PATHOGENICITY OF FUSARIUM SPP. ISOLATED FROM WEEDS AND PLANT DEBRIS IN EASTERN CROATIA TO WHEAT AND MAIZE

Ilić, Jelena; Ćosić, Jasenka; Jurković, Draženka; Vrandečić, Karolina

ISSN 1330-7142
UDK = 632.25:633.11+633.15

PATHOGENICITY OF *FUSARIUM* SPP. ISOLATED FROM WEEDS AND PLANT DEBRIS IN EASTERN CROATIA TO WHEAT AND MAIZE

Jelena Ilić, Jasenka Ćosić, Draženka Jurković, Karolina Vrandečić

Original scientific paper
Izvorni znanstveni članak

SUMMARY

Pathogenicity of thirty isolates representing 14 Fusarium species isolated from weeds and plant debris in eastern Croatia was investigated in the laboratory. Pathogenicity tests were performed on wheat and maize seedlings. The most pathogenic Fusarium spp. was F. graminearum isolated from Amaranthus retroflexus, Abutilon theophrasti and Chenopodium album. There was a noticeable inter- and intraspecies variability in pathogenicity towards wheat and maize. Isolates of F. solani from Sonchus arvensis and F. verticillioides from C. album were highly pathogenic to wheat seedlings and apathogenic to maize seedlings. Isolates of F. venenatum were very pathogenic to wheat and maize being the first report about pathogenicity of this species. This experiment proves that weeds and plant debris can serve as alternate hosts and source of inoculum of plant pathogens.

Key-words: pathogenicity, Fusarium spp., weeds, plant debris

INTRODUCTION

Genus *Fusarium* belongs to class *Hyphomycetes*, order *Hyphales* including over 1000 species, both saprophytic and phytopathogenic. *Fusarium* species are present in all parts of the world, some of them are ubiquist, while other can live only in specific climate conditions. They were isolated from eternal ice on Arctic and sand of Sahara desert (Booth 1971). Pathogenic *Fusarium* species cause diseases, mycosis of plants and mycotoxicosis of animals and humans. Many consider this fungal genus as the one of the most important with species that can significantly influence yield and quality of cultivated plants. It is supposed that the number of *Fusarium* species is much higher than currently reported.

Depending on the plant species and the stage of plant development *Fusarium* spp. can cause various plant diseases: seed rot, seedlings blight, root rot, bulb rot, rot of lower stem part, head blight, ear rot, tracheofusariosis (Lević, 2008).

Fusarium species belong to the most commonly isolated plant pathogens and, as many other fungi, can survive on different substrates. For example they were found in conserved food, stored chemicals and fuel tanks (Gaylarde et al., 1999). Numerous weed species can serve as alternate hosts to fungal plant pathogens and several authors have proved that fungal isolates from symptomless weed can be pathogenic to cultivated plants (Helbig and Caroll, 1984; Jenkinson and Parry 1994; Inch and Gilbert 2003).

Among other pathogenic fungal species, *Fusarium* spp. can also often be found on plant debris (Parry et al., 1995; Vrandečić et al., 2006; Postic et al., 2012). In Croatia, several authors have investigated this issue and determined the significant presence of maize, wheat, sunflower and soybean pathogens and their pathogenicity to cultivated plants (Vrandecic et al., 2003; Svitlica et al., 2008; Ćosić et al., 2009).

Plant debris can also serve as hosts for plant pathogens survival during unfavourable conditions. Pereyra et al. (2004) investigated survival and inoculum production of *Gibberella zeae* (Schw.) Petch on wheat debris in the field and determined that fungi can survive for more than two years after the harvest.

Cotten and Munkvold (1998) investigated survival of *F. moniliforme* Sheld., *F. proliferatum* (Matsushima) Nirenberg and *F. subglutinans* (Wollenw. & Rein.) Nelson,

DSc Jelena Ilić (jelena.ilic@pfos.hr), Prof.DSc Jasenka Ćosić, Prof. DSc Draženka Jurković, Prof.DSc Karolina Vrandečić – J.J. Strossmayer University of Osijek, Faculty of Agriculture in Osijek, K. Petra Svačića 1d, 31000 Osijek, Croatia

Tousson & Marasas on maize debris in the field and determined that they can survive for at least 630 days and in such way serve as a long term inoculum source for infection of cultivated plants.

In previous research we isolated *Fusarium* spp. from plant debris and symptomless weeds from the field. The objective of this research was to investigate pathogenicity of selected *Fusarium* spp. isolated from weeds and plant debris to wheat and maize seedlings.

