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Distribution and interaction of *Fusarium avenaceum* (Fr.) Sacc. with other root-associated fungi

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Fusarium avenaceum is one of the most widespread root-associated fungi. It was identified in the roots of wheat, rye, barley, oat as well as in the roots of 13 wild growing plant species occurring nearby. The distribution frequency of this pathogen exceeded 9.7%. The interaction *in vitro* between *F. avenaceum* and nine most widespread root-associated fungi was diverse and strongly determined by the species and isolate of fungus. Fungistatic trophic and mutual antagonisms prevailed among the four forms of interactions of the micromycetes tested. *Aspergillus ochraceus, Chaetomium globosum* and *Rhizoctonia* spp. most strongly inhibited the growth of *F. avenaceum*.

Key words: cereal, wild growing plants, *Fusarium avenaceum*, root-associated fungi, interaction, distribution

INTRODUCTION

Fusarium avenaceum (Fr.) Sacc. is a prominent world-wide distributed cereal parasite. Although it occurs wherever crops are grown, it is chiefly a fungus of temperate regions, detected more frequently in cold, wet areas than in warmer, drier regions. This soil inhabitant is transmitted by seeds and by soil or by wind-borne crop residues. It causes seedling disease and is associated with the 'spring yellows', damping-off and root rots of many plants [6, 7, 9, 10]. Although *F. avenaceum* is generally a weaker parasite than *Fusarium culmorum* or *Fusarium graminearum*, it is still a serious pathogen able to cause severe lesions to cereal. Infecting roots of non-cereal crops grown in rotation with cereals, *F. avenaceum* might contribute to the level of fusarium head blight [5]. Apart from being a hazardous parasite of the *Gramineae* Juss., this fungus has been reported on more than 160 plant genera [2].

F. avenaceum, as most soil pathogens, rarely exists in isolation but occurs in association with other Fusaria as well as fungi of other genera [3, 4, 8, 14–16]. Two or more fungi can simultaneously attack the same plant and are observed in the lesions of the same host. The interactions between these fungi can influence their growth and distribution. Elucidation of these interactions is of particular significance for disease suppression.

The goal of this investigation was to determine the most widespread fungi on the roots of cereal and wild growing neighbouring plants, and to study their interaction with *F. avenaceum*.

MATERIALS AND METHODS

Injured plants were collected in 26 localities of different regions of northern Lithuania. Root-associated fungi were isolated from the roots of cereals (*Secale cereale* L., *Triticum aestivum* L., *Hordeum distichon* L., *Avena sativa* L.) and 26 neighbouring wild growing plant species (*Agropyron repens* (L.) P. B., *Arthemisia vulgaris* L., *Centaurea cyanus* L., *Cirsium arvense* Scop., *Dactylis glomerata* L., *Chenopodium album* L., *Ch. hybridum* L., *Erigeron annuus* (L.) Pers., *Euphorbia helioscopia* L., *Medicago lupulina* L., *Melilotus albus* Med., *Mentha arvensis* L., *Myosotis arvensis* (L.) Hill, *Plantago major* L., *Phleum pratense* L., *Rumex acetosella* L., *Taraxacum officinale* Weber, *Sonchus arvensis* L., *Trifolium arvense* L., *T. hybridum* L., *T. pratense* L., *T. repens* L., *Tripleurospermum perforatum* (Mérat) M. Laînz, *Tussilago farfara* L., *Vicia angustifolia* Grufb., *V. sativa* L.). In every locality five plants of each species were collected before the harvest time of cereals.

Pure cultures of fungi were isolated employing the generally applied methods [12, 18–20]. The fungal species were identified on the basis of their cultural and morphological characteristics, according to Arx [1], Ellis [5], Gerlach, Nirenberg [7], Nelson et al. [13], Bilai [18]. The distribution frequency (DF) of separate fungi species and the percentage they made up in the total number of isolates were calculated. Single spore cultures of the selected isolates were transferred on malt extract agar medium (MEA) in tubes for preservation and were used in the interrelation survey.

