JOURNAL OF PLANT PROTECTION RESEARCH
Vol. 41, No. 4 2001

THE RESPONSE OF MEADOW FESCUE, PERENNIAL RYEGRASS AND ITALIAN RYEGRASS TO INFECTION BY *FUSARIUM AVENACEUM, F. CULMORUM* AND *F. GRAMINUM*

BARBARA GOŁĘBNIAK

Agricultural University, Department of Phytopathology,
Dąbrowskiego 159, 60-594 Poznań, Poland
e-mail: zweber@au.poznan.pl

Accepted: September 19, 2001

Abstract: In greenhouse experiments the susceptibility of meadow fescue, perennial ryegrass and Italian ryegrass to *Fusarium avenaceum, F. culmorum* and *F. graminum* infection was studied. Various responses to *Fusarium* spp. infection were observed among the tested grass species and their cultivars. Meadow fescue was the most susceptible to all the *Fusarium* isolates used. *F. avenaceum* isolates also strongly reduced perennial ryegrass emergence. In the experiments with Italian ryegrass the number of seedlings having survived the artificial infection of seeds with *Fusarium* spp. was significantly larger for Atos, Gran, Mitos and Polus cultivars than for Kroto, Lotos and Tur. All of the studied grasses were more susceptible to the strongly pathogenic *F. avenaceum* isolates than to *F. culmorum* and *F. graminum* isolates, having moderate pathogenicity.

Key words: meadow fescue, perennial ryegrass, Italian ryegrass, *Fusarium avenaceum, F. culmorum, F. graminum,* susceptibility

I. INTRODUCTION

Fusarium spp. occurrence on and harmfulness for grasses has been the subject of many surveys, including Mühle et al. 1975; Prończuk et al. 1984; Winter 1986; Engels and Kramer 1996; Cagas et al. 1998; Korbas and Gwiazdowski 1999; Prończuk 2000. The various symptoms appearing on grasses and caused by these fungi comprise: pre-emergence and post-emergence damping-off, snow mould, or root and stem rot. *Fusarium* fungi cause losses on grassland, seed plantations and in lawn maitenance.

Breeding and cultivation of resistant varieties is a way to prevent grass diseases caused by *Fusarium* spp. (Jamalainen 1974; Prończuk et al. 1984; Prończuk 2000). Resistant or less susceptible forms are searched for. Though there is a rich literature of fodder grass susceptibility to *Fusarium nivale* (*Microdochium nivale*), data concerning grass infection by the other *Fusarium* species are scarce.

The aim of this study was to evaluate susceptibility to *Fusarium avenaceum, F. culmorum* and *F. graminum* in some cultivars of major fodder grass species.

II. MATERIAL AND METHODS

The species and cultivars of grasses covered by these studies are detailed in table 1. Infection of the cultivars by the *Fusarium* spp. was evaluated in greenhouse conditions and in pot experiments conducted in the years 1998–1999. The experiments were carried out in autumn. The average daily temperature ranged from 11°C to 19°C when the minimum temperature was 8.5°C and the maximum temperature was 26.8°C.

Table 1

Species and cultivars of grasses tested in greenhouse experiments

Species	Cultivars	Origin of seeds
Festuca pratensis Huds.	Skawa, Skra, Skrzeszowicka, POB 592	Plant Breeding Station Krzeszowice
Lolium perenne L.	Anna, Argona, Arka, Maja	Plant Breeding Station Marchwacz
	Niga, Nira	Plant Breeding Station Nieznanice
Lolium multiflorum Lam.	Atos, Gran, Kroto, Lotos, Mitos, Polus, Tur	Plant Breeding Station Szelejewo

The studied grasses were inoculated with *Fusarium avenaceum* (Fr.) Sacc.– two isolates of which were obtained from barley grains (F-1 and F-2), *F. culmorum* (W. G. Smith) Sacc. – the isolate C-3 obtained from perennial ryegrass stems, and *F. graminum* Corda – the isolate G-4 from corn seedlings. The isolates obtained were identified according to Booth (1971) and Kwaśna et al. (1991).

In infection tests the pots (10-cm-diameter) were filled with steamed soil. Fourteen-day-old cultures of fungi, grown on PDA medium (Sigma Chemical Co.), were removed from Petri dishes and placed in pots on soil. Next on the surface of inoculum (prepared as disk of 90-mm-diameter of PDA overgrown with mycelium of the above-mentioned *Fusarium* isolates) 50 seeds of grass per pot were placed.

Then the seeds were covered with a thin layer of steamed soil. Four replications (4 x 50 seeds per pot) were performed for each cultivar and *Fusarium* isolate. The same number of seeds were used in the control combination (without inoculum). The results of the infection experiments, assessed after 2, 4, 6 and 8 weeks, were based on the number of seedlings, which had survived the artificial infection. This assessment criterion was chosen after Mańka (1989). The obtained results were analyzed statistically, using STAT computer program. Two-factor variance analysis was applied, and mean values were compared using Duncan's test, with significance level $\alpha = 0.05$.