MATERIAL AND METHODS

In the laboratory trials we investigated the pathogenicity of 30 monosporic isolates of *Fusarium* spp. representing 14 *Fusarium* species: *Fusarium acuminatum* Ellis & Everhart, *Fusarium avenaceum* (Fries) Sacc., *Fusarium concolor* Reinking, *Fusarium crookwellense* Burgess, Nelson & Tousson *Fusarium equiseti* (Corda) Saccardo, *Fusarium graminearum* Schw., *Fusarium oxysporum* Schlech. emend. Snyder & Hansen, *Fusarium proliferatum* (Matsushima), *Fusarium semitectum* Berk. & Rav., *Fusarium solani* (Martius) Appel & Wollenw. emend. Snyder & Hansen, *Fusarium sporotrichioides* Sherb., *Fusarium subglutinans* (Wollenw. & Rein.) Nelson, Tousson & Marasas, *Fusarium venenatum* Nirenberg *and Fusarium verticillioides* (Sacc.) Nirenberg. Isolates originated from the hosts *Abutilon theophrasti* Med., *Agrostemma githago* L., *Amaranthus retroflexus* L., *Ambrosia artemisiifolia* L., *Arctium lappa* L., *Capsella bursa pastoris* L. Medik., *Chenopodium album* L., *Sonchus arvensis* L., *Sorghum halepense* (L.) Pers. and maize debris (Table 1) were collected from agricultural fields on 12 locations in Eastern Croatia.

Table 1. *Fusarium* spp. used for pathogenicity tests and their hosts

Tablica 1. Fusarium spp. primijenjene za test patogenosti i njihovi domaćini

Fusarium spp.	Host - *Domaćin*	*Fusarium* spp.	Host - *Domaćin*
F. acuminatum 88	*A. theophrasti*	*F. proliferatum* 101	*C. album*
F. acuminatum 265	*C. bursa pastoris*	*F. semitectum* 125	*A. theophrasti*
F. avenaceum 312	*A. githago*	*F. solani* 112	*C. album*
F. concolor 282	maize debris	*F. solani* 149	*S. arvensis*
F. crookwellense 271	*A. lappa*	*F. solani* 185	*A. theophrasti*
F. equiseti 50	*A. theophrasti*	*F. sporotrichioides* 1	maize debris
F. graminearum 92	*A. theophrasti*	*F. sporotrichioides* 4	maize debris
F. graminearum 249	*A. retroflexus*	*F. subglutinans* 91	*A. theophrasti*
F. graminearum 277	*C. album*	*F. subglutinans* 111	*C. album*
F. oxysporum 61	*A. theophrasti*	*F. venenatum* 21	*A. theophrasti*
F. oxysporum 87	*A. theophrasti*	*F. venenatum* 24	maize debris
F. oxysporum 99	*A. artemisiifolia*	*F. venenatum* 193	maize debris
F. oxysporum 119	*A. artemisiifolia*	*F. verticillioides* 68	*A. retroflexus*
F. oxysporum 175	*S. halepense*	*F. verticillioides* 102	*C. album*
F. proliferatum 86	*A. theophrasti*	*F. verticillioides* 305	*A. githago*

Pathogenicity of selected *Fusarium* spp. were tested on wheat seedlings with the method described by Mesterhazy (1978). Pure 7-day old cultures of *Fusarium* spp. were homogenized by adding 40 ml of destiled water to each Petri dish. Ten wheat grains, previously disinfected in ethanol, were placed in each Petri dish, covered with 10 ml of mycelial suspension and incubated for 24 hours (12 hours light/12 hours dark regime) at 20°C. As a control 10 grains were covered with the equal amount of distilled water. Inoculated grains were planted into sterile sand (3 hours at 100°C), at room temperature and watered when needed. Grading of healthy and diseased seedlings was done after 15 days at scale 0 to 5 (0 – healthy seedling, 5 – rot seedling, non-germinating). Based on these grades we determined Disease Index by McKinney (1923).

$$\mathrm{I} = \frac{\sum (nxk)}{NxK} x100$$

n – number of plants by categories

k – number of categories

N – number of all investigated plants

K – number of adopted categories

We also determined the pathogenicity of chosen *Fusarium* species to maize seedlings using the method described by Molot-Simone (1967): selected *Fusarium* spp. were grown on PDA (Potato Dexstroze Agar) media and kept in a growth chamber at 22°C, with 12 hours day/12 hours night regime. After 7 days mycelial suspension was prepared from and maize grains were inoculted in Petri dishes. The control was covered with the equal amount of distilled water. Petri dishes were kept for 48 hours at 22°C in the dark and for 72 hours at 10°C. We planted inoculated grains into pots with sand. Pots with inoculated maize grains were placed in growing chamber at 22°C and 12/12 light regime and watered with distilled water. At the stage of three leaves we removed the plants from the pots and graded root and hypocotile rot by the scale 0 to 5 (0 – healthy seedling, 5 – rot seedling, non-germinating). Based on these grade scale the Disease Index was determined using McKinney formula (1923).

RESULTS AND DISCUSSION

All tested isolates of *Fusarium* spp. were pathogenic to wheat seedlings and the disease index was statistically significantly higher than the disease index of the control (5.5). The most pathogenic isolates were *F. graminearum* isolated from *A. retroflexus* and *A. theophrasti* and *F. solani* from *S. arvensis* with disease index 100.0. (Table 2).

