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OCCURRENCE OF *FUSARIUM* SPECIES IN SPEARS OF ASPARAGUS (*ASPARAGUS OFFICINALIS*)

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Abstract

Several pathogenic *Fusarium* species occurred in white and green spears of asparagus. *Fusarium oxysporum* and *F. proliferatum* were found most often, while *F. culmorum*, *F. heterosporum*, *F. scirpi*, *F. solani* and *F. verticillioides* occurred only occasionally. Mostly the epidermal base part of asparagus spears was infected. White asparagus spears were infected more often than green ones.

Key words: *Fusarium oxysporum*, *F. proliferatum*, *Fusarium* spp., white and green asparagus spears

Introduction

Asparagus has recently received increased worldwide interest because of its unique taste, high nutritional value and the presence of biotic compounds (Shao et al. 1999). Presently, over 210,000 ha throughout the world are under production of this traditionally European crop (Wong and Jeffries 2006). An asparagus crop can remain profitable for 10–15 years if properly managed. However, several diseases cause severe losses in its production. Fungi of *Fusarium* genus belong to most serious pathogens of asparagus (Elmer et al. 1996). *Fusarium culmorum* is known as the cause of foot and stem rot and is also mentioned in relation to asparagus decline in European countries (Blok and Bollen 1995). Root and crown rot is generally ascribed to *F. oxysporum* f.sp. *asparagi* and *F. proliferatum*. Spear rot has been attributed to *F. redolens*, a species was also reported to be associated with asparagus root and crown rot (Baayen et al. 2000). As asparagus plantings age, the incidence of *F. proliferatum* tends to increase, whereas *F. oxysporum* is more prevalent in younger plantings (Elmer 2000). Importance of particular *Fusarium* spp. in disease incidence depends on asparagus cultivar susceptibility, environmental conditions, agricultural practices and other factors (Sadowski and Knaflewski 1990, Logrieco

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et al. 1998, Gossmann et al. 2001, Seefelder et al. 2002, Weber et al. 2006). The dynamic equilibrium of an ecosystem is driven by mutual feedback interactions between asparagus and soil microorganisms. Asparagus excretes such the persistent phenolic acids that they can have a selective impact on soil microorganisms and may be involved in *Fusarium* crown and root rot (Hamel et al. 2005). Knowledge of the problem is limited, so far.

The aim of this study was to assess the occurrence of *Fusarium* species in white and green spears of asparagus.

Material and methods

Two asparagus cultivars: 'Eposs' and 'Gijnlim' were analysed for the presence of *Fusarium* species. Asparagus spears were collected from a farm in Świdwowiec (100 km west of Poznań) in 2005 and 2006 and from the Marcelin Experimental Station of The Agricultural University (suburbs of Poznań) in 2005. In Świdwowiec 'Gijnlim' and 'Eposs' cultivars were planted on sandy soil in 1993 and 1997, respectively. Therefore, 'Gijnlim' spear were sampled in the 12th and 'Eposs' in the 8th and 9th year of harvest. In Marcelin both cultivars were planted on sandy loam soil in 2000 and spears were sampled in the 5th year of harvest. The total yearly precipitation was 500 mm in both locations in 2005 and 370 mm in Świdwowiec in 2006. No irrigation was applied.

10 white spears of cv. 'Eposs', 10 green spears of cv. 'Gijnlim' from Świdwowiec and 10 green spears of each cultivar from Marcelin were collected on May 23th, 2005. Each spear was divided into six parts (epidermal: base, center, top, and pericambium and vascular: base, center, top). 40 white spears and 20 green spears of cv. 'Eposs' from Świdwowiec were collected both on May 29th and June 14th, 2006. Each spear was divided into three parts (base, center, top). Each part was analysed for presence of *Fusarium* by isolation on potato dextrose agar (PDA) amended with streptomycin at 100 μg/ml. The boundary between discoloured and healthy tissues of the symptomatic spears or 1 cm^2 pieces of tissue from particular parts of asymptomatic spears were used for isolation. After 10 min long disinfection with 1% sodium hypochlorite five sections of tissue (2 mm in diameter) were cut from each of six spear parts in 2005, and each of three spear parts in 2006, and transferred into separate Petri dishes with PDA. Fungi growing from sections were transferred on synthetic nutrient agar (SNA, Nirenberg 1976; 1 g KH_2PO_4, 1 g KNO_3, 0.5 g $MgSO_4 \cdot 7H_2O$, 0.5 g KCl, 0.2 g glucose, 0.2 g sucrose, 20 g agar, 1 l distilled water) and identified according to Booth (1971), Gerlach and Nirenberg (1982), Kwaśna et al. (1991), Barnett and Hunter (1998).