Forty-nine isolates of nine micromycete species widespread in the roots of the test plants were selected for investigation of their interaction with ten isolates of *F. avenaceum*: *F. culmorum* (Wm. G. Sm.) Sacc. (6 isolates), *F. oxysporum* (Schltdl.) W. C. Snyder et H. N. Hansen (13), *F. sambucinum* Fuckel var. *minus* Wollenw. (7), *Bipolaris sorokiniana* (Sacc.) Shoemaker (6), *Rhizoctonia* spp. (5), *Aspergillus ochraceus* K. Wilh. (3), *Chaetomium globosum* Kunce: Fr. (2), *Gliocladium catenulatum* J. C. Gilman et E. V. Abbott (9), *Talaromyces flavus* (Klöcker) Stolk et Samson (6). The research on the interaction of micromycetes was carried out *in vitro* in a dual-plate assay on the MEA, evaluating them after 5, 10, 15 and 20 days of growth. For evaluation of the interaction among the micromycetes, the interaction forms of microorganisms proposed by I. Babushkina [17] were applied. The forms of micromycetes' interaction was evaluated visually according to the growth character of fungi. The percentage of each form of interaction made up of the total number of evaluated interactions was calculated [17].

RESULTS AND DISCUSSION

Great numbers of fungi are usually detected in the roots of injured plants. Some of them are parasites actively participating in the process of root injury and destruction, others are saprotrophes involved in root destruction without being the cause of injury. Forty-eight taxa of root-associated micromycetes belonging to 26 genera (*Acremoniella* Sacc., *Acremonium* Link: Fr., *Alternaria* Nees, *Apiosordaria* Arx et W. Gams, *Arthrinium* Kunze: Fr. in Kunze et J. C., *Aspergillus* P. Michel ex Link: Fr., *Bipolaris* Shoemaker, *Cylindrocarpon* Wolllenw., *Chaetomium* Kunze:Fr., *Cladosporium* Link:Fr., *Fusarium* Link: Fr., *Gliocladium* Corda, *Nigrospora* Zimm., *Papulaspora* Preuss, *Penicillium* Link: Fr., *Periconia* Tode: Fr., *Phoma* Sacc., *Rhizoctonia* DC, *Sepedonium* Link: Fr., *Stemphyllium* Wallr., *Ulocladium* Preuss, *Talaromyces* C. R. Benj., *Thielaviopsis* Went, *Trichoderma* Pers.: Fr., *Zygodesmus* Corda, *Zygorrhynchus* Vuill.) were ascertained during our investigation in the roots of cereal and neighbouring wild growing plants [11]. Fungi of the genera *Fusarium* (DF 64.7%), *Phoma* (DF 13.4%), *Rhizoctonia* (DF 10.2%), *Talaromyces* (DF 10.0%), *Alternaria* (DF 6.1%) and *Gliocladium* (DF 5.8%) were most frequent. The genus *Fusarium* was characterised by the richest species composition: fungi of 15 species and 2 varieties of this genus were identified (Table 1). *F. sambucinum* var. *minus*, *F. culmorum*, *F. avenaceum* and *F. oxysporum* predominated and amounted to 69.2% of all *Fusarium* isolates [11]. *F. avenaceum* was one of the most frequent micromycetes, making up to 15.0% of the total number of *Fusarium* and 6.6% of all isolates. The distribution frequency of this fungus reached 9.7%. *F. avenaceum* was identified in the roots of all cereals (*Secale cereale*, *Triticum aestivum*, *Hordeum distichon*, *Avena sativa*) as well as in the roots of 13 wild growing plant species (*Agropyron repens*, *Arthemisia vulgaris*, *Matricaria maritima*, *Medicago lupulina*, *Melilotus albus*, *Mentha ar-*

Table 1. **Distribution of root-associated *Fusarium* in cereal crops and neighbouring wild growing plants**

Micromycetes	Distribution frequency, %		
	Cereal crops	Wild growing plants	Total
Fusarium acuminatum Ellis et Everh.	0.8	0	0.2
F. avenaceum (Fr.) Sacc.	13.5	8.1	9.7
F. chlamydosporum Wollenw. et Reinking	0.8	0	0.2
F. culmorum (Wm. G. Sm.) Sacc.	29.4	4.9	12.4
F. javanicum Koord.	0	1.4	1.0
F. graminearum Schwabe	4.0	1.1	1.9
F. graminum Corda	4.8	1.1	2.2
F. heterosporum Nees	1.6	1.1	1.2
F. oxysporum (Schltdl.) W. C. Snyder et H. N. Hansen	7.9	6.7	7.1
F. poae (Peck) Wollenw.	0.8	0	0.2
F. sambucinum Fuckel	7.9	1.1	3.2
F. sambucinum Fuckel var. *minus* Wollenw.	30.2	9.1	15.6
F. semitectum Berk. et Ravenel	3.2	1.4	1.9
F. solani (Mart.) Appel et Wollenw.	2.4	2.5	2.4
F. solani (Mart.) Appel et Wollenw. var. *argillaceum* (Fr.) Bilai	2.4	1.8	1.9
F. sporotrichiella Bilai	3.2	1.4	1.9
F. tricinctum (Corda) Sherb.	0	0.7	0.5

