THE OCCURRENCE OF *Fusarium poae* (Peck) Wollenw. ON OAT (*Avena sativa* L.) PANICLES AND ITS HARMFULNESS

[1]Irena Kiecana, [1]Małgorzata Cegiełko, [1]Elżbieta Mielniczuk, [2]Juliusz Perkowski

[1] Department of Phytopathology and Mycology, University of Life Sciences in Lublin,
ul. Leszczyńskiego 7, 20-069 Lublin, Poland
[2] Department of Chemistry, University of Life Sciences in Poznań
e-mail: irena.kiecana@up.lublin.pl

Abstract

Field observations of oat panicles carried out in the fields of Danko Plant Breeding Company in the period 2006–2007 and in the fields of Strzelce Plant Breeding Company in 2008 showed the occurrence of panicles with *Fusarium* head blight symptoms in each growing season. In 2006 the percentage of such panicles ranged from 0.25 to 1.5%, in 2007 from 2.0 to 9.0%, whereas in 2008 from 0.5 to 8.0%. The species *Fusarium poae* was the main causal agent of *Fusarium* head blight. A study on inoculation of panicles of 12 genotypes of oats with *Fusarium poae* strain no. 35, which was conducted in 2008 in experimental fields near the city of Zamość, determined the number of kernels per panicle, grain yield from 40 panicles (4×10 panicles), and 1000-kernels weight (TKW) after the harvest of the crop at full grain maturity. Compared to the control, the lowest reduction in the number of kernels per panicle was found in the case of the cultivar 'Krezus' (88.69% of the control), while the highest one in 'Szakal' (22.46% of the control). As a result of inoculation of panicles with *F. poae*, the breeding line STH 8107 was characterized by the lowest decrease in kernels yield (69.76% of the control), whereas the highest decrease was found in the breeding line CHD 1430/02 (14.26% of the control). Compared to the control, the lowest reduction in TKW was observed in the breeding line STH 8107 (96.46% of the control), whereas the highest one in the breeding line CHD 1430/02 (45.06% of the control). The presence of secondary metabolites of *F. poae* and group A trichothecene compounds: HT-2 toxins (from 0 to 0.013 mg × kg^{-1}), diacetoxyscirpenol (DAS) (from 0 to 0.002 mg × kg^{-1}), T-2 tetraol (from 0.001 to 0.014 mg x g^{-1}), and scirpentriol (from 0.008 to 0.074 mg × kg^{-1}), was found in infected oat kernels. Group B trichothecenes: nivalenol (from 0 to 0.157 mg × g^{-1}), deoxynivalenol (DON) (from 0 to 0.127 mg × kg^{-1}) as well as its acetylated derivatives: 3-AcDON (from 0 to 0.059 mg × kg^{-1}) and 15-Ac DON (from 0 to 0.288 mg × kg^{-1}), were also present in oat kernels obtained from panicles artificially infected with *Fusarium poae*.

Key words: oats, genotypes, *Fusarium poae*, *Fusarium* head blight, trichothecene compounds

INTRODUCTION

The first reports on the occurrence of *Fusarium* head blight in oats come from the 1920's and they relate to crops in the state of Indiana in the United States of America, but the authors did not mention the species responsible for this disease (M a i n s et al. 1929, according to P a r r y et al. 1995). At the beginning of the 20th century, *Fusarium graminearum* Schwabe was considered to be the main cause of *Fusarium* head blight in oats in Wales (M o o r e , 1929, according to P a r r y et al. 1995). *Fusarium poae* (Peck) Wollenw. proved to be the main cause of this disease in oats grown in the state of Manitoba (Canada) in the years 1993 and 1994, whereas in 2002 and 2003 it ranked second, after *F. graminearum*, as the casual agent of *Fusarium* head blight in oats grown in this region (T e k a u z et al. 2004; D e s j a r d i n s , 2006). In Denmark in the period 2003–2007, *Fusarium poae* belonged to the species that were dominant in causing *Fusarium* head blight in oats, alongside with *F. langsethiae* sp. nov. Torp and Nirenberg as well as *F. avenaceum* (Fr.) Sacc. (N i e l s e n et al. 2010).

Under the conditions of south-eastern Poland, *F. poae* ranked second in importance, after *Fusarium avenaceum*, in causing *Fusarium* head blight in oats grown in this region in the period 1996–1998 (M i e l - n i c z u k , 2001), while in 2000 it proved to be the dominant fungus among *Fusarium* species in infected panicles (K i e c a n a et al. 2005).

