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Fungi communities colonizing the stem base of winter wheat

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In the present study species which colonize the stem base of winter wheat and cause different types of diseases were analyzed. It was demonstrated that *Fusarium avenaceum*, *F. culmorum*, *Pseudocercosporella herpotrichoides* and *Rhizoctonia cerealis* were most often isolated from the stem base of winter wheat. It was not always possible to determine the pathogen which was responsible for the specific disease symptoms.

Key words: *Fusarium*, *Pseudocercosporella herpotrichoides*, *Rhizoctonia cerealis*, stem base, wheat.

INTRODUCTION

The symptoms of stem base diseases intensify with the size of cereal crops and environmental factors that favour the development of pathogens (W o j c i e c h o w s k a-K o t et al. 1989). However, the particular fungi causing root rot disease are characterized by different requirements for soil-climatic conditions and growth dynamics. Depending on the external conditions and ability to compete with each other different groups of pathogens may dominate (Ł a c i c o w a et al. 1985).

In the recent years, *Pseudocercosporella herpotrichoides* Fron. has been reported to occur frequently in Poland (P i e l k a 1984; J a ń c z a k 1990). A strong crop infection amounting to more than 90% can lead to wheat yield reduction by 30% (J a c z e w s k a-K a l i c k a 1996). In the past years, an increased appearance of *Fusarium* spp. during ripening of cereals has been observed (B u r g i e ł 1996; J a ń c z a k 1990). On the other hand, infestation of cereal crops by *Gaeumannomyces graminis* is of less importance (Ł a c i c o w a and W a g n e r 1989). For several years it has been noted at the level of 4%, only locally being of greater importance

(Grendowicz et. al. 1996). The sharp eyespot caused by *Rhizoctonia cerealis* v.d. Hoeven has been frequently recorded. In winter wheat fields this disease is noted on 3 to 26% of the plants observed (Jańczak 1990; Wójcik 1993). Its noxiousness is controversial, but its spread arouses concern, especially in areas of warmer climate (Pokacka and Wojtaszek 1977; Lucas and Cavalier 1983).

Studies conducted in north-eastern Poland aimed at determining the composition of fungi communities colonizing the stem base of winter wheat. The objective of this study was to determine which fungi species were associated with five definite stem base disease symptoms.

METHODS

In 1990–1991 stem samples of several winter wheat cultivars grown in state farms of Olsztyn province were collected (Tabs 1, 2). At milk-wax stage (Feekes's scale 11.1/11.2) 300 culms were randomly collected from each field. In the laboratory, the soil and leaf sheath were removed from the stems. Samples from 15 fields were analyzed. On the basis of macroscopic analysis, the stems were divided into healthy ones and those showing disease symptoms at the base. The following symptoms were detected (Polley and Turner 1995):

Lesion with bleached, sometimes shredded centres and thin, well-defined brown margins (Fig. 1).

Black lines or brown discolouration of the whole or part of the stem at the lowest internode (Fig. 2).

Brown eyeshaped lesion (Fig. 3).

Charcoal grey discolouration of part of the stem at the lowest internode.

Mixed infections.

From each separated group of disease symptoms, five stems of winter wheat were taken for laboratory analyses. Altogether 66 samples were analyzed.

Mycological analysis was performed according to the recommendations by Rashid and Schlösser (1977) and Reinecke and Fehrmann (1979).

The laid out stem fragments were incubated for 6 days under Polamp lamps of 40 W at about 28°C. The appearing fungi were transmitted on PDA. The fungi colonies obtained were divided into morphological groups and kept in optimum conditions for producing spores by particular species. *Pseudocercosporella herpotrichoides* produced spores in the dark at 6°C after three weeks. Fungi were identified on the basis of the available keys and monographs.

Figs 1–3. Lesion of winter wheat stems: Fig. 1. Lesion with bleached, sometimes shredded centres and thin, well-defined brown margins; Fig. 2. Black lines or brown discolouration of the whole or part of the stem at the lowest internode; Fig. 3. Brown eyeshaped lesion

RESULTS

Mycological studies of the stem base of winter wheat conducted at the end of July 1990 and 1991 aimed at determining the species composition of fungi communities colonizing the stem with five symptoms of disease. In addition the usefulness of R e i n e c k e and F e h r m a n n method (1979) for isolation of fungi that grew more slowly than *Fusarium* species was assessed.