Two-way analysis of variance ANOVA (Bogartz 1994) was carried out to determine the effect of epidermal and pericambium tissue (EP), base, center, top (BCT) and the epidermal, pericambium × base, center, top (EP × BCT) interaction on the variability of examined traits in 2005 as well as the effects of white, green spears (WG), base, center, top (BCT) and the white, green spears × base, center, top (WG

× BCT) interaction on the variability of examined traits in 2006. To compare the percentages of spear sections of particular parts infected by particular *Fusarium* sp. Newmann-Keulus test was performed.

Results

In Świdwowiec *Fusarium oxysporum* occurred significantly more often in epidermal than in pericambium and vascular tissue (Tables 1 and 2). *Fusarium proliferatum*, *F. culmorum*, *F. heterosporum* and *F. solani* occurrence was similar in all spear parts. *Fusarium oxysporum* occurred more often in white spears of 'Eposs' cv. (Table 1) than in green spears of 'Gijnlim' cv. (Table 2). In 2005 none of the *Fusarium* spp.

Table 1

Occurrence of *Fusarium* spp. in white spears of asparagus 'Eposs' – Świdwowiec, 23.05.2005 (%)

Part of spear		*F. oxysporum*	*F. proliferatum*	*F. culmorum*	*F. heterosporum*
Epidermal	base	36.0	20.0	0.0	2.0
	center	16.0	12.0	0.0	0.0
	top	8.0	8.0	0.0	0.0
	mean	20.0 a	13.3	0.0	0.7
Pericambium and vascular tissue	base	6.0	8.0	0.0	0.0
	center	4.0	2.0	2.0	0.0
	top	0.0	0.0	0.0	0.0
	mean	3.3 b	3.3	0.7	0.0

In columns means followed by the same letters are not significantly different at 5% level.

Table 2

Occurrence of *Fusarium* spp. in green spears of asparagus 'Gijnlim' – Świdwowiec, 23.05.2005 (%)

Part of spear		*F. oxysporum*	*F. proliferatum*	*F. culmorum*	*F. heterosporum*	*F. solani*
Epidermal	base	16 a	4	4	2	2
	center	0 b	0	0	0	0
	top	0 b	0	0	0	0
Pericambium and vascular tissue	base	4 b	0	0	0	0
	center	0 b	0	0	0	0
	top	0 b	0	0	0	0

In columns means followed by the same letters are not significantly different at 5% level.

was isolated from green spears of the asparagus 'Eposs' and only *F. heterosporum* was isolated from one section from asparagus 'Gijnlim' green spears, grown in Marcelin.

Fusarium oxysporum, *F. proliferatum* and *F. verticillioides* occurred in white spears of asparagus 'Eposs' grown in Świdwowiec, which were collected in both terms of 2006 (Tables 3 and 4). *Fusarium scirpi* was found only in the second term of the year (Table 4). *Fusarium oxysporum* and *F. proliferatum* occurred more often in white than in green spears of 'Eposs' cv. in both terms.

Table 3

Occurrence of *Fusarium* spp. in spear epidermal part of asparagus 'Eposs' – Świdwowiec, 29.05.2006 (%)

Spear		*F. oxysporum*	*F. proliferatum*	*F. verticillioides*
White	base	18.5	4.5	0.5
	center	9.0	1.5	0.5
	top	3.0	0.0	0.0
	mean	10.2 a	2.0 a	0.3
Green	base	6.0	0.0	0.0
	center	0.0	0.0	0.0
	top	0.0	0.0	0.0
	mean	2.0 b	0.0 b	0.0

In columns means followed by the same letters are not significantly different at 5% level.

Table 4

Occurrence of *Fusarium* spp. in spear epidermal part of asparagus 'Eposs' – Świdwowiec, 14.06.2006 (%)

Spear		*F. oxysporum*	*F. proliferatum*	*F. verticillioides*	*F. scirpi*
White	base	13.5	10.0	1.0	0.5
	center	10.5	4.0	0.0	0.0
	top	4.5	1.0	0.0	0.0
	mean	9.5 a	5.2 a	0.3	0.2
Green	base	0.0	0.0	0.0	0.0
	center	0.0	0.0	0.0	0.0
	top	0.0	0.0	0.0	0.0
	mean	0.0 b	0.0 b	0.0	0.0

In columns means followed by the same letters are not significantly different at 5% level.