Grain (M i e l n i c z u k et al. 2010) and post-harvest residues (M c M u l l e n and S t a c k , 1983) are the primary source of inoculum of fungi causing *Fusarium* head blight in cereals. Weeds can be an important source of inoculum of *Fusarium* spp. (F a r r et al. 1989, according to S h a n e r , 2003).

In oat grain infected by *Fusarium poae*, the occurrence of the following trichothecene compounds has been found: nivalenol (NIV), deoxynivalenol (DON), diacetoxyscirpenol (DAS), monoacetoxyscirpenol (MAS), scirpentriol (STO), fusarenon-X (FUS-X), T-2 toxins, HT-2 toxins, and neosolaniol (NEO) (L a n g s e t h et al. 1997; K i e c a n a and P e r k o w s k i, 1998; K i e c a n a et al. 2005; P a r i k k a et al. 2010). Moreover, *F. poae* can produce metabolites such as: beauvericin, butenolide, culmorin, cyclonerodiol, enniatins, and fusarin C (F a b e r and A n d e r s, 1986a; T h r a n e, 1989; 2001; D e N i j s et al. 1996; L o g r i e c o et al. 1998b; 2002a, according to D e s j a r d i n s, 2006).

Due to an increase in the percentage of *Fusarium poae* in the species composition of fungi colonizing cereal grain, a study was undertaken to determine the contribution of *F. poae* to infection of panicles of oats grown in two Polish regions and to assess the harmfulness of the above-mentioned species to some genotypes of this cereal.

MATERIALS AND METHODS

Field observations of *Fusarium* head blight in oats *Avena sativa* L. were carried out in the period 2006–2007. In the years 2006 and 2007, the study was conducted in the fields of Danko Plant Breeding Company (located in Wielkopolska Voivodeship (region)) where the genotypes were grown on podzolic soil, while in 2008 it was carried out in the fields of Strzelce Plant Breeding Company (located in Łódź Voivodeship) with typical brown soil. A list of cultivars and breeding lines is shown in Fig. 1. Each year, the occurrence of *Fusarium* head blight was studied at full grain maturity (92 in the Zadoks scale according to Tottman, 1987). The study material consisted of 100 successive panicles collected from four places of the field, that is, a total of 400 panicles of each genotype were examined, among which the number of panicles with *Fusarium* head blight symptoms was determined. 20 panicles from each cultivar and breeding line were sampled for laboratory analysis. In the laboratory, kernels and chaff were separated from the sampled panicles in order to isolate fungi by the method described earlier by K i e c a n a and M i e l n i c z u k (2010) and using mineral medium (M i e l n i c z u k et al. 2010). 50 kernels and 50 chaff (chaff) from the panicles collected from a single study area were analysed.

Fungi of the genus *Fusarium* were identified using the keys and monographs referenced in the paper by K i e c a n a and M i e l n i c z u k (2010).

A strictly controlled experiment with panicle inoculation was conducted in 2008 in experimental fields near the city of Zamość on leached brown soil derived from loess deposits. The study included 12 genotypes of oats (Table 2) and *Fusarium poae* strain no. 35, with its pathogenicity proved by the method of M i s h r a and B e h r (1976). The harmfulness of *F. poae* to panicles of 12 genotypes of oats was determined on the basis of a field experiment with artificial inoculation of panicles with *F. poae* no. 35 during flowering. Infectious material was prepared following M e s t e r h á z y (1978), but with a modification since the fungus was cultured on SNA medium based on a decoction of oat leaves (K i e c a n a et al. 2002). The method of inoculation of panicles in field was the same as in the case of barley (K i e c a n a, 1994). The infectious material consisted of a suspension of coinidia of *F. poae* no. 35 with a density of $5 \times 10^5 \times 1ml^{-1}$. Plants whose panicles were inoculated and control plants were grown in 10 m^2 plots. There were 1 m wide buffer strips and 50 cm wide paths between the plots. Panicles were inoculated at the flowering stage, which was between 27 June and 2 July 2008. 80 panicles of each genotype were inoculated with the infectious fungal material and 20 panicles were considered to be one replication. Inoculation was performed using a garden sprayer and 4 ml of infectious material per 1 panicle. Panicles sprayed only with sterile distilled water were the control. After inoculation, the panicles were covered with plastic bags and in this way the infectious material was protected against air currents and drying for 48 hours.

At full grain maturity (92 in the Zadoks scale according to T o t t m a n, 1987), inoculated and control panicles were cut off and kernels were separated; subsequently, the number of kernels per panicle was determined in 40 panicles (4×10 panicles) as well as kernels yield obtained from them and 1000 kernels weight. The obtained results were statistically analysed using analysis of variance and Tukey's multiple confidence intervals. Tukey's least significant differences were calculated for a significance level of ≤0.05 (Ż u k, 1989).