Altogether 1076 fungi colonies belonging to 47 genera and species were isolated from the stem base of winter wheat. Four groups of unidentified *Penicillium* spp., yeast-like fungi, dark and light nonsporulating colonies were also isolated (Tab. 1 and 2).

Fungi communities colonizing the stem base of winter wheat in 1990 and 1991 differed in the number of colonies of dominating fungi groups (Tab. 1 and 2). The following species were noted: *Fusarium* spp., *Pseudocercosporella herpotrichoides*, *Rhizoctonia cerealis*, *Aureobasidium bolleyi* and nonsporulating dark fungi. Fungi from the genus *Fusarium* made 44.6% and 17.5% of all the colonies in 1990 and 1991, respectively. The dominating species was *F. avenaceum* (16.4 and 12.4%). In 1990, *F. culmorum* (11.6%) and *F. sporotrichoides* (10.7%) were frequently found. Some of the species being recognized as strong pathogens of cereal crops were rarely isolated: *F. graminearum* – 5 colonies, *Microdochium nivale* (*F. nivale*) – 1 colony. Lower internodes of winter wheat were infested by *P. herpotrichoides* (108 and 100 colonies, i.e. 22.1% and 17.0% respectively) to a high degree. Large groups were made of nonsporulating dark colonies, the percentage of which were 8.8 and 34.2% in 1990 and 1991, respectively. *R. cerealis* appeared in both years forming 24 and 33 colonies (4.9 and 5.6%), respectively. Attention should also be paid to *A. alternata*, infecting the stem base to a higher degree than *R. cerealis* (15 and 16 colonies in 1990 and 1991, respectively). In 1991, *A. bolleyi* was frequently isolated (6.8%).

The symptoms could be associated with the isolated fungi only temporarily (Tab. 3). It seems that the method employed favoured the growth of *P. herpotrichoides* and *Fusarium* ssp.

R. cerealis was obtained from most of the samples with sharp eyespot symptoms from cultivars Milan, Parada, Emika and Koda. In two cases (Koniewo, cv. Oda, Pozorty, cv. Gama) it could not be isolated from the first group of disease symptoms, although the species from genus *Fusarium* and the fungus *P. herpotrichoides* were isolated. This suggests that typical sharp eyespot lesions are unlikely to be diagnosed incorrectly. *R. cerealis* was not generaly obtained from other types of symptoms, including black lines or brown discolouration, brown eyeshaped lesion, charcoal grey discolouration and mixed infections (Tab. 1 and 2). In 1990, this species made up to 26.3% of isolates of sharp eyespot and in 1991 as much as 55% (Tab. 3). It was accompanied, in great number, by *P. herpotrichoides* (19.7 and 13.3%, respectively).