III. RESULTS

Various infections by *Fusarium* spp. were observed among the fodder grass species and cultivars covered by these studies. Meadow fescue proved to be the most susceptible, few of its seedlings having survived artificial infection with *F. avenaceum* and *F. graminum* isolates (Tabs 2, 3). In the combination with *F. culmorum*, the number of seedlings having survived the greenhouse test was significantly larger for Skra and Skrzeszowicka cultivars than for Skawa cultivar and POB 592 line (Tab. 2).

Table 2

Infection of meadow fescue cultivars by *Fusarium avenaceum* and *F. culmorum*

Cultivars	Percentage of healthy seedlings in combinations*		
	without inoculum	seeds inoculated with	
		F. avenaceum F-1	*F. culmorum*
Skawa	88^{e}	7^{ab}	6^{ab}
Skra	88^{e}	2^{ab}	20^{d}
Skrzeszowicka	84^{e}	9^{bc}	16^{cd}
POB 592 line	76^{e}	1^{a}	4^{ab}

*Mean values from four observations. Values followed by different letters are significantly different at level $\alpha = 0.05$

Table 3

Infection of meadow fescue cultivars by *Fusarium avenaceum* and *F. graminum*

Cultivars	Percentage of healthy seedlings in combinations*		
	without inoculum	seeds inoculated with	
		F. avenaceum F-2	*F. graminum*
Skawa	84^{e}	0^{a}	4^{bc}
Skra	80^{e}	0^{a}	7^{c}
Skrzeszowicka	77^{e}	0^{a}	5^{c}
POB 592 line	49^{d}	0^{a}	1^{ab}

*Explanations see Table 2

F. avenaceum isolates also strongly reduced perennial ryegrass emergence (Tabs. 4, 5). However, for the combination with *F. culmorum* the percentage of emerged, healthy seed-

Table 4

Infection of perennial ryegrass cultivars by *Fusarium avenaceum* and *F. culmorum*

Cultivars	Percentage of healthy seedlings in combinations*		
	without inoculum	seeds inoculated with	
		F. avenaceum F-1	*F. culmorum*
Anna	74^{gh}	1^{a}	48^{de}
Argona	69^{fgh}	8^{c}	50^{def}
Arka	85^{gh}	8^{c}	68^{fgh}
Maja	86^{gh}	6^{bc}	75^{gh}
Niga	79^{gh}	6^{bc}	42^{d}
Nira	81^{gh}	2^{ab}	62^{efg}

*Explanations see Table 2

Table 5

Infection of perennial ryegrass cultivars by *Fusarium avenaceum* and *F. graminum*

Cultivars	Percentage of healthy seedlings in combinations*		
	without inoculum	seeds inoculated with	
		F. avenaceum F-2	*F. graminum*
Anna	85^{g}	5^{ab}	33^{de}
Argona	75^{g}	0^{a}	29^{de}
Arka	87^{g}	11^{bc}	60^{fg}
Maja	89^{g}	1^{a}	41^{ef}
Niga	72^{g}	3^{ab}	33^{de}
Nira	86^{g}	0^{a}	16^{cd}

*Explanations see Table 2

lings was quite large, for some cultivars ('Arka', 'Maja') showing no significant difference in relation to the control combination (Tab. 4). Even in this combination, though, some seedlings showed fusariosis symptoms and died. In the variant with *F. graminum*, Arka cultivar was the only one for which the number of healthy seedlings obtained showed no significant difference in relation to the control combination (Tab. 5).

In the experiments with Italian ryegrass, substantial differences were observed in responses of cultivars to the infection of *F. avenaceum* isolates (Tabs. 6, 7). The number of seedlings having survived the artificial infection was significantly larger for Atos, Gran and Polus cultivars than for Kroto, Lotos, Mitos and Tur. Also for combination with *F. culmorum*, healthy seedlings of Atos, Gran, Mitos and Polus outnumbered significantly those of the other Italian ryegrass cultivars (Tab. 6). In the combination with *F. graminum*, the number of seedlings that survived the greenhouse test was substantially larger than in

Table 6

Infection of Italian ryegrass cultivars by *Fusarium avenaceum* and *F. culmorum*

Cultivars	Percentage of healthy seedlings in combinations*		
	without inoculum	seeds inoculated with	
		F. avenaceum F-1	*F. culmorum*
Atos	98^{f}	42^{c}	84^{ef}
Gran	99^{f}	55^{d}	86^{ef}
Kroto	95^{ef}	28^{b}	56^{d}
Lotos	92^{ef}	6^{a}	50^{cd}
Mitos	98^{f}	28^{b}	77^{e}
Polus	98^{f}	45^{cd}	81^{ef}
Tur	97^{f}	25^{b}	49^{cd}