In the grain samples obtained from panicles artificially infected with *F. poae*, an analysis of the content of *Fusarium* toxins was performed at the Department of Chemistry of the Poznań University of Life Sciences.

To determine the content of group A and B trichothecenes, the grain samples were extracted with a mixture of acetonitrile/water (82:18, v/v) and subsequently they were purified using columns filled with 5 cm^3 of a mixture of activated carbon (Draco G 60, 100 mesh), celite (Celite 545), and neutral aluminium oxide (70–230 mesh), mixed at a weight ratio of 1:1:1.

Group A trichothecenes were analysed as trifluoroacetylated derivatives, while group B trichothecenes as trimethylsilyl derivatives. The analysis was performed in the selected ion monitoring (SIM) mode. For

group A trichothecenes, these were: STO 456 and 555; T-2 tetraol 455 and 568; T-2 triol 455 and 569; DAS 402 and 374; HT-2 455 and 327; T-2 327 and 401; as well as Mirex 332 and 509. Retention time for these toxins was, respectively: 14.71; 15.18; 18.23; 18.62; 19.54; 21.56; and 21.32 minutes.

To identify group B trichothecenes, SIM analysis was also performed. These were: for DON ions 103 and 512; 3-AcDON 117 and 482; 15-AcDON 193 and 482; FUS 103 and 570; NIV 191 and 600. Retention time for these toxins was, respectively: 19.53; 20.88; 21.07; 21.01; and 21.25 minutes.

To confirm the presence of the identified toxins in the sample, a full mass range (from 100 to 700 amu) analysis was performed which produced a mass spectrum that was compared to the reference spectrum obtained in the same way. This spectrum, together with a comparison of retention times of the compound in question with the reference standard, is the basis for the identification of toxins. In addition to the qualitative analysis, the concentrations of the examined toxins were determined by comparing the relative heights of selected ions. The obtained results were processed using Chem Station software and the quantitative content of toxins in the oat samples assayed was determined.

Information on weather patterns in the study area was obtained from the Zamość-based Faculty of Agricultural Sciences of the University of Life Sciences in Lublin.

RESULTS

The field observations carried out at full grain maturity in the fields of Danko Plant Breeding Company and Strzelce Plant Breeding Company showed that plants with ears exhibiting *Fusarium* head blight symptoms occurred each year. In 2006 the percentage of panicles with *Fusarium* head blight symptoms ranged from 0.25 to 1.5%, in 2007 from 2.0 to 9.0%, whereas in 2008 from 0.5 to 8.0% (Fig. 1). As a result of mycological analysis of kernels and chaff collected from the panicles with *Fusarium* head blight symptoms, 2383 fungal isolates were isolated (Table 1). Depending on the growing period, colonies of fungi of the genus *Fusarium* isolated from kernels and chaff accounted for, respectively: 24.5% (2006), 48.7% (2007), and 26.0% (2008) of all fungal isolates (Table 1). Fungi of the genus *Fusarium* were represented by *F. avenaceum*, *F. crookwellense*, *F. culmorum*, *F. graminearum*, *F. oxysporum*, *F. poae*, and *F. sporotrichioides* (Table 1; Fig. 2). Isolates of other fungi belonged to the following: *Alternaria alternata, Aspergillus flavus, Bipolaris sorokiniana, Botrytis cinerea, Chaetomium globosum, Cladosporium cladosporioides, Drechslera avenae, Epicoccum nigrum, Gilmaniella humicola,*

Humicola fuscoatra, Mucor hiemalis, Penicillium nigricans, Penicillium verrucosum var. *cyclopium, Periconia macrospinosa, Torula herbarum* as well as to non-sporulating forms. Irrespective of the place of cultivation and year, the species *F. poae* commonly infected grain and chaff in question. In the period 2006–2008, isolates of this species accounted for 29.7% to 52.5% of isolates of all *Fusarium* spp. in the case of kernels and for 15.0% to 34.5% in the case of chaff (Fig. 2).