Table 1
Fungi communities colonizing the stem base od winter wheat in 1990

Species	Region and culture																										Total
	Bałcycny									Łężany									Pozorty								
	cv. Weneda					cv. Emika				cv. Parada					cv. Milan				cv. Gama					cv. Emika			
	1*	2	3	4	5	1	3	4	5	1	2	3	4	5	1	2	3	4	1	2	3	4	5	2	3	4	5	
Acremonium strictum W. Gams	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	1
Acremonium sp.	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	2
Alternaria alternata (Fr.) Keisler	–	–	1	–	–	–	–	–	–	–	–	1	1	–	–	1	3	2	–	–	2	1	–	–	–	3		15
Aurebasidium pullulans (de Bary) Arnaud	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	1	–	–	–	–	3	–	1	–	1	–	–	7
Botrytis sp.	–	–	–	–	–	–	1	–	–	1	2	–	–	–	–	–	–	–	4	–	3	–	2	–	5	1	3	22
Cladosporium cladosporioides (Fr.) de Vries	1	–	–	–	–	–	1	–	–	–	–	1	–	1	–	–	–	–	–	–	–	1	2	–	1	–	–	7
Cladosporium oxysporum Berk. et Curt.	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Epiccocum purpuroscens Ehrenb. ex Schl.	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	1
Epiccocum sp.	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	2
Dimargaris cristaligena v. Tiegh.	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Fusarium avenaceum (Corda. Fr.) Sacc.	1	–	3	–	–	9	2	15	2	1	1	2	1	5	1	–	6	–	–	7	2	10	4	–	2	5	1	80
Fusarium concolor Reinking	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Fusarium culmorum (W.G. Smith) Sacc.	–	–	–	1	1	1	1	1	–	–	–	–	2	1	–	–	1	8	–	6	5	–	–	4	9	8	8	57
Fusarium graminearum Schwabe	–	–	–	–	–	–	–	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	3
Fusarium oxysporum Schlecht.	–	–	1	–	–	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	1	6
Fusarium poae (Peck) Wollenw.	2	–	–	–	–	5	–	2	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	11
Fusarium solani (Mart.) Sacc.	–	–	–	2	–	2	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	5
Fusarium sporotrichoides Sherb.	–	–	–	1	–	2	1	5	5	–	–	–	–	–	1	–	2	–	–	3	3	8	10	2	4	2	3	52
Fusarium sp.	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	3
Gliomastix cerealis (Kart.) Dickinson	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	1
Penicillium spp.	1	–	–	–	1	–	2	–	–	1	–	1	3	1	1	3	–	–	–	–	–	–	–	–	–	–	–	14
Phoma herbarum Westend.	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	3
Pseudeurotium sp.	1	–	1	1	1	2	–	–	–	–	2	2	–	1	–	–	–	–	–	–	1	–	–	–	1	–	–	12
Pseudocercosporella herpotrichoides Fron.	12	–	6	11	10	1	4	2	1	3	2	6	3	5	3	–	19	1	–	5	4	2	–	1	2	2	3	108
Rhizoctonia cerealis v. d. Hoeven	–	–	–	–	–	8	–	–	–	4	–	–	–	–	12	–	–	–	–	–	–	–	–	–	–	–	–	24
Rhizopus nigricans Ehrenb.	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2
Scytalidium lignicola Pesenic	–	–	–	–	–	–	–	–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	2
Scytalidum sp.	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1
Dark nonsporulating colonies		–	3	1	1	–	2	–	–	3	2	2	2	2	–	2	5	3	–	3	4	–	4	–	1	1	2	43
Total number of fungi	20	1	15	16	14	31	14	27	9	15	11	19	12	20	21	7	38	16	4	25	27	23	25	7	26	24	21	488
Total number of fungi on cultivars	66					81				77					83				102					78				
Total number of fungi in a given region	147									169									180									

*– see text

From the culms on which black lines and brown patches occurred *Fusarium* species were mainly isolated, particularly *F. avenaceum* (15.6 and 6.7% in the consecutive years of study), and *F. sporotrichoides* (13.7%). The stems with this category of symptoms and especially those with brown base were also infected by *P. herpotrichoides* (15.6% of colonies in 1990 and 17.9% of isolates in 1991) (Tab. 3).

The stems with characteristic brown eyeshaped lesions were mainly colonized by *P. herpotrichoides* (29.3 and 20.5% of isolates in the group). However *Fusarium* spp. were also frequently noted. These fungi constituted the most numerous group among the colonies isolated from black patches. The dominating species *F. avenaceum* made up 26.3 and 27.2% of isolates in this group of symptoms (Tab. 3).

From the stems of winter wheat on which various disease symptoms were observed *P. herpotrichoides* and fungi from the genus *Fusarium* were most frequently isolated (Tab. 3).

DISCUSSION

The mycological analysis showed that cereal stems were usually infected by several fungi species causing root rot disease. This is in agreement with the findings of Łacicowa and Wagner (1989). The pathogens early colonizing the host plant can cause the disease, in spite of the presence of pathogens with high competitive abilities in the soil. Studies on the dynamics of sharp eyespot indicated that most of the stems with symptoms of infestation by *R. cerealis* were observed in mid-June and later their number decreased in favour of *P. herpotrichoides* (Brück 1978). The latter species, in spite of lower competitive abilities, showed high specialization in infesting the culm base of winter wheat (Bojarczuk and Bojarczuk 1979).