Discussion

In the USA, *Fusarium proliferatum* is the dominant asparagus pathogen in the states with warmer climate (California, North Carolina), while *F. oxysporum* predominates in states with colder climate (Elmer 2000). Asparagus grown further south, e.g. in Mexico and Peru has even higher incidence of colonization by *F. proliferatum* than asparagus from California (Elmer 2000).

In Europe similar preferences of *Fusarium* species for temperature are observed. In Italy, 72% and 28% of diseased asparagus plants are colonized by *F. proliferatum* and *F. oxysporum*, respectively, and another 23% of diseased plants by group of species including *F. equiseti*, *F. solani*, *F. acuminatum* subsp. *acuminatum*, *F. scirpi* and *F. graminearum* (Logrieco et al. 2003). Similarly in Spain, *F. oxysporum* f.sp. *asparagi* and *F. proliferatum* are the main pathogens of asparagus, recorded at rates of 40% each (Wong and Jeffries 2006). In south eastern part of The Netherlands, in contrast, *F. oxysporum* was the most common species isolated from 80% of examined asparagus plants. Neither *F. moniliforme* nor *F. proliferatum* occurred in The Netherlands (Blok and Bollen 1995). In our work *F. oxysporum* was the dominant species in cold term on May 29, 2006 (Table 3), while in warmer term on June 14, 2006 (Table 4) the occurrence frequency of *F. oxysporum* and *F. proliferatum* was comparable. The incidence of *Fusarium* colonization was bigger in the basal parts of spears than apical ones, which is in agreement with observations of Elmer (2000) and Weber et al. (2006).

Fusarium oxysporum and *F. proliferatum*, occurring in asparagus spears in our study, are known as the most important fungal pathogens worldwide causing crown and root rot of asparagus (Elmer et al. 1996, Logrieco et al. 1998). In our work, besides the two species, occasionally occurred *F. culmorum*, *F. heterosporum*, *F. scirpi*, *F. solani* and *F. verticillioides* while Gossmann et al. (2001) occasionally found *F. acuminatum*, *F. avenaceum*, *F. culmorum*, *F. redolens*, *F. sambucinum*, *F. solani*, and *F. subglutinans*.

In some green spears of asparagus in Świdwowiec only *F. oxysporum* was found while in Sadowski's and Knaflewski's (1990) study only *F. culmorum* was isolated from above-ground parts. The occurrence of *Fusarium* species only in the base of green spears supports the data on the occurrence of *Fusarium* pathogens mainly in underground parts of green spears of asparagus.

Streszczenie

WYSTĘPOWANIE GRZYBÓW RODZAJU *FUSARIUM* W WYPUSTKACH SZPARAGA (*ASPARAGUS OFFICINALIS*)

Fuzarioza jest jedną z groźniejszych chorób szparaga. W praktyce jest dostrzegana zwykle w ostatnim etapie rozwoju, gdy następuje zamieranie porażonych roś-

lin. We wczesnych fazach jej szkodliwość wyraża się zmniejszeniem wielkości i pogorszeniem jakości plonu szparagów.

W pracy zidentyfikowano grzyby rodzaju *Fusarium* w szparagach bielonych i zielonych. Grzyby izolowano z sześciu części (nasady, środka i wierzchołka warstwy zewnętrznej i wewnętrznej), z 10 wypustek każdej z dwóch odmian ('Eposs', 'Gijnlim') szparaga w roku 2005 oraz z trzech części (nasady, środka i wierzchołka warstwy zewnętrznej), z 40 bielonych i 20 zielonych wypustek odmiany 'Eposs' w roku 2006.

Gatunki *F. oxysporum* i *F. proliferatum* występowały najczęściej, a *F. culmorum*, *F. heterosporum*, *F. scirpi*, *F. solani* i *F. verticillioides* notowano sporadycznie. Grzyby te występowały najczęściej w nasadowej, zewnętrznej i sporadycznie w wierzchołkowej, środkowej części szparagów. Bielone wypustki szparaga były porażone częściej niż zielone. Występowanie grzybów rodzaju *Fusarium* notowano częściej w szparagach z brązowymi przebarwieniami (tzw. ordzawieniem) niż w szparagach nieprzebarwionych.

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