Table 2. **Forms of interaction among separate isolates of *Fusarium avenaceum* and other root-associated fungi**

Micromycetes	Isolates	*Fusarium avenaceum* isolates									
		10395	10141	10038	10201	10169	10189	10231	10244	10093	10053
Aspergillus ochraceus	10352	II	II	II	IV	II	IV	IV	IV	IV	II
	10390	II	II	II	IV	II	IV	IV	IV	IV	II
	10433	II	II	II	IV	II	IV	IV	IV	IV	II
Bipolaris sorokiniana	10289	IV	II	II	II	I	I	IV	II	II	IV
	10364	IV	II	II	II	II	I	–	IV	II	IV
	10409	IV	II	IV	II	II	I	–	II	II	IV
	10413	II	II	IV	IV	IV	II	–	II	II	IV
	10232	IV	I	II	I	I	I	–	I	I	I
	10276	IV	I	II	I	I	I	–	I	I	I
Chaetomium globosum	10626	II/IV	IV	II/IV	IV	II	IV	IV	II	IV	II
	10604	III	IV	III	II	III	II	II	II	II	II
Gliocladium catenulatum	10050	III	III	III	III	III	III	III	III	III	III
	10363	III	III	III	III	III	III	III	III	III	III
	10337	III	III	III	III	III	III	III	III	III	III
	10323	IV	IV	IV	IV	IV	IV	IV	IV	IV	III
	10275	III	III	III	III	III	III	III	III	III	III
	10452	III	III	III	III	III	III	III	III	III	III
	10235	III	III	III	III	III	III	III	III	III	III
	10044	III	III	III	III	III	III	III	III	III	III
	10250	III	III	III	III	III	III	III	III	III	III
Fusarium culmorum	10230	IV	IV	II	IV	II	II	IV	IV	IV	IV
	10580	IV	II	IV	II	II	II	II	II	II	IV
	10398	IV	II	II	II	II	II	II	II	II	IV
	10302	IV	II	IV	II	II	II	II	II	II	II
	10316	IV	II	II	II	IV	II	II	II	II	IV
	10326	IV	II	IV	II	IV	II	II	II	II	IV
F. oxysporum	10281	II	II	IV	II	IV	I	II	II	II	II
	10348	II	II	IV	IV	II	I	IV	IV	IV	IV
	10575	II	II	IV	II	II	II	II	II	II	V
	10510	II	II	II	II	II	II	II	II	II	II
	10196	II	II	II	II	IV	II	II	II	II	II
	10103	II	IV	II	IV	II	II	IV	IV	II	IV
F. sambucinum var. *minus*	10034	I	IV	IV	IV	II	IV	I	IV	II	II
	10215	I	II	III	II	II	II	IV	II	II	II
	10444	IV	IV	IV	II	IV	IV	I	IV	IV	II
	10418	IV	IV	III	II	II	IV	I	IV	IV	IV
	10271	I	IV	III	II	II	IV	II	IV	II	II
	13011	I	IV	III	II	II	IV	IV	IV	IV	II
	10185	II	IV	III	II	II	IV	II	I	IV	II
Rhizoctonia spp.	10633	IV	IV	II	II	II	II	IV	II	II	II
	10478	II	I	II	IV	II	I	II	II	II	II
	10110	IV	IV	IV	IV	II	II	IV	II	II	II
	10252	II	IV	IV	II	II	I	IV	II	I	II
Talaromyces flavus	10360	II	II	II	II	II	II	I	II	II	II
	10628	II	II	II	II	II	II	I	II	II	II
	10504	I	II	II	II	II	II	II	II	II	II
	10392	II	I	II	II	II	II	II	II	II	II
	10458	II	I	II	II	II	II	II	II	II	IV
	10467	II	I	II	II	II	II	II	II	II	II