Inoculation of panicles with *F. poae* strain proved to be effective. The panicles exhibited symptoms of premature whitening of heads. Kernels derived from inoculated panicles were small, light, and soft, while kernels obtained at that time from control panicles were properly developed. Artificial infection of panicles with *F. poae* had a significant effect on reducing the number of kernels per panicle in 10 oat genotypes, compared to the control; 'Chwat' and 'Krezus' were an exception. The lowest reduction in the number of kernels per panicle, compared to the control, was found in the case of 'Krezus' (88.69% of the control), whereas the highest one in 'Szakal' (22.46% of the control) (Table 2). Significant differences in kernels yield, compared to the control, were observed in all genotypes tested; the breeding line STH 8107, in the case of which kernels yield accounted for 69.76% of the control, was characterized by the lowest decrease in grain yield as a result of inoculation of panicles with *F. poae*, while the highest decrease was recorded in the breeding line CHD 1430/02 – 14.26% of the control (Table 2). The statistical analysis of TKW found that artificial inoculation of panicles with *F. poae* resulted in a significant decrease in 1000 kernels weight in 9 oat genotypes. Compared to the control, the lowest reduction in TKW was found in the case of the breeding line STH 8107 (96.46% of the control) and the highest one in the breeding line CHD 1430/02 (45.06% of the control) (Table 2).

The analysis of secondary metabolites of *F. poae* showed the presence of group A trichothecene compounds: HT-2 toxins, diacetoxyscirpenol (DAS), T-2 tetraol, and scirpentriol, in infected oat kernels. The content of HT-2 toxin was from 0.01 mg × kg^{-1} for the breeding line CHD 1430/02 to 0.013 mg × kg^{-1} for 'Koneser'. In the case of the breeding line CHD 1375/00, this metabolite was not found to occur. The presence of diacetoxyscirpenol was found in 11 grain samples assayed, except for the cultivar 'Chwat'. The contamination of oat grain with the above-mentioned metabolite was from 0.001 mg × kg^{-1} for 'Krezus', 'Szakal', 'Zuch', CHD 1375/00, CHD 1430/02, and STH 8307 to 0.002 mg × kg^{-1} in the case of the genotypes 'Haker', 'Koneser', 'Polar', 'Sławko', and STH 8107. The content of T-2 tetraol in the grain samples assayed ranged

between 0.001 mg × kg⁻¹ (CHD 1375/00, STH 8107) and 0.014 mg × kg⁻¹ ('Haker', 'Koneser'). The concentration of scirpentriol in grain of the tested genotypes of oats was from 0.008 mg × kg⁻¹ (STH 8107) to 0.074 mg × kg⁻¹ ('Haker') (Table 3).

The presence of group B trichothecenes – nivalenol, deoxynivalenol and its acetylated derivatives (3-Ac DON, 15-Ac DON), was also found in grain derived from panicles artificially infected with *Fusarium poae*. The presence of deoxynivalenol (DON) was detected in the case of seven oat genotypes at a level from 0.036 ('Zuch') to 0.127 mg × kg⁻¹ ('Szakal'), while the presence of 15-Ac DON was observed in the case of eight genotypes at a concentration from 0.017 ('Zuch')

to 0.288 (STH 8107). 3-Ac DON was found to be present only in 'Szakal' at a level of 0.059 mg × kg⁻¹. Oat grain contamination with nivalenol was observed in most of the genotypes assayed, except for cv. 'Krezus' and the breeding line STH 8107. The highest amounts of this compound (0.157 mg × kg⁻¹) were found in grain of the breeding line CHD 1430/02 (Table 3).

In Zamość, the 2008 growing season was characterized by temperature higher than the long-term mean in April, May, June, July, and August by +2.2°C up to +3.5°C. The percent of normal rainfall, as compared to the long-term mean, was higher in April, May, July, and August by 11.3% up to 91.7%, whereas in June 2008 it was 64.8% of normal rainfall (Table 4).

Table 1

Fungi isolated from oat kernels and chaff in 2006–2008

No.	Fungal species	2006			2007			2008			Total number of isolates
		1	2	3	1	2	3	1	2	3	
1	*Fusarium avenaceum* (Fr.) Sacc.	32	20	52	37	19	56	54	40	94	202
2	*Fusarium crookwellense* Burgess, Nelson & Toussoun	-	-	-	27	11	38	-	-	-	38
3	*Fusarium culmorum* (W. G. Sm.) Sacc.	14	8	22	108	72	180	12	8	20	222
4	*Fusarium graminearum* Schwabe	-	-	-	5	0	5	-	-	-	5
5	*Fusarium oxysporum* Schl.	1	2	3	-	-	-	-	-	-	3
6	*Fusarium poae* (Peck) Wollenw.	63	20	83	81	40	121	67	10	77	281
7	*Fusarium sporotrichioides* Sherb.	10	8	18	15	11	26	3	9	12	56
8	Other colonies	250	299	549	216	233	449	242	336	578	1576
	Total	370	357	727	489	386	875	378	403	781	2383

1– kernels; 2 – chaff; 3 – kernels + chaff

Table 2

Effect of artificial inoculation of oat panicles with *Fusarium poae* on the number of kernels per panicle, kernels yield, and 1000 kernels weight