Traditional methods of isolation based on rich media can effect the growth of accompanying microflora, especially fungi from the genus *Fusarium* which inhibit the growth of the remaining pathogens (Łacicowa 1979; Majchrzak 1985). The poor mineral medium applied in the present study enabled a relatively frequent isolation of *R. cerealis* and *P. herpotrichoides*, which were often partly inhibited by fungi from the genus *Fusarium*. The species cannot be isolated by other methods (Łacicowa 1979; Łacicowa et al. 1985; Łacicowa and Wagner 1989; Mikołajska et al. 1996). The identification of *P. herpotrichoides* may be difficult since only specific conditions favour its sporogenesis (Bojarczuk and Bojarczuk 1979).

Tab

Fungi communities colonizing the

Species	Region														
	Bałcycny									Łęża-					
	cv. Parada				cv. Koda					cv. Parada					
	1*	2	3	5	1	2	3	4	5	1	2	3	4	5
Acremonium breve (Suk. et Thirum) W. Gams	1	–	–	–	–	–	–	–	–	–	–	–	–	–
Acremonium furcatum (F. et R. Moreau) ex W.G.	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Acremonium strictum W. Gams	–	–	–	–	–	–	–	–	1	–	–	–	–	–
Alternaria alternata (Fr.) Keisler	–	2	2	–	1	–	–	–	–	3	2	3	–	1
Arthrinium phaeospermum (Corda) M. B. Ellis	–	–	–	–	–	–	–	–	–	–	4	–	–	–
Aureobasidium bolleyi Sprague	–	–	–	–	–	–	–	–	2	–	1	–	–	1
Aureobasidium pullulans (de Bary) Arnaud	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Bipolaris sorokiniana (Sacc. in Sorok.) Shoem	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Botryotrichum piluliferum Sacc. et March.	–	–	–	–	–	–	–	–	2	–	–	–	–	–
Botrytis sp.	–	–	–	–	–	–	–	–	–	–	–	1	–	–
Cladosporium cladosporioides (Fresen.) de Vries	–	–	1	–	–	–	–	–	–	–	–	–	–	–
Epiccocum purpuroscens Ehrenb. ex Schlecht.	–	–	–	–	–	–	–	–	–	–	–	2	–	4
Fusarium avenaceum (Corda: Fr.) Sacc.	2	4	–	5	–	–	–	–	–	–	1	–	16	16
Fusarium concolor Reinking	–	–	–	1	–	–	–	–	–	–	–	–	–	–
Fusarium culmorum (W. G. Smith) Sacc.	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Fusarium equiseti (Carda) Sacc.	–	–	–	–	–	–	–	–	1	–	–	–	–	–
Fusarium fusarioides (Frag. et Clif.) C. Booth	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Fusarium graminearum Schwabe	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Fusarium oxysporum Schlecht.	–	–	–	1	–	–	–	–	1	–	–	–	–	–
Fusarium poae (Peck.) Wollenw.	–	–	–	–	–	–	–	–	1	–	–	4	–	–
Fusarium semitectum Berk. et Rav.	–	–	–	–	2	–	–	–	–	–	–	–	–	1
Fusarium sporotrichioides Sherb.	1	–	–	–	–	–	–	–	–	–	–	–	–	–
Fusarium sp.	–	–	–	–	–	–	–	–	–	–	–	–	1	–
Microdochium nivale (Fr.) Samuels et Hallett	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Gilmaniella humicola Barron	–	–	–	–	–	2	–	–	–	–	1	–	–	–
Gliomastix murorum (Corda) Hughes	–	–	–	–	–	1	–	4	–	–	–	–	–	–
Humicola brevis Gilman et Abbott	–	–	–	–	–	–	–	–	–	–	4	–	–	2
Monodictis levis (Wiltshire) Hughes	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Penicillium spp.	1	–	–	–	–	–	–	–	–	1	1	–	–	–
Phialophora fastigate (Lag. Lund. et Melin)	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Phialophora radicola Cain.	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Phialophora verrucosa Medlar	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Pseudocercosporella herpotrichoides Fron.	2	5	13	1	–	8	3	2	10	2	–	–	1	1
Rhizoctonia cerealis v. d. Hoeven	8	–	–	–	5	–	–	–	–	10	–	–	–	–
Torula graminis Desm.	–	–	–	–	–	–	–	1	–	–	–	–	–	2
Sclerotinia sclerotiorum (Lib.) de Bary	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Yeast-like fungi	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Dark nonsporulating colonies	3	13	7	10	1	4	9	2	12	2	9	4	2	2
Light nonsporulating colonies	–	–	–	–	–	–	1	–	1	1	–	–	–	–
Total number of fungi	18	24	23	18	7	15	13	9	31	19	19	14	20	29
Total number of fungi on cultivars	83				76					101				
Total number of fungi in a given region	158									18				

