and 1000 kernel weight, the panicle infection being more pronounced when the 1000 kernel weight is higher.

![Figure 4](image3.png)  
**Figure 4.** Relationships between 1000 kernel weight and *Fusarium* infection level on panicle
CONCLUSIONS

As a result of artificial inoculation tests with mixture of *Fusarium* spp. on *Avena* accessions belonging to different biological categories, specific symptoms appeared on panicles and kernels.

The biological material of *Avena* (wild and cultivated species) showed a low variability, concerning the days to heading and days to maturity, and high variability of the yields traits (panicle length, number of panicles/m² and 1000 kernel weight).

Artificial inoculation with *Fusarium* spp. revealed a high variability of attack intensity to *Avena* accessions, showing coefficients of variation between 31.48 and 131.8%.

Infection on grains showed a leptokurtic distribution of the values, the probability of existence of resistance sources being in the cultivars of both classes of infections with a large interval of data dispersion towards the end of the variation curve.

Among the evaluated agronomic characters, there were significantly negative correlations between *Fusarium* infection on panicles and kernels and days to maturity, and positive significant correlation between *Fusarium* infection on panicle and 1000 kernel weight, these traits having an important role in the manifestation on panicle and grain infection.

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REFERENCES