I – no impact; II – fungistatic trophic, III – territorial and IV – mutual antagonisms.

vensis, *Myosotis arvensis*, *Plantago major*, *Phleum pratense*, *Sonchus arvensis*, *Trifolium pratense*, *Tussilago farfara*, *Vicia angustifolia*) from the neighbourhood. *F. avenaceum* was most frequently revealed in roots of wheat (DF 25.0%) and more rarely of rye (DF 14.3%), oats (DF 7.1%), barley (DF 2.7%). The distribution frequency of *F. avenaceum* in roots of wild growing plants reached the average of 8.1% and its isolates made up 19.0% of the total number of all fusaria. Most frequently (DF 20.0%) *F. avenaceum* was detected in roots of *Arthemisia vulgaris*, *Medicago lupulina*, *Mentha arvensis*, *Myosotis arvensis*, *Plantago major*, *Phleum pratense*. The distribution *F. avenaceum* in roots of other wild growing plants amounted to 4.0–10.0%.

Results of the investigation on the interaction of *F. avenaceum* and nine most widespread root-associated micromycetes demonstrated the diversity and a strong dependence of these interactions upon the species and isolate of fungus. Four forms of micromycete interaction were revealed:

no impact – fungus overgrows the pathogen, but the growth of the latter does not stop; both of them grow on;

fungistatic trophic antagonism – fungus overgrows the pathogen, the growth of the latter stops;

territorial antagonism – fungus overgrows the pathogen, a zone where the pathogen does not grow forms; the growth of the pathogen is usually slower;

mutual antagonism – both fungi negatively influence the growth of each other; the zone could form where neither of the fungi grows (Table 2).

The forms of fungistatic trophic and mutual antagonisms prevailed, amounting to 47.6% and 26.1%, respectively. Territorial antagonism was revealed in 18.3% and no impact among the fungi in 8.0% of the cases.

The fungistatic trophic antagonism dominated in the interaction between the tested isolates of *F. avenaceum* and *T. flavus* (88.3%), as well as *F. oxysporum* (70.0%), F. *culmorum* (63.3%), and *Rhizoctonia* spp. (60.0%). The territorial antagonism was most evident in the interaction between *F. avenaceum* and *G. catenulatum* (90.0%); however, this form of interaction was ascertained only in 7.1% of cases between *F. avenaceum* and *F. sambucinum* var. *minus* and was not detected in the interaction of *F. avenaceum* with other investigated fungi. The mutual antagonism dominated between the isolates of *F. avenaceum* and *A. ochraceus* and *F. sambucinum* var. *minus*, amounting to 50.0% and 44.3%, respectively. The least impact on each other had the isolates of *F. avenaceum* and *B. sorokiniana*: even in 32.7% of cases no interaction between these fungi was ascertained (Figure).

Investigation of interaction between *F. avenaceum* and other root-associated fungi showed that the isolates of *F. avenaceum* inhibited the growth of *F. oxysporum*, *F. culmorum* and *B. sorokiniana* and more or less overgrew their mycelium. Fungistatic trophic antagonism dominated between the isolates of *F. avenaceum* and *F. oxysporum* (Figure). *F. oxysporum* isolates 10348 and 10103 were most resistant to the impact of *F. avenaceum*. Mutual antagonism was revealed between these isolates of *F. oxysporum* and the tested isolates of *F. avenaceum*; they inhibited the growth of each other, still the mycelium was not overgrown and a distinct border of the colonies remained. The growth of all other *F. oxysporum* isolates was stopped and their colonies were overgrown. The *F. oxysporum* isolate 10281 was most sensitive to the impact of *F. avenaceum*.

The fungistatic trophic antagonism prevailed in the interactions between *F. avenaceum* and *F. culmorum* as well (Figure). The majority of *F. avenaceum* and *F. culmorum* isolates suppressed the growth of each other. The growth of *F. culmorum* was faster, more intensive and abundant; nevertheless, *F. avenaceum* in most cases intensively inhibited the growth of *F. culmorum* mycelium and more or less overgrew it. The *F. culmorum* isolate 10316 was most sensitive, although the isolates 10230, 10580 and 10326 were most resistant towards the impact of *F. avenaceum*. The growth of some *F. avenaceum* isolates was stopped and their mycelium was almost completely overgrown by the *F. culmorum* isolate 10326. The mycelium of the *F. avenaceum* isolate 10189 grew sickly at the edge of the colony. The most evident mutual antagonism was revealed between the *F. avenaceum* isolate 10395 and all *F. culmorum* isolates.

