

ASSESSING OF GENETIC VARIABILITY OF *Avena* ACCESSIONS ARTIFICIALLY INOCULATED WITH *Fusarium* spp.

Domnica Daniela Plăcintă¹, Danela Murariu^{1*}, Cătălin Enea²

¹Suceava Genebank, 1 Mai Blvd., no. 17, 720224 Suceava, Suceava County, Romania

²Agricultural and Research Development Station of Suceava, 1 Decembrie 1918 Blvd., no. 15,
720237 Suceava, Suceava County, Romania

*Corresponding author. E-mail: dmurariu@suceava.astral.ro

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

The biological material chosen for experiment is represented by 330 accessions of *Avena* ssp. (288 - *A. sativa*, 8 - *A. byzantina*, 15 - *A. strigosa*, 2 - *A. abyssinica* and 17 wild species).

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* (foto 1 a, b, c, d, e).

Panicles infection level with *Fusarium* spp. 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 (\bar{X}), variation amplitude (X_{max} , X_{min}), variance (S^2), variation coefficient (S%), Kurtosis coefficient (K%) and Pearson correlation coefficients ($r\%$).



Foto 1. Macroconidia of: *Fusarium graminearum* (a), *Fusarium culmorum* (b), *Fusarium avenacea* (c), *Fusarium sporotrichioides* (d), microconidia of *Fusarium langsethiae* (e)

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

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

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.

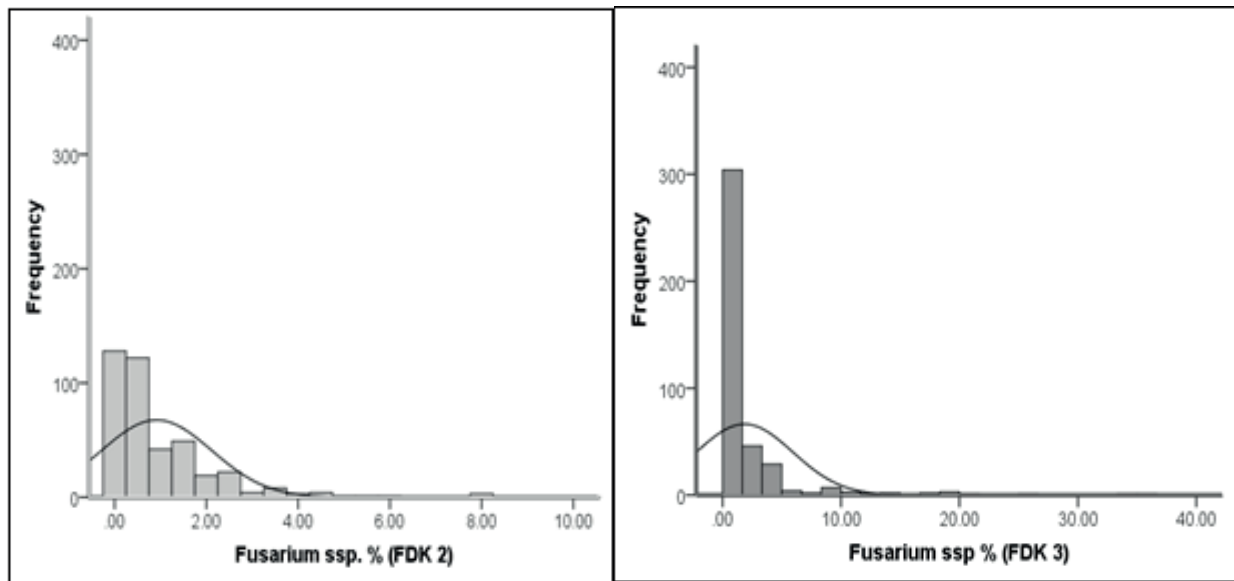


Figure 1. Histograms (SPSS Statistics 20) on the dispersion of *Fusarium* spp. fungus on infection classes 2 and 3, in the tested *Avena* accessions

Significant correlation coefficients were found between *Fusarium* spp. infection on panicles (FHB) or on seeds (FDK 2, FDK 3) 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 (-0.160⁰⁰). Also, there

was a distinctly significant correlation between *Fusarium* infection on kernels (FDK 3%) and days to maturity (0.136^{**}). Significant correlations were found between *Fusarium* infection level on kernels (FDK 2%) and panicle numbers/m² (0.115^{*}), 1000 kernels weight (0.108^{*}) and days to maturity (-0.106⁰).

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

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

(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.