*Explanations see Table 2

Table 7

Infection of Italian ryegrass cultivars by *Fusarium avenaceum* and *F. graminum*

Cultivars	Percentage of healthy seedlings in combinations*		
	without inoculum	seeds inoculated with	
		F. avenaceum F-2	F. graminum
Atos	93^{h}	9^{b}	77^{efg}
Gran	97^{h}	9^{b}	86^{fgh}
Kroto	93^{h}	6^{b}	69^{de}
Lotos	91^{gh}	1^{a}	35^{c}
Mitos	96^{h}	3^{a}	59^{d}
Polus	95^{h}	9^{b}	72^{def}
Tur	86^{fgh}	2^{a}	43^{c}

*Explanations see Table 2

the combination with the strongly pathogenic *F. avenaceum* isolate (F-2) used as inoculum (Tab. 7). Italian ryegrass seedlings having survived artificial infection with *F. avenaceum* isolates were growing normally, without any symptoms of fusariosis.

IV. DISCUSSION

The studied grasses showed various responses to *F. avenaceum*, *F. culmorum* and *F. graminum* infection, depending on the *Fusarium* species/isolate used. Among the fodder grass species covered by these studies, meadow fescue was the most susceptible to all the *Fusarium* isolates used (Tab. 8). Perennial ryegrass proved to be very susceptible to *F. avenaceum*. Italian ryegrass showed low susceptibility to *F. culmorum* and *F. graminum*.

In Holmes's survey (1983), Italian ryegrass cultivars appeared to be highly resistant to *F. culmorum*. His studies indicate that meadow fescue is very susceptible to *F. culmorum*.

Table 8

Comparison of the responses of tested grass species to *Fusarium* spp. infection

Grass species	Percentage of seedlings which survived artificial inoculation with				
	Fusarium avenaceum		*Fusarium culmorum*	*Fusarium graminum*	average*
	F-1	F-2			
Meadow fescue	4.8	0.0	11.5	4.3	5.2^{a}
Perennial ryegrass	5.2	3.3	57.5	35.3	25.3^{ab}
Italian ryegrass	32.7	5.6	69.0	63.0	42.6^{b}

*Values followed by different letters are significantly different at level $\alpha = 0.05$

Also Lutyńska and Witkowska (1983) claim low resistance of meadow fescue to fungal diseases.

According to Mesterhazy (1974), susceptibility of plants to infestation by *Fusarium* spp. depends on environmental conditions and varies with *Fusarium* species. This attitude is confirmed by the results obtained in these studies, where significant differences were observed in grass susceptibility to various *Fusarium* species and isolates. All of the studied grasses were more susceptible to the strongly pathogenic *F. avenaceum* isolates than to moderately pathogenic *F. culmorum* and *F. graminum* isolates. The strong pathogenicity of *F. avenaceum* to grasses was found by Ärsvoll in Norway (according to Prończuk et al. 1984). Its significant harmfulness for cereal seedlings was reported by Łacicowa and Kiecana (1987), Kiecana and Kocylak (1999), and others.

As proved by Jamalainen (1974), among grass species susceptible to *Fusarium* some resistant forms exist. According to this author, native cultivars and ecotypes show higher resistance and longer life than those imported from regions of other climate. Examining European perennial ryegrass ecotypes in terms of their resistance to snow mould in North-East Poland, Schmidt and Kaszuba (1997) found that ecotypes coming from Italy, Spain and Greece were the worst winter survivors, while the best ecotypes were from Poland and Czech Republic. According to these authors, greenhouse tests of resistance to snow mould can be used for determining potential winter damages in field conditions.

The results of these studies, provide information on potential menace to major fodder grass species and cultivars, caused by *F. avenaceum* and *F. culmorum*, the fungi common in the soil. The plants, which have survived the infection tests with strongly pathogenic isolates of *Fusarium* spp., could be used in resistance breeding.

ACKNOWLEDGEMENTS

The author wishes to thank Plant Breeding Stations: Szelejewo, Marchwacz, Krzeszowice and Nieznanice for supplying with the seeds of grass cultivars.