Three forms of interaction between *F. avenaceum* and *B. sorokiniana* were revealed. They were: no impact, fungistatic trophic, and mutual antagonism which amounted up to 32.7%, 40.0% and 27.3% of the cases, respectively (Figure). The majority of *F. avenaceum* isolates inhibited the growth of *B. sorokiniana* mycelium and overgrew it. The *B. sorokiniana* isolate 10413 was most sensitive and the isolate 10409 most resistant to the impact of *F. avenaceum*. Among the *F. avenaceum* isolates studied, the isolate 10169 showed the weakest suppression to the growth of *B. sorokiniana* mycelium. The most evident antagonism was revealed between the *F. avenaceum* isolate 10053 and *B. sorokiniana* isolates. The weakest impact on the growth of each other was observed between the *F. avenaceum* isolate 10189 and all studied isolates of *B. sorokiniana* as well as between almost all *F. avenaceum* isolates and the *B. sorokiniana* isolates 10232 and 10276.

All *F. sambucinum* var. *minus* isolates grew more intensively and abundantly and in the majority of cases inhibited the growth of *F. avenaceum* mycelium and more or less overgrew it. The *F. sambucinum* var. *minus* isolate 10215 abundantly overgrew

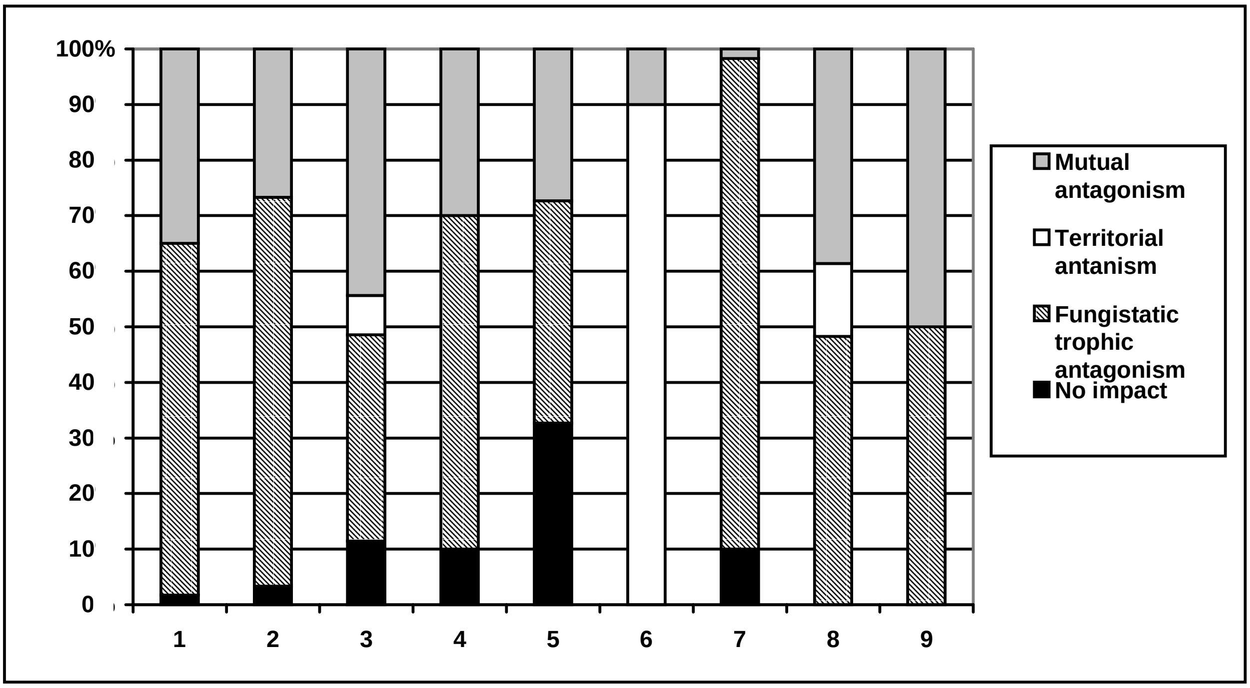

Figure. Interaction forms of *Fusarium avenaceum* with most widespread root-associated fungi (%). *1 – Fusarium culmorum, 2 – F. oxysporum, 3 – F. sambucinum* var. *minus, 4 – Rhizoctonia* spp., *5 – Bipolaris sorokiniana, 6 – Gliocladium catenulatum, 7 – Talaromyces flavus, 8 – Chaetomium globosum, 9 – Aspergillus ochraceus*

