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THE OCCURRENCE OF *FUSARIUM* SPP. ON PANICLES OF OAT (*AVENA SATIVA* L.)

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Abstract. Investigations were carried out in 1996-1998 on experimental plots sown with different oat cultivars and lines. Symptoms of the fusarium panicle blight developed on 0.5-15% of oat plants. Results of this studies showed that fusarium blight of oat panicles is widespraed in Lublin region. *Fusarium avenaceum* and *F. poae* proved to be the cause of the disease. Also *F. culmorum, F. crookwellense, F. equiseti, F. oxysporum, F. sporotrichioides* were isolated from infected panicles.

Key words: *Fusarium avenaceum, F. poae,* fusarium panicle blight, avenacin

I. INTRODUCTION

Oat has been more often used in the human nourishment in recent years, because of the highest amount of dissolvable fiber, especially β-glucan in its kernels, this being necessary for any rational diet (Wood and Veisz 1984). *Fusarium* spp. are pathogens directly affecting oat panicles and kernels (Veisz et al. 1997).

These fungi can infect at various phases of vegetation, but the most dangerous infection takes place in the blooming stage, particularly if temperature is increased (Sutton 1982). Infection in this stage decreases the number of kernels in a panicle, and decreases the weight of 1000 kernels. It also reduces kernel yield due to kernel underdevelopment (Kiecana 1994).

Moreover the consequence of head and panicle fusarium blight is the pollution of kernels with mycotoxins, especially with trichothecene compounds and moniliformin, which are harmful to hematothermal organisms (Perkowski et al. 1997; Goliński et al. 1999). Mycotoxins relocate deeply in kernels and cumulate in aleurone and underaleurone layer of the endosperm. Processing of the affected kernels such as grinding or baking only slightly decreases the content of mycotoxins in a product (Abbas et al. 1985). Particularly dangerous species for oat is *F. avenaceum* producing moniliformin (Goliński et al. 1999). This toxin is harmful to both animals and humans. The compound is phytotoxic, causing leaf necrosis and chlorosis and disorders in cell divisions (Cole et al. 1973; Packa 1997). Since *Fusarium* spp. are highly harmful to cereal heads (Snijders 1990; Kiecana 1994; Goliński et al. 1999) and there are only a few data on the effect of these fungi to oat panicles (Veisz et al. 1997; Kiecana 1998), there has been a need to conduct the presented research.

II. MATERIAL AND METHODS

The studies were carried out in 1996-1998 in the Experimental Station of Cultivars Evaluation in Uhnin situated on a podzolic silty soil on light loan, on plots sown with different oat cultivars and lines (Bajka, Borowiak, Boryna, Borys, Farys, German, Komes, Kwant, Santor, Skrzat, Sławko, CHD 894, CHD 1095, CHD 1236, CHD 1396, STH 2393, STH 2795, STH 3096, STH 3196, STH 3296, STH 3497, POB 3395, POB 3696, POB 3896). Every year each cultivar and line was grown on four 10 m^2 plots, with potatoes as a forecrop.

Disease symptoms were recorded in full maturity stage of oat (92 in the Tottman scale (1987)). Among 400 tested panicles of each genotype, the panicles with fusarium blight symptoms where counted and their percentage in the examined sample was estimated. Twenty of such panicles of each cultivar and line were collected for the laboratory analysis. In the laboratory, the cause of infection was first determined on the basis of results of microscopic examination of *Fusarium* spp. sporulation found on chaffs. Chaffs and kernels were subjected to mycological analysis performed according to the method described by Łacicowa (1964; 1970). One hundred chaffs and kernels were examined of each oat genotype. Fungi belonging to *Fusarium* genus were identified using monographs by Nelson et al. (1983) and Burgess at al. (1988).

The weather data were obtained from Meteorogical Station in Uhnin and from Department of Agrometeorology, Agricultural University of Lublin.

III. RESULTS

Results of the research conducted in full maturity stage of oat revealed the occurrence of plants with symptoms of fusarium blight on panicles. The infected panicles differed in pre-mature bleaching and salmon-pink coating composed of mycelium and *Fusarium* spp. sporulation located on chaffs of one to three spikelets in a panicle. Majority of infected kernels had the same size as not infected ones, but they were gray, lighter and of softer consistency.