Oat genotypes	Average number of kernels per panicle		% of the control	Average grain yield per 10 panicles (g)		% of the control	Average 1000 grain weight (TKW) (g)		% of the control
	F. poae	Control		*F. poae*	Control		*F. poae*	Control	
Chwat	60.20	70.13	85.84	17.10*	29.06	58.84	21.65*	41.38	52.32
Haker	42.83*	107.38	39.89	11.25*	34.89	32.24	26.08*	33.27	78.39
Koneser	58.13*	110.30	52.70	11.25*	35.90	31.34	30.21	32.21	93.79
Krezus	76.83	86.63	88.69	16.10*	28.04	57.42	16.13*	32.57	49.52
Polar	32.23*	61.98	52.00	5.93*	20.52	28.90	29.81	33.15	89.92
Sławko	74.54*	90.13	82.70	20.36*	32.82	62.03	27.34*	36.36	75.19
Szakal	18.65*	83.03	22.46	5.22*	28.66	18.21	28.29*	34.58	81.81
Zuch	38.00*	123.55	30.76	9.20*	35.91	25.62	23.59*	29.06	81.18
CHD 1375/00	29.05*	87.35	33.26	6.76*	33.30	20.30	23.22*	38.18	60.82
CHD 1430/02	27.23*	86.53	31.47	5.43*	38.08	14.26	19.90*	44.16	45.06
STH 8107	48.93*	74.45	65.72	18.32*	26.26	69.76	36.02	37.34	96.46
STH 8307	31.28*	47.85	65.37	7.79*	15.62	49.87	24.84*	32.67	76.03

* Compared to the control, the means differ significantly at P≤ 0.05.

Table 3
Content of mycotoxins (mg × kg⁻¹) in oat grain obtained from panicles artificially inoculated with *F. poae*

Oat genotypes	Type B					Type A		
	DON	3-AcDON	15-AcDON	NIV	STO	T-2 Tetraol	DAS	HT-2
Chwat	0.000	0.000	0.028	0.087	0.029	0.009	0.000	0.007
Haker	0.090	0.000	0.078	0.064	0.074	0.014	0.002	0.006
Koneser	0.000	0.000	0.127	0.111	0.042	0.014	0.002	0.013
Krezus	0.070	0.000	0.277	0.000	0.034	0.005	0.001	0.004
Polar	0.000	0.000	0.171	0.073	0.029	0.006	0.002	0.004
Sławko	0.096	0.000	0.000	0.035	0.026	0.004	0.002	0.002
Szakal	0.127	0.059	0.000	0.035	0.034	0.007	0.001	0.008
Zuch	0.036	0.000	0.017	0.050	0.019	0.003	0.001	0.002
CHD 1375/00	0.000	0.000	0.000	0.019	0.010	0.001	0.001	0.000
CHD 1430/02	0.068	0.000	0.058	0.157	0.052	0.005	0.001	0.001
STH 8107	0.000	0.000	0.288	0.000	0.008	0.001	0.002	0.002
STH 8307	0.067	0.000	0.000	0.019	0.013	0.003	0.001	0.002
Mean	0.0462	0.0049	0.0870	0.0542	0.0308	0.0060	0.0013	0.0043

DON – deoxynivalenol, NIV – nivalenol, STO – scirpentriol, DAS – diacetoxyscirpenol

Table 4
Temperature and rainfall in the Zamość area in the 2008 oat growing season