almost all *F. avenaceum* isolates studied. In the relationship between *F. sambucinum* var. *minus* and *F. avenaceum*, four forms of microorganism interaction were revealed. The mutual and fungistatic trophic antagonisms prevailed, making 44.3% and 37.1%, respectively (Figure). Fungistatic trophic antagonism was characteristic of the *F. avenaceum* isolates 10201, 10169, 10053 and mutual antagonism of the isolates 10141, 10189, 10244, 10093. Only the *F. avenaceum* isolate 10038 showed the fungistatic territorial antagonism in the interaction with *F. sambucinum* var. *minus* isolates (Table 2).

The *Rhizoctonia* spp. suppressed the growth of *F. avenaceum* especially intensively. The *Rhizoctonia* spp. isolates 10633 and 10252 inhibited the growth of all *F. avenaceum* isolates, abundantly overgrew or even destroyed the mycelium of those more sensitive. The *Rhizoctonia* spp. isolates 10478 and 10110 only inhibited the growth of *F. avenaceum* mycelium but did not stop it. *F. avenaceum* isolates 10141, 10189 and 10231 were most resistant to the impact of *Rhizoctonia* spp., although, *F. avenaceum* isolates 10395 and 10169 demonstrated the highest sensitivity and were abundantly overgrown by all *Rhizoctonia* spp. isolates. The fungistatic trophic antagonism dominated in the interaction between *F. avenaceum* and *Rhizoctonia* spp. (Figure, Table 2).

The isolates of *C. globosum* also inhibited the growth of *F. avenaceum*. The *C. globosum* isolate 10604 stopped the growth of all *F. avenaceum* isolates and, abundantly overgrowing the mycelium, destroyed the majority of them. The *F. avenaceum* isolates 10141, 10201, 10093 were most resistant, the isolates 10038, 10169, 10244 being most sensitive to the impact of *C. globosum*.

All *A. ochraceus* isolates inhibited the growth of *F. avenaceum*, and the mycelium of less resistant isolates (10038, 10395, 10169) was destroyed. Fungistatic trophic and mutual antagonisms between *F. avenaceum* and *A. ochraceus* were ascertained. The form of interaction depended on the *F. avenaceum* isolate (Figure, Table 2).

Fungistatic trophic antagonism predominated in the interactions between *F. avenaceum* and *T. flavus*, amounting even to 88.3% of all cases (Figure). The growth of *F. avenaceum* was faster and more intensive; its mycelium reached and overgrew the colony of *T. flavus*. However, the growth of *T. flavus* did not stop. On the contrary, *T. flavus* began to inhibit the growth of *F. avenaceum* and to grow on it. The impact of all *T. flavus* isolates was similar and the interaction mostly depended on a *F. avenaceum* isolate. The *F. avenaceum* isolates 10038 and 10093 were most resistant. The antagonism was most evident between *F. avenaceum* isolates and *T. flavus* isolate 10458.

When investigating the interaction between *F. avenaceum* and *G. catenulatum*, it was observed that at the beginning the growth of *F. avenaceum* was more intensive and abundant, and its mycelium began to overgrow the colonies of *G. catenulatum*. However, the growth of *G. catenulatum* did not stop. Its growth continued and *G. catenulatum* began to inhibit the growth of *F. avenaceum*, more or less overgrowing its mycelium. The *G. catenulatum* isolate 10250 abundantly overgrew all *F. avenaceum* isolates. The *F. avenaceum* isolates 10141 and 10093 were most resistant to the impact of *G. catenulatum*. The antagonism was most evident between the *F. avenaceum* isolates and the *G. catenulatum* isolate 10323: both fungi inhibited the growth of each other, and a distinct inhibition zone developed in the majority of cases. The mycelium of *F. avenaceum* isolates 10169 and 10189 lysed under the impact of this *G. catenulatum* isolate. The territorial antagonism between *F. avenaceum* and *G. catenulatum* reached even 90.0% of interactions (Figure).