In 1996 percentage of panicles with disease symptoms fluctuated from 0.5% (Farys) to 3% (Boryna, Borys, Komes). In 1997 this percentage ranged from 3.5% for CHD 1095 line to 15% for German cultivar and CHD 1236 line, and in 1998 from 1% (Bajka, Borowiak, CHD 1095, POB 3696) to 4% (CHD 1236).

On the basis of microscopic examination, it was proved that each year *F. avenaceum* very often occurred on tested panicles. *Fusarium culmorum* and *F. sporotrichioides* were also noticed every year, but appeared only sporadically.

The mycological analysis of chaffs and kernels yelded 3,731 (Tab.), isolates belonging to 23 species and mycelia sterylia.

Fusarium spp. constituted 25.2% of all fungal isolates from kernels and 18.5% from chaffs. They were more often isolated from kernels than from chaffs. Depending on the year of investigation *Fusarium* spp. amounted to 19.1% (1996), 47.2% (1997) and 14.1% (1998)

Table 1

Fungi isolated from kernels and chaffs of oat in 1996-1998

Fungus species	Number of isolates											
	1996			1997			1998			1996-1998		
	1	2	total	1	2	total	1	2	total	1	2	all together
Alternaria alternata (Fr.) Keissler	479	129	608	181	55	236	526	93	619	1,186	277	1,463
Bipolaris sorokiniana (Sacc.) Shoem.	0	0	0	57	14	67	2	38	40	55	52	107
Epicoccum purpurascens Ehrenberg	404	79	483	160	12	172	329	27	356	893	118	1,011
Fusarium avenaceum (Fr.) Sacc.	100	15	115	323	34	357	113	21	134	536	70	606
Fusarium crookwellense Burgess, Nelson, Toussoun	4	0	4	3	0	3	9	0	9	16	0	16
Fusarium culmorum (W.G.Sm.) Sacc.	0	0	0	21	0	21	11	0	11	32	0	32
Fusarium equiseti (Corda) Sacc.	0	0	0	1	0	1	0	0	0	1	0	1
Fusarium oxysporum Schlecht	11	0	11	0	0	0	0	0	0	11	0	11
Fusarium poae (Peck.) Wr.	88	40	128	5	2	7	20	3	23	113	45	158
Fusarium sporotrichioides Sherb.	9	11	20	51	0	51	2	0	2	62	11	73
Other colonies	7	39	46	9	11	20	69	4	73	85	54	139
Mycelia sterylia	0	30	30	40	13	53	19	12	31	59	55	114
Total	1,102	343	1,445	847	141	988	1,100	198	1,298	3,049	682	3,731

1 – isolates obtained from kernels
2 – isolates obtained from chaffs

of all isolates from kernels and 19.2% (1996), 25.5 (1997) and 12% (1998) of isolates from chaffs (Tab.).

Fusarium spp. were represented by *F. avenaceum*, *F. crookwellense*, *F. culmorum*, *F. equiseti*, *F. oxysporum*, *F. poae* and *F. sporotrichioides* (Tab.).

In each vegetation season *F. avenaceum* predominant among *Fusarium* spp. obtained from kernels. Isolates of this species constituted 47.2% in 1996, whereas in 1997 and 1998, they amounted to 80% and 72%, respectively (Tab.).

In the case of chaffs, *F. avenaceum* dominated in 1997 and 1998 and its isolates constituted 95% and 87%, respectively (Tab.).

In 1996, 1997 and 1998 *F. poae* was isolated both from kernels and chaffs. Percentage of these isolates amounted to 41.5%, 1.6% and 13% of total number of *Fusarium* spp. isolates from kernels and 60.6%, 5.5%, and 13% from chaffs, respectively (Tab.).

The *F. sporotrichioides* occurred on tested kernels every year and in 1996 also on chaffs, but in 1997 the percentage of this species was the highest (12.5%). In 1996 and 1998 the percentage of *F. sporotrichioides* isolates obtained from kernels amounted only to 4.2% and 1.0%, respectively (Tab.).

In 1997 and 1998 *F. culmorum* was isolated only from kernels, the isolates constituted 5.0% and 7.0% of all *Fusarium* spp. isolates (Tab.).