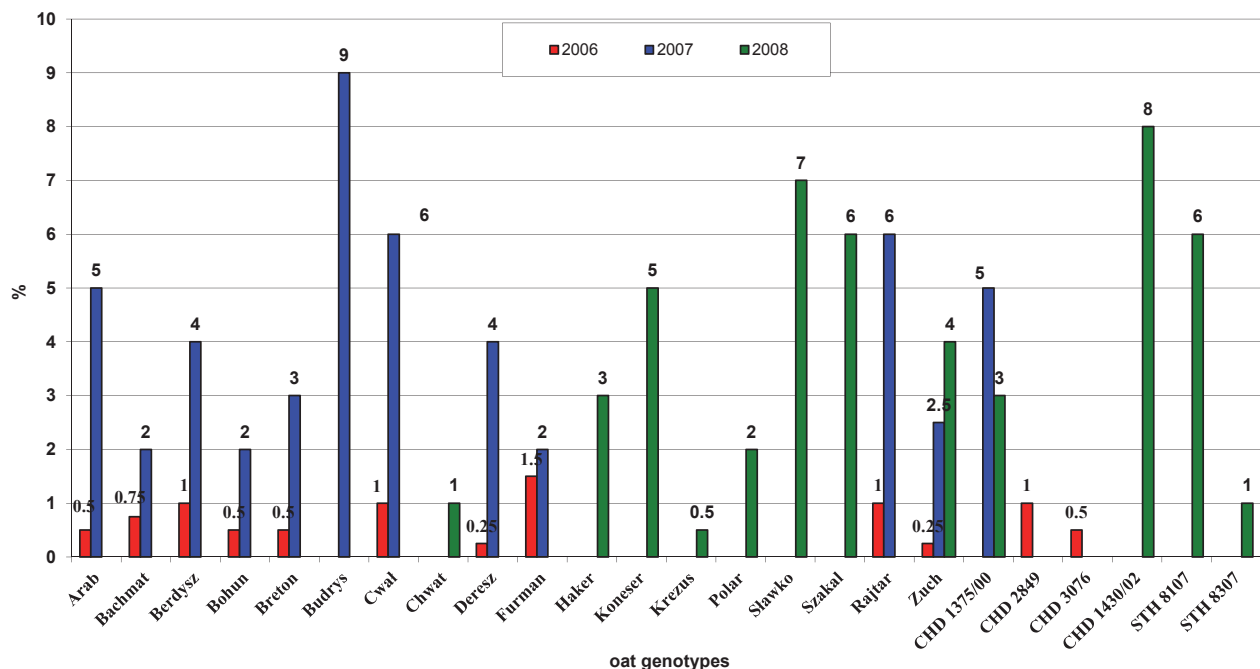| Month	Long-term mean (1951-1975)		Deviations in air temperatures	Percent of normal monthly rainfall
	Air temperature [ºC]	Rainfall [mm]		
April	7.5	37.3	+ 3.2	191.7
May	12.5	67.2	+ 2.5	111.3
June	16.7	75.5	+ 2.7	64.8
July	18.0	82.1	+ 2.2	169.7
August	17.1	72.4	+ 3.5	137.7

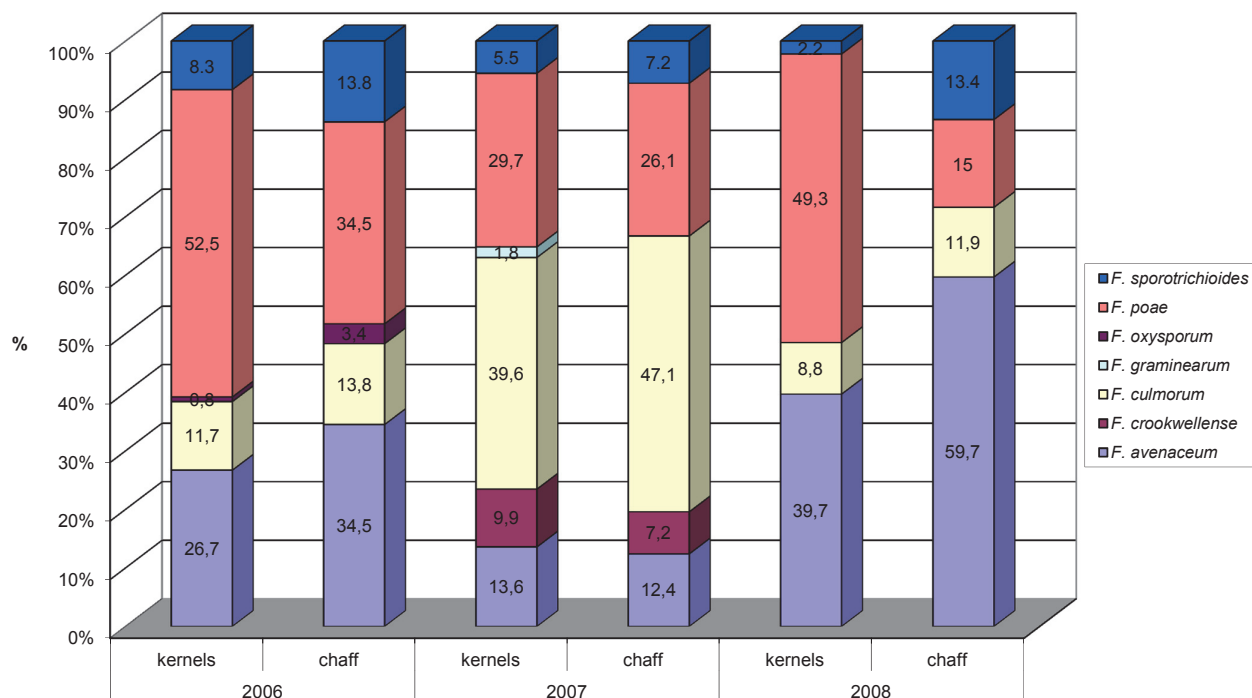Fig. 1. Percentage of oat panicles with *Fusarium* head blight symptoms in 2006–2008.