This investigation has shown that the interactions of *F. avenaceum* with other root-associated fungi are diverse and depend on the species and particularly on the isolate. Most *F. avenaceum* isolates stopped the growth of *F. culmorum*, *F. oxysporum* and *B. sorokiniana* and heavily overgrew their mycelium. The other fungi (*A. ochraceus*, *C. globosum*, *G. catenulatum*, *F. sambucinum var. minus*, *Rhizoctonia* spp., *T. flavus*) suppressed the growth of *F. avenaceum*. The *F. avenaceum* isolates 10141 and 10093 were most resistant and the isolate 10169 was most sensitive to the impact of the root-associated fungi studied. The highest suppression ability was revealed for *Rhizoctonia* spp., *C. globosum* and *A. ochraceus.* Some of their isolates destroyed the mycelium of *F. avenaceum* and demonstrated a fungistatic or even a fungicidal effect.

CONCLUSIONS

1. *Fusarium avenaceum* is widespread in the roots of cereal as well as neighbouring wild-growing plant species. The distribution frequency of this pathogen in the roots of the study plants exceeded 9.7%.

2. The interactions of *Fusarium avenaceum* with other root-associated fungi are diverse and depend on the species and particularly on the isolate. Fungistatic trophic and mutual antagonisms prevailed among them. The *F. avenaceum* isolates 10141 and 10093 were most resistant and the isolate 10169 was most sensitive to the impact of the studied root-associated fungi.

3. *Aspergillus ochraceus*, *Chaetomium globosum* and *Rhizoctonia* spp. suppressed the growth of *F. avenaceum* most strongly, demonstrating a fungistatic or even a fungicidal effect.

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References

1. Arx J. A. The Genera of Fungi Sporulating in Pure Culture. Vaduz: J. Cramer Verlag, 1981. 424 p.
2. Booth C. The Genus *Fusarium*. Kew, Surrey: Commonwealth Mycological Institute, 1971. 237 p.
3. Doohan F. M., Brennan J., Cooke B. M. Influence of climatic factors on *Fusarium* species pathogenic to cereales // European Journal of Plant Pathology. 2003. Vol. 109. P. 755–5–768.
4. Dawson W. A. J. M., Bateman G. L. Fungal communities on roots of wheat and barley and effects of seed treatments containing fluquinconazole applied to control take-all // Plant Pathology. 2001. Vol. 50. P. 75–82.
5. Ellis M. B. More Dematiaceous Hyphomycetes. Kew: Commonwealth Mycological Institute, 1976. 507 p.
6. Fernandez M. R. Pathogenisity of *Fusarium avenaceum* isolates from cereal and non cereal crops on durum wheat // Canadian Journal of Plant Pathology. 2002. Vol. 24. P. 95.
7. Gerlach W., Nirenberg H. The Genus *Fusarium* – a Pictorial Atlas. Berlin-Dahlem: Mitt. Biol. Bundesanst. Land- und Forstwirt., 1982. 406 p.
8. Gonzalez M. S., Trevathan L. E. Identity and pathogenicity of fungi associated with root and crown rot of soft red winter wheat grown on the upper coastal plain land resource area of Missisippi // Journal of Phytopathology. 2000. Vol. 148(2). P. 77–85.
9. Golæbniak B. The response of meadow fescue, perennial ryegrass and Italian ryegrass to infection by *Fusarium avenaceum, F. culmorum* and *F. graminum* // Journal of Plant Protection Research. 2001. Vol. 41(4). P. 78–84.
10. Hwang S. F., Gossen B. D., Turnbull G. D. et al. Effect of temperature, seeding date, fungicide seed treatment and inoculation with *Fusarium avenaceum* on seedling survival, root rot severity and yield of lentil // Canadian Journal of Plant Science. 2000. Vol. 80(4). P. 899–907.
11. Maèkinaitë R. *Fusarium culmorum* (Wm. G. Sm.) Sacc. interaction with other root-associated fungi of cereals // Biologija. 2001. Nr. 3. P. 30–33.
12. Methods for Research on Soilborne Phytopathogenic Fungi. Ed. Singleton L. L., Mihail D. J., Rush C. M. St. Poul, Minnesota: APS Press, 1993. 265 p.
13. Nelson O. P., Toussoun T. A., Marasas W. F. O. *Fusarium* Species: An Illustrated Manual for Identification. London: The Pennsylvania State University Press, University Park, 1983. 193 p.
14. Patkowska E. The role of rhizosphere antagonistic microorganisms in limiting the infection of underground parts of spring wheat // Electronic Journal of Polish Agricultural Universities. Horticulture. 2002. Vol. 5(2). P. 1–7.
15. Pettitt T., Xu X., Parry D. Association of *Fusarium* species in wheat stem rot complex // European Journal of Plant Pathology. 2003. Vol. 109. P. 769–774.
16. Weber R., Kita W., Hrynczuk B. et al. Effects of tillage methods on the occurrence of culm base disease in several winter wheat cultivars // Electronic Journal of Polish Agricultural Universities. Agronomy. 2001. Vol. 4(2). P. 1–14.
17. Бабушкина И. Н. Взаимоотношения почвенных микроскопических грибов с *Verticillium dahliae* Kleb. // Микология и фитопатология. 1974. № 8(5). С. 395–401.
18. Билай В. И. Фузарии. Киев: Наукова думка, 1977. 442 с.