Fusarium crookwellense was obtained from kernels every year. Its isolates amounted to 0.7 – 6.0% of all *Fusarium* spp. isolates (Tab.).

Other *Fusarium* spp. were sporadically obtained.

Among isolated saprophytic fungi many isolates of *Alternaria alternata* and *Epicoccum purpurascens* were obtained each year in considerable numbers from chaffs and kernels. These isolates amounted to 40.6% and 17.3% of all isolates received from chaffs and 38.8% and 29.2% from kernels, respectively (Tab.).

Bipolaris sorokiniana was isolated only in 1997 and 1998 from kernels and chaffs (Tab.).

Other fungi were represented only by a few isolates.

IV. DISCUSSION

Results of isolations from panicles of various cultivars and lines of oat with symptoms of fusarium blight indicate the harmfulness of the disease. The percentage of infected panicles amounted to 0.5-15. Investigations conducted hitherto in south-eastern Poland showed that wheat heads were infected by *Fusarium* spp. more frequetly than oat panicles (Łacicowa et al. 1987) but barley and triticale heads – less frequently (Kiecana 1988; 1994).

Literature reports indicate, that fusarium blight of oat panicles, just as of other cereal heads is caused by: *F. avenaceum*, *F. poae*, *F. sporotrichioides* and *F. culmorum* (Kiecana 1994; Łacicowa et al. 1987; Michuta-Grimm and Forster 1989). *Fusarium avenaceum* was a prerdominating species infecting oat panicles, as it was also stated for the wheat heads in Canada (Clear and Patrick 1990).

A common occurrence of *F. avenaceum* on oat panicles can be explained by its high tolerance to temperature and humidity (Duben and Fehrman 1979; Kiecana 1994).

According to the previous tests, *F. avenaceum* was one of the most important pathogens of oat seedlings, roots and stem base in Lublin region (Kiecana 1998; Kiecana and Kocyłak 1999). On the contrary to other *Fusarium*, this species shows the ability to hydrolyze fungitoxic saponins including avenacin, in oat roots. *Fusarium avenaceum* can decompose molecules of active avenacin, but only if the ratio of avenacin concentration to fungus mass is in a low enough concentration. (Lüning et al. 1978). According to Lüning and co-authors (1978) the proportion of 500 μg/ml avenacin concentration to 2 g of *F. avenaceum* mycelium dry mass does not stop the fungus development. Increasing avenacin concentration above 500 μg/ml affects the cell membranes permeability and limits the fungus development. It may be assumed that tested cultivars produced only such amounts of avenacin, which could be easily hydrolyzed by *F. avenaceum.*

It enabled the fungus to infect oat roots and stem base. Under favourable conditions, *F. avenaceum* abundantly produced spores on infected organs, this could be a natural source of spikelet infection. Those suggestions are based on the previous research done by Kiecana (1998), which revealed a frequent appearance of discussed species on oat roots and stem base, and on investigations of performed by Duben and Fehrman (1980), indicating the correlation between *F. avenaceum* appearance on the stem base and the frequency of wheat kernels infection.

The results have confirmed that warm weather with showers is conducive to *F. culmorum* infection of heads (Kiecana 1988; 1994). Such weather conditions occurred in 1997 and 1998 during flowering, and in those vegetation seasons *F. culmorum* was found on analysed panicles. Among *Fusarium* spp., *F. culmorum* is regarded as the most important cause of fusarium head blight of cereals cultivated in different regions, regardless of climate conditions (Mesterházy 1978; Michuta-Grimm and Froster 1989; Wakuliński and Chełkowski 1993; Kiecana 1994). Although there are strains of variable virulence within *F. culmorum*, populations of all of them have the ability to infect cereals (Gang et al. 1998).

Fusarium poae was frequently obtained from infected oat panicles and this species occurred often also on the oat kernels received from panicles with fusarium blight symptoms in Lublin region in 1994-1996 (Kiecana and Perkowski 1998) and panicles in Norway (Langseth et al. 1995). Earielr this species was also obtained from kernels of oat (Łacicowa 1967; Clear et al. 1996), wheat (Clear and Patrik 1990), triticale (Kiecana 1988), barley (Kiecana 1994; Clear et al. 1996) and corn (Chełkowski et al. 1994). According to Łacicowa (1963) *F. poae* does not influence the change of shape nor development of wheat kernels and their sprouting. This species colonizes cereal heads, before *F. culmorum* and *F. graminearum* (Mills 1989).