Fig. 2. Percentages of individual species of the genus *Fusarium* in infection of oat kernels and chaff in oat crops grown in the plots of Danko Plant Breeding Company and Strzelce Plant Breeding Company in 2006–2008.

DISCUSSION

In recent years, increased colonization of *F. poae* have been observed in oat grain (M i e l n i c z u k, 2001; K i e c a n a et al. 2005; Mielniczuk et al. 2010) as well as in wheat, barley, and maize grain under natural infection conditions (L ő i v e k e, 2004; A r s e - n i u k and G ó r a l, 2005; S a d o w s k i et al. 2007; N a r k i e w i c z - J o d k o et al. 2008; C h o o et al. 2010; N i e l s e n et al. 2010). This species has been isolated from maize cobs with symptoms of both pink and red rot (L o g r i e c o et al. 2003; A r s e n i u k and G ó r a l, 2005). The percentage proportion of the species *F. poae* in causing *Fusarium* head blight in cereals and oats as well as ear rot of maize changes depending on weather conditions (K i e c a n a, 1994; M i e l n i - c z u k, 2001; L o g r i e c o et al. 2003; A r s e n i u k and G ó r a l, 2005; K i e c a n a and M i e l n i c z u k, 2010). *Fusarium poae* usually occurs in colder regions (D o o h a n et al. 2003). Nevertheless, this species can be the casual agent of *Fusarium* head blight in cereals grown in regions with a hot and dry climate (X u et al. 2008). According to S a d o w s k i et al. (2007), hot and dry weather during flowering and grain maturation in the period 2001–2002 proved to be beneficial for the growth of *F. poae* in grain of winter wheat grown in the Polish region of Żuławy.

According to P a r r y et al. (1995), optimal temperature for infection of ears by *F. poae* is 25ºC, though they can also be infected at a temperature of 15ºC under the conditions of increased humidity. In the case of the present study, which was carried out under the conditions of a strictly controlled field experiment, temperature in excess of 20ºC and increased humidity after inoculation of oat panicles seemed to be beneficial for the growth of *F. poae* in these organs.

To study different aspects of *Fusarium* head blight, the most effective inoculation methods are selected (T a k e d a and H e t a, 1989; M c C a l l u m and T e k a u z, 2002; M i e l n i c z u k et al. 2004; K i e - c a n a et al. 2006). In the present study, oat panicles were sprayed with a suspension of *F. poae* coinidia, because this method was considered to be the closest to natural infection.

Taking into account the varying virulence of strains within the population of the tested species (M a ń k a, 1989; K i e c a n a and K o c y ł a k, 1999; K i e c a n a et al. 2005), the infectious material was prepared from *F. poae* strain with its pathogenicity proved by the method of M i s h r a and B e h r (1976). The present strictly controlled field experiment demonstrates that artificial inoculation of panicles with *F. poae* strain no. 35 using the method applied proved to be effective, since it had an effect on reducing the number of kernels per panicle and inhibited their growth, but typical etiological signs were not observed on the panicle heads, similarly as in the case of wheat and oat kernels obtained from ears and panicles inoculated with *F. poae* (S c h i p i l o v a and G a k a e v a, 1997; K i e c a n a et al. 2005).

The present study shows that infection of panicles with *F. poae* in 2008 had a similar effect on reducing kernels yield as infection of these organs of oats by *F. culmorum* in the period 1996–1998 (M i e l n i c z u k, 1999).

The results of quantitative and qualitative analysis of mycotoxins in oat grain infected with *F. poae* no. 35 has proved the ability of this species to produce group A and B trichothecene compounds (L a n g s e t h et al. 1999; B o t t a l i c o and P e r r o n e, 2002; L o g r i e c o et al. 2003; D e s j a r d i n s, 2006; S c h o l l e n b e r g e r et al. 2011).