V. REFERENCES

1. Booth C. 1971. The genus *Fusarium*. Commonwealth Mycological Institute Kew, Surrey England, pp. 237.
2. Cagas B., Zemanova A., Fojtik A. 1998. *Fusarium* species a likely cause of *Lolium* wilt. Plant Protection Science 34 (3): 109–111.
3. Engels R., Kramer J. 1996. Incidence of *Fusaria* and occurrence of selected mycotoxins on *Lolium* spp. in Germany. Mycotoxin Res., 12 (1): 31–40.
4. Holmes S.J.I. 1983. The susceptibility of agricultural grasses to pre-emergence damage caused by *Fusarium culmorum* and its control by fungicidial seed treatment. Grass and Forage Science 38 (3): 209–214.
5. Jamalainen E.A. 1974. Resistance in winter cereals and grasses to low temperature parasitic fungi. Annual Rev. of Phytopathology 12: 281–302.
6. Kiecana I., Kocylak E. 1999. Pathogenicity of *Fusarium* spp. on oats seedlings (*Avena sativa* L.). Plant Breeding and Seed Science 43 (1): 91–99.
7. Korbas M., Gwiazdowski R. 1999. Grzyby chorobotwórcze występujące na wybranych gatunkach traw w roku 1998. Prog. Plant Protection/Post. Ochr. Roślin 39 (2): 797–800.

8. Kwaśna H., Chełkowski J., Zajkowski P. 1991. Grzyby (*Mycota*). T. XXII. Grzyby niedoskonałe (*Deuteromycetes*) Strzępczakowe (*Hyphomycetales*) Gruzełkowate (*Tuberculariaceae*) Sierpik (*Fusarium*). PAN. Warszawa–Kraków: 1–136.
9. Lutyńska R., Witkowska A. 1983. Ocena zdrowotności krajowych i zagranicznych traw badanych na terenie Polski południowej. Biul. IHAR 150: 109–116.
10. Łacicowa B., Kiecana I. 1987. Występowanie *Fusarium culmorum* (W.G. Smith) Sacc. i *Fusarium avenaceum* (Fries) Sacc. na pszenżycie oraz podatność rodów hodowlanych na porażenie. Rocz. Nauk Roln. – Seria E – Ochrona Roślin 17 (1): 161–178.
11. Mańka M. 1989. Patogeniczność wybranych gatunków z rodzaju *Fusarium* dla siewek zbóż. Rocz. AR, Poznań, Rozprawy Nauk., 201: 1–64.
12. Mesterhazy A. 1974. Fusarium diseases of wheat and triticale in Southeast Hungary. Cereal Res. Commun., 2–3: 167–173.
13. Mühle E., Frauenstein K., Schumann K., Wetzel T. 1975. Choroby i szkodniki traw pastewnych. PWRiL, Warszawa.
14. Prończuk M., Prończuk S., Góral S. 1984. Wpływ chorób fuzaryjnych na trwałość *Lolium perenne* L. Biul. IHAR 155: 187–192.
15. Prończuk M. 2000. Choroby traw – występowanie i szkodliwość w uprawie na nasiona i użytkowaniu trawnikowym. Monografie i Rozprawy Nauk. IHAR 2000, Radzików, 4: 1–183.
16. Schmidt J., Kaszuba J.W. 1997. Uszkodzenia zimowe a plonowanie europejskich ekotypów życicy trwałej *Lolium perenne* L. Zesz. Probl. Post. Nauk Roln., 451: 287–292.
17. Winter W. 1986. Winter killing in pure ryegrass stands, the importance of fungal pathogens and their possible control. I. Results from field trials with natural infection. J. of Phytopathology 117 (3): 226–243.

VI. POLISH SUMMARY

REAKCJA KOSTRZEWY ŁĄKOWEJ, ŻYCICY TRWAŁEJ ORAZ ŻYCICY WIELOKWIATOWEJ NA ZAKAŻENIE PRZEZ *FUSARIUM AVENACEUM, F. CULMORUM* I *F. GRAMINUM*

Reakcję kilku ważniejszych gatunków traw pastewnych i ich odmian na zakażenie przez *Fusarium* spp. oceniano w stadium siewki, w doświadczeniach infekcyjnych, przeprowadzonych w warunkach szklarniowych w latach 1998–1999.

Badane trawy różnie reagowały na zakażenie przez *Fusarium* spp. W warunkach sztucznej infekcji najbardziej podatna na zastosowane izolaty okazała się kostrzewa łąkowa (*Festuca pratensis*). Izolaty *F. avenaceum* spowodowały silną redukcję wschodów życicy trwałej (*Lolium perenne*). W doświadczeniach z życicą wielokwiatową (*Lolium multiflorum*) stwierdzono duże różnice w reakcji odmian na zakażenie *F. avenaceum* – liczby siewek, które przeżyły sztuczną inokulację nasion u odmian Atos, Gran, Polus, były istotnie większe niż u odmian Kroto, Lotos, Mitos i Tur. Życica wielokwiatowa charakteryzowała się małą podatnością na *F. culmorum* i *F. graminum*.

W przeprowadzonych badaniach zaznaczyły się wyraźnie różnice w reakcji badanych traw na gatunki i izolaty *Fusarium*. Wszystkie badane trawy były bardziej podatne na silnie patogeniczne izolaty *F. avenaceum* niż na średnio patogeniczne izolaty *F. culmorum* oraz F. *graminum*.