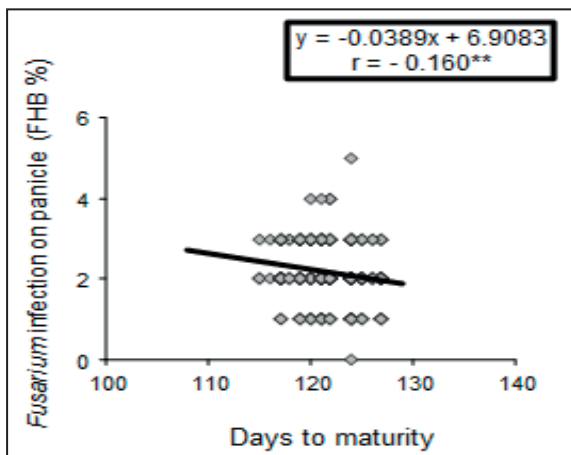


Figure 2. Relationships between days to maturity and *Fusarium* infection level on panicles

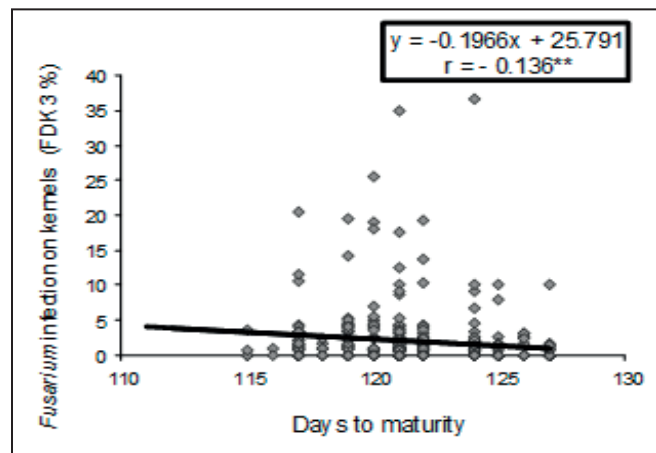


Figure 3. Relationships between days to maturity and *Fusarium* infection level on kernels (FDK 3%)

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.

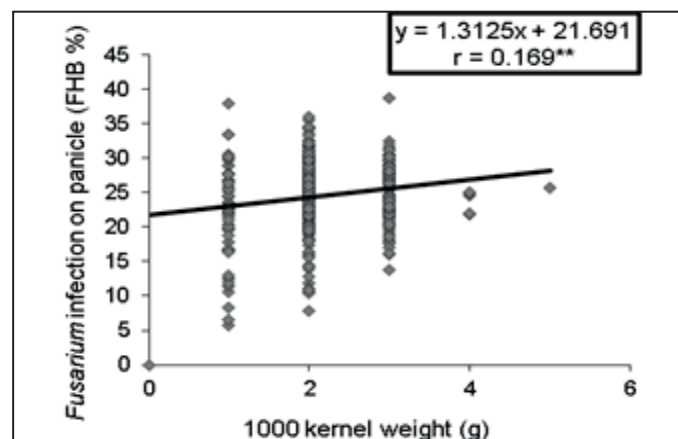


Figure 4. Relationships between 1000 kernel weight and *Fusarium* infection level on panicle

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.

Infestation with *Fusarium* fungus was different 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.

REFERENCES

- Bottalico, A., Perrone, G., 2002. *Toxigenic Fusarium species and mycotoxins associated with head blight in small-grain cereals in Europe*. European Journal of Plant Pathology, 108: 611-624.
- Doohan, F.M., Brennan, J. and Cooke, B.M., 2003. *Influence of climatic factors on Fusarium species pathogenic to cereals*. Eur. J. Plant Pathology, 109: 755-768.
- Langevin, F., Eudes, F., Comeau, A., 2004. *Effect of trichothecenes produced by Fusarium graminearum during Fusarium head blight development in six cereal species*. European Journal of Plant Pathology. ISSN 0929-1873.
- Llorens, A., Hinojo, M.J., Mateo, R., Medina, A., Valle-Algarra, F.M., Gonzales-Jaen, M.T., Jimenez, M., 2006. *Variability and characterization of mycotoxin-producing Fusarium sp. isolates by PCR-RFLP analysis of the IGS-Rdna region*. Antonie van Leeuwenhoek, 89: 465-478.
- Tekauz, A., Fetch, J.M., Rossnagel, B.G., 2005. *Fusarium Head Blight of Oat: Occurrence, Cultivar Responses and Research Update*. Proceedings 4th Canadian Workshop on Fusarium Head Blight, Ottawa, Canada, November 1-3: 22-23.