In the present study, the presence of diacetoxyscirpenol (DAS) and HT-2 toxins from group A trichothecenes and nivalenol from type B trichothecenes was found in the case of most of the oat samples assayed. The above-mentioned metabolites are typical of the profile of mycotoxins produced by *F. poae* strains, both under laboratory and field conditions (K i e c a n a and P e r k o w s k i, 1998; B o t t a l i c o and P e r r o n e, 2002; T h r a n e et al. 2004; K i e c a n a et al. 2005; S t e n g l e i n, 2009; S c h o l l e n b e r g e r et al. 2011). The ability of *F. poae* to produce nivalenol has been proved in the colder regions of Japan (in the island of Hokkaido) and in Scandinavian countries (P e t t e r s s o n, 1993; S u g i u r a et al. 1993; L a n g s e t h et al. 1995; P e t t e r s s o n et al. 1995; L i u et al. 1998; Y l i - M a t t i l a et al. 2008). However, in 2008 the level of oat grain contamination with nivalenol was lower than in 2001 (K i e c a n a et al. 2005). According to S t e n g l e i n (2009), A b r a m s o n et al. 1993, S a l l a s et al. 1999, and J e s t o i et al. 2008 inform that *F. poae* may produce DON whose presence was found in the grain of the oat genotypes tested.

M a r a s a s et al. (1984, according to D e s j a r d i n s, 2006) found the ability of *F. poae* strains originating from North America to produce small amounts of DAS and T-2 toxin. *F. poae* strain no. 35 in question did not produce T-2 toxin in oat grain. 15-monoacetoksyscirpenol (15-MAS), neosolaniol (NEO), and fusarenon-X (FUS X), often produced by *F. poae*, also were not found in the grain of the genotypes studied (L i u et al. 1998; L o g r i e c o et al. 2003; T h r a n e et al. 2004). On the other hand, the investigated *F. poae* strain no. 35 produced STO and T-2 tetraol in infected oat grain. The former compound was also detected in kernels obtained from panicles inoculated with *F. poae* strain no. 37 in 2001 (K i e c a n a et al. 2005). The occurrence of T-2 tetraol was found in oat grain harvested from panicles naturally infected by this fungal species in plantations of Lubelskie and Podlaskie Voivodeships (K i e c a n a and P e r k o w s k i, 1998).

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Występowanie *Fusarium poae* (Peck) Wollenw. na wiechach owsa (*Avena sativa* L.) i jego szkodliwość

Streszczenie

Obserwacje polowe wiech owsa przeprowadzone w latach 2006–2007 na polach Hodowli Roślin Danko i w 2008 roku na polach Hodowli Roślin Strzelce, wykazały w każdym sezonie wegetacji występowanie wiech z objawami fuzariozy. W 2006 roku odsetek takich wiech wynosił od 0,25 do 1,5%, w 2007 roku od 2,0 do 9,0%, zaś w 2008 roku od 0,5 do 8,0%. Głównym sprawcą fuzariozy wiech był gatunek *Fusarium poae*. W badaniach ze sztucznym zakażaniem wiech 12 genotypów owsa szczepem nr 35 *Fusarium poae*, przeprowadzonych w 2008 roku na polach doświadczalnych koło Zamościa, po zbiorze roślin w fazie dojrzałości pełnej ziarna określano liczbę ziarniaków w wiesze, plon ziarna z 40 wiech (4 × 10 wiech) oraz masę 1000 ziaren (MTZ). Najmniejszą redukcję liczby ziarniaków w wiesze w porównaniu do kontroli zanotowano w przypadku odmiany Krezus (88,69% kontroli), największą zaś u odmiany Szakal (22,46% kontroli). Najmniejszą obniżką plonu ziarna w wyniku inokulacji wiech przez *F. poae* charakteryzował się ród hodowlany STH 8107 (69,76% kontroli), największą zaś ród hodowlany CHD 1430/02 (14,26% kontroli). Najmniejszą redukcję MTZ w porównaniu do kontroli stwierdzono w przypadku rodu hodowlanego STH 8107 (96,46% kontroli), największą natomiast u rodu hodowlanego CHD 1430/02 (45,06% kontroli). W porażonych ziarniakach owsa stwierdzono obecność drugorzędowych metabolitów wtórnych *F. poae*, związków trichotecenowych z grupy A: HT-2 toksyny (od 0 do 0,013 mg × kg^{-1}), diacetoksyscirpenolu (DAS) (od 0 do 0,002 mg × kg^{-1}), T-2 tetraolu (od 0,001 do 0,014 mg × g^{-1}) i scirpentriolu (od 0,008 do 0,074 mg × kg^{-1}). W ziarnie owsa pochodzącym z wiech sztucznie zakażanych *Fusarium poae* były również obecne trichoteceny z grupy B: niwalenol (od 0 do 0,157 mg × g^{-1}), deoksyniwalenol (DON) (od 0 do 0,127 mg × kg^{-1}) oraz jego acetylowe pochodne 3- AcDON (od 0 do 0,059 mg × kg^{-1}) i 15-Ac DON (od 0 do 0,288 mg × kg^{-1}).