* – see text

l e 2

base of winter wheat in 1991

and cultivares																											Total
ny					Pozorty								Klewki			Koniewo					Prejłowo						
cv. Nike					cv. Gama				cv. Emika				cv.Parada			cv. Oda					cv. Parada						
2	3	4	5	2	3	4	5	2	3	4	5	2	3	5	1	2	3	4	5	1	2	3	4	5		
–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		2
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–		1
–	–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		2
1	5	–	2	1	–	1	–	–	–	3	–	–	1	–	–	2	–	–	–	1	–	–	–	–		26
–	–	–	–	–	–	1	–	–	–	1	–	–	–	–	–	–	–	–	–	1	–	–	–	–		7
3	3	7	–		3	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–		40
–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–		1
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	1		2
–	–	1	1	1	1	–	–	2	3	2	1	–	–	–	–	–	–	–	–	–	–	–	–	–		15
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		1
–	–	–	1	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–		4
–	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–		9
–	–	1	–	3	1	4	13	–	–	–	–	–	1	5	–	2	–	1	–	–	–	3	1	–		73
–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		2
–	–	–	–	–	–	1	–	–	–	–	–	–	4	–	–	–	–	–	–	–	–	–	–	–		5
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		1
–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–		1
–	–	–	–	–	–	–	2	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		2
–	–	–	–	1	–	1	1	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–		5
–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–		6
–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–		4
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		1
–	–	–	–	–	–	1	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		3
–	–	–	–	–	1	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–		1
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		3
–	–	–	–	–	–	–	–	–	–	–	–	–	4	–	–	–	–	–	–	–	–	–	–	–		10
–	–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–		2
–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		1
–	–	–	–	1	–	–	1	–	–	–		–	–	–	–	–	–	–	–	–	1	–	1	–		7
–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		1
–	–	–	–	–	–	–	–	–	–	1	–	–	–	–	–	–	–	1	–	–	–	–	–	–		2
–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		1
4	7	1	5	4	10	–	2	1	3	–	2	4	–	2	–	–	–	–	–	–	–	1	2	4		100
–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	9	–	–	–	–		33
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		3
–	–	–	–	–	1	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		1
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	1	–	–		1
13	8	9	7	5	11	2	8	11	4	4	10	–	–	–	1	–	5	2	2	3	2	2	1	11		201
–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–	–		4
21	24	20	6	24	28	10	28	18	19	9	22	4	10	10	1	4	5	4	2	15	4	9	6	16		588
81				90				68				24			16					50						
2				158								24			16					50						

Table 3

Percentage of lesions in each symptom category from which species of *Fusarium*, *Pseudocercosporella herpotrichoides* and *Rhizoctonia cerealis* were isolated in 1990 and 1991