19. Дудка И. А. Методы экспериментальной микологии. Киев: Наукова думка, 1982. 550 с.
20. Методические указания. Изучение популяций возбудителей фузариозного и вертицилезного вилта сельскохозяйственных культур. Ленинград: ВИЗР, 1985. 27 с.

Rimutë Maèkinaitë

FUSARIUM AVENACEUM (FR.) SACC. IR KITØ MIKROMICETØ, APTINKAMØ AUGALØ ÐAKNYSE, IÐPLITIMAS IR TARPUSAVIO RYÐIAI

Santrauka

Tyrimai parodë, kad *Fusarium avenaceum* yra plaèiai iðplitæs augalø ðaknyse. Jis buvo identifikuotas kvieèiø, rugiø, mieþiø, aviþø, taip pat 13 ðalia auganèiø spontaninës floros augalø ðaknyse. Jo iðplitimo daþnis augalø ðaknyse siekë 9,7%. *F. avenaceum* ir devyniø daþniausiai tirtø augalø ðaknyse aptinkamø mikromicetø tarpusavio ryðiai *in vitro* yra labai ávairûs ir priklauso nuo mikromiceto rûðies bei izoliato. Ið keturiø tarpusavio ryðiø formø vyravo fungistatinis trofinis ir tarpusavio antagonizmas. Labiausiai *F. avenaceum* augimà stabdë *Aspergillus ochraceus, Chaetomium globosum* ir *Rhizoctonia* spp.

Raktaþodþiai: javai, spontaninës floros augalai, *Fusarium avenaceum*, ðaknø mikromicetai, tarpusavio ryšys, išplitimas

Римуте Мачкинайте

РАСПРОСТРАНЕНИЕ И ВЗАИМООТНОШЕНИЯ *FUSARIUM AVENACEUM* (FR.) SACC. С ДРУГИМИ МИКРОМИЦЕТАМИ, ОБИТАЮЩИМИ В КОРНЯХ РАСТЕНИЙ

Резюме

Исследования показали, что *Fusarium avenaceum* является одним из наиболее распространенных микромицетов, обитающих в корнях растений. Он обнаружен в корнях пшеницы, ржи, ячменя, овса, а также в корнях 13 родов рядом с названными растущих диких растений. Частота его встречаемости составляет 9,7%. Исследование *in vitro* взаимоотношений *F. avenaceum* с девятью другими наиболее часто встречаемыми в пораженных корнях растений микромицетами показало, что эти взаимоотношения очень разнообразны и в значительной мере зависят от рода и изолята исследуемого гриба. Фунгистатический трофный и взаимный антагонизмы преобладали среди четырех форм взаимоотношений исследованных микромицетов. *Aspergillus ochraceus, Chaetomium globosum* и *Rhizoctonia* spp. наиболее сильно подавляли рост *F. avenaceum*.

Ключевые слова: зерновые злаки, дикорастущие растения, *Fusarium avenaceum*, микромицеты корней, взаимоотношения, распространение