Fusarium poae is capable of synthesize toxic trichthecenes from A group in infected kernels, especially diacetoxyscirpenol (DAS) and monoacetoxyscirpenol (MAS) (Perkowski et al. 1997; Kiecana and Perkowski 1998). Pettersson (1991) reported the ability to produce nivalenol by *F. poae.*

In each research year, *F. sporotrichioides* isolates were obtained from analysed kernels from panicles with symptoms of fusarium blight. This species was formerly observed on oat kernels (Kiecana and Perkowski 1998). *Fusarium sporotrichioide*s was found to be less pathogenic to oat seedlings than *F. culmorum* and *F. avenaceum* (Kiecana and Kocyłak

1999). According to the investigations of Wakuliński and Chełkowski (1993) only few *F. sporotrichioides* isolates were phytotoxic to wheat seedlings and were producing remarkable amount of mycotoxin from A group (T-2 and HT-2 toxin).

Fusarium crookwellense was also isolated from the examined panicles. This species is the fourth most important cause of fusarium head blight in Canada after *F. graminearum*, *F. culmorum* and *F. avenaceum* (Miller 1994 in Clear et al. 1996). Wakuliński and Chełkowski (1993) reported *F. crookwellense* presence on cereal kernels in Poland, and Pettersson noticed it in Sweden (1991).

Bipolaris sorokiniana has been quite often obtained from oat panicles being affected with *Fusarium* spp., it indicates the possibility of common infection. In such cases *B. sorokiniana* is a primary colonizer of other cereals (Eng Chong Pua, Pelletier 1985; Kiecana 1994). Łacicowa noticed *B. sorokiniana* appearance on oat kernels (1967).

I the case of other cereals, *Alternaria alternata* has been also isolated from oat kernels and chaffs. The above fungus can reduce kernel quality, particularly under high humidity conditions (Dickson 1949). The following toxins were stated in cereal kernels infected by *Alternaria alternata*: tenauzonic acid, alternariol and alter-toxin I (Grabarkiewicz – Szczęsna et al. 1990).

Epicoccum purpurascens, which was often obtained from kernels and chaffs, has been recognized in India as the cause of sheath spot of wheat (Goel and Glupta in Ting and Reedler 1991).

V. CONCLUSION

1. On the basis of field observations of plants growing in the cultivation with natural conditions, as well as on microscopic and mycological analysis of infected chaffs and kernels, it was stated that, *F. avenaceum* and *F. poae* constitute the significant reason for causing the oat fusarium head blight.
2. Appearance of those two species in oat cultivation in each research year, confirms their high tolerance for temperature and humidity.
3. Distinctive domination of *F. avenaceum* among other fungi of *Fusarium* spp. isolated from panicles with fusarium blight, shall be a consequence of this fungus ability to hydrolize the fungitoxic avenacin being present in oat roots.

VI. REFERENCES

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WYSTĘPOWANIE *FUSARIUM* SPP. NA WIECHACH OWSA (*AVENA SATIVA* L.)

STRESZCZENIE

Badania nad występowaniem fuzariozy wiech owsa prowadzono w latach 1996-1998 w regionie Lubelskim. Procent roślin z objawami chorobowymi wahał się od 0,5-15.

Obserwacje polowe roślin wzrastających w naturalnych warunkach uprawy oraz wyniki analizy mikologicznej plew i ziarniaków wskazują, że znaczny udział w powodowaniu fuzariozy wiech owsa mają *F. avenaceum* i *F. poae*.

Występowanie w każdym roku badań obydwu gatunków w uprawach owsa potwierdza dużą tolerancję tych grzybów na temperaturę i wilgotność.

Spośród innych *Fusarium* spp., z porażonych wiech otrzymywano także *F. culmorum*, *F. crookwellense*, *F. equiseti*, *F. oxysporum* i *F. sporotrichioides*.