Pathogen species	Symptom category*									
	1		2		3		4		5	
	1990	1991	1990	1991	1990	1991	1990	1991	1990	1991
Number of colonies	91	60	51	147	140	171	118	81	89	183
Rhizoctonia cerealis	26.3	55	0	0	0	0	0	0	0	0
Pseudocercosporella herpotrichoides	19.7	13.3	15.6	17.8	29.3	20.5	17.8	7.4	22.5	11.5
Fusarium avenaceum	13.2	3.3	15.6	6.7	12.1	6.4	26.3	27.2	13.5	21.3
Fusarium culmorum	1.1	0	19.6	0	10.7	2.3	16.9	1.2	11.2	0
Fusarium graminearum	0	0	1.9	0	0	0	0.8	0	1.1	1.1
Fusarium poae	7.6	0	0	0.7	0.7	2.3	1.7	0	1.1	1.1
Fusarium sporotrichioides	3.2	1.6	13.7	0	7.1	0	13.6	0	20.2	0
Fusarium (other species)	3.2	3.3	0	0.8	1.4	1.2	2.5	1.2	15.7	1.6

* – see text

The results obtained indicate that fungi from the genus *Fusarium* play an important role in the disease process. These species should be recognized as the main colonizers of cereal stems infecting crops throughout the vegetation period (Mańka, et al. 1983; Łacicowa et al. 1985; Łacicowa and Wagner 1989; Majchrzak 1985; Truszkowska et al. 1988; Kurowski et al. 1990; Mikołajska and Majchrzak 1990). These pathogens are characterized by high competitive abilities and large tolerance of changes in environmental conditions (Ellis 1971).

Among the isolated *Fusarium* spp., *F. avenaceum* and *F. culmorum*, which dominated during the two-year study, turn attention. *F. avenaceum* has been isolated more frequently in cool areas (Majchrzak and Mikołajska 1982; Łacicowa and Wagner 1989; Kurowski et al. 1990) as it has lower requirements for temperature (Ellis 1971). The frequent isolation of *F. culmorum* (Truszkowska et al. 1988; Kurowski et al. 1990) is associated with its higher tolerance of moisture conditions (after Łacicowa et al. 1985).

From the accompanying fungi, attention should also be paid to *A. bolleyi* and *A. alternata*, whose role in the disease process is not yet known (Majchrzak and Mikołajska 1982; Truszkowska et al. 1983; Łacicowa and Wagner 1989). According to Łacicowa, the mixed infections can contribute to a quicker destruction of infested tissues (Łacicowa et al. 1985).

A visual attempt at determining the type of disease symptoms and then attributing them to one pathogen resulted in partial success. In most cases *R. cerealis* was isolated from the characteristic spots of sharp eyespot. Sometimes species belonging to the genus *Fusarium* (particularly *F. avenaceum*) and *P. herpotrichoides* and saprotrophic fungi were also isolated. Difficulties of the visual identification of the cause of lesions and discolouration on the stem bases of cereals are often noted (Truszkowska et al. 1983; Polley and Turner 1995). Since the disease expression depends to some extent on the external environment, the differences between the isolation rates of pathogens from a particular symptom type. Also, mixed infections often occur. A separate group, difficult to identify, gathers smalls lesions or discolourations, which do not have yet distinct characters (Pokacka 1980; Truszkowska et al. 1983; Łacicowa and Wagner 1989; Polley and Turner 1995). In the case of *Fusarium* species it is difficult to determine the relationship between the symptoms and species (Polley and Turner 1995). *P. herpotrichoides* could sometime occur on stems without causing characteristic symptoms.

The accurate identification of the damages and over-colouring on the stem base of cereals, especially at the first stages of growth, could be useful in planning a proper strategy of controlling root rot diseases of cereals. Traditional research methods of isolation of fungi from the culm base of cereals are not reliable. Therefore the rapid progress in identification of the fungi pathogens of root rot diseases in plant tissues by immunological technique or DNA analysis is very promising (Polley and Turnaer 1995; Nicholson and Parry 1996).

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Zbiorowiska grzybów zasiedlających podstawę źdźbła pszenicy ozimej

Streszczenie

Badano grzyby wywołujące choroby podstawy źdźbła pszenicy ozimej. Nie zawsze możliwe było określenie patogena wywołującego objawy choroby. Do najczęściej stwierdzonych należały: *Fusarium avenaceum*, *F. culmorum*, *Pseudocercosporella herpotrichoides* i *Rhizoctonia cerealis*.