Table 2. Pathogenicity of *Fusarium* isolates for wheat seedlings

Tablica 2. Patogenost Fusarium izolata za klijance pšenice

Fusarium spp.	Disease index *Indeks bolesti*	*Fusarium* spp.	Disease index *Indeks bolesti*
F. graminearum 249	100.0^{A}	*F. oxysporum* 87	70.0^{DEF}
F. graminearum 92	100.0^{A}	*F. concolor* 282	67.5^{DEFG}
F. solani 149	100.0^{A}	*F. semitectum* 125	66.0^{DEFG}
F. crookwellense 271	95.0^{AB}	*F. avenaceum* 312	60.0^{EFGH}
F. venenatum 193	90.0^{ABCD}	*F. solani* 112	57.5^{FGHI}
F. venenatum 21	90.0^{ABCD}	*F. acuminatum* 88	56.5^{FGHI}
F. acuminatum 265	82.5^{ABCD}	*F. equiseti* 50	51.5^{FGHI}
F. verticillioides 305	82.5^{ABCD}	*F. venenatum* 24	51.25^{FGHI}
F. subglutinans 91	81.5^{ABCD}	*F. oxysporum* 175	50.0^{GHI}
F. proliferatum 101	80.0^{BCD}	*F. proliferatum* 86	47.5^{HIJ}
F. sporotrichioides 1	80.0^{BCD}	*F. verticillioides* 68	45.0^{HIJ}
F. graminearum 277	77.5^{BCD}	*F. solani* 185	42.5^{HIJ}
F. sporotrichioides 4	76.0^{BCD}	*F. oxysporum* 99	40.0^{HIJ}
F. oxysporum 119	72.5^{CDE}	*F. oxysporum* 61	27.5^{J}
F. subglutinans 111	72.5^{CDE}	Control	5.5^{K}
F. verticillioides 102	72.5^{CDE}		

*values in columns marked with the same letter do not have significant difference according to LSD test (P<0.05) - *vrijednosti u stupcima označene istim slovom ne razlikuju se značajno prema LSD testu (P<0,05)

Regarding the pathogenicity of selected *Fusarium* isolates to maize seedlings, the most pathogenic was the isolate *F. graminearum* from *A. theophrasti* with disease index 96 (Table 3).

Table 3. Disease index of artificial infection of maize seedlings with *Fusarium* spp.

Tablica 3. Indeks bolesti umjetne infekcije klijanaca kukuruza s Fusarium spp.

Fusarium spp.	Disease index *Indeks bolesti*	*Fusarium* spp.	Disease index *Indeks bolesti*
F. graminearum 92	96^{A}	*F. proliferatum* 86	24.5^{EFGH}
F. avenaceum 312	95.5^{A}	*F. semitectum* 125	24^{EFGH}
F. graminearum 249	88.5^{A}	*F. acuminatum* 88	22^{FGHI}
F. subglutinans 111	86^{A}	*F. oxysporum* 175	20^{FGHI}
F. crookwellense 271	84.5^{A}	*F. solani* 112	18.5^{FGHI}
F. graminearum 277	75.5^{AB}	*F. sporotrichioides* 4	17.5^{FGHI}
F. subglutinans 91	63^{BC}	*F. solani* 185	17^{FGHI}
F. sporotrichioides 1	49^{CD}	*F. equiseti* 50	12.5^{FGHI}
F. venenatum 193	46.5^{CD}	*F. oxysporum* 119	12.5^{FGHI}
F. oxysporum 87	45^{CDE}	*F. proliferatum* 101	10^{GHI}
F. venenatum 24	45^{CDE}	*F. verticillioides* 68	8.5^{GHI}
F. verticillioides 305	33.5^{DEF}	*F. oxysporum* 61	8^{GHI}
F. venenatum 21	32^{DEF}	*F. solani* 149	6.5^{HI}
F. oxysporum 99	28.5^{DEFG}	*F. verticillioides* 102	2.5^{I}
F. acuminatum 265	25^{EFGH}	Control	7.5^{GHI}
F. concolor 282	24.5^{EFGH}		

*values in columns marked with the same letter do not have significant difference according to LSD test (P<0,05) - **vrijednosti u stupcima označene istim slovom ne razlikuju se značajno prema LSD testu (P<0,05)*

The most pathogenic *Fusarium* species in our research was *F. graminearum.* Isolates of *F. graminearum* from *A. theophrasti*, *A. retroflexus* and *C. album* were very pathogenic to wheat and maize. Ćosić et al. (2007) determined that the most dominant *Fusarium* species found on wheat and barley in Croatia is *F. graminearum*. Spanic et al. (2010) in their research determined that the most significant pathogens which cause Fusarium Head Blight in eastern Croatia are *F. graminearum*, *F. avenaceum* and *F. culmorum*. In our research we also determined pathogenicity of other *Fusarium* spp. and noticed inter- and intraspecies variability and specialisation towards different hosts and phases of plant development. *F. avenaceum* isolated from *A. githago* was pathogenic to wheat seedlings and very pathogenic to maize seedlings. *F. crookwellense* isolated from *A. lappa* was very pathogenic to wheat and maize seedlings. Chehri et al. (2011) proved that *F. crookwellense* is pathogenic to wheat seedlings. *F. oxysporum* isolated from *A. artemisiifolia* caused very high disease index of wheat seedlings. On the other hand it was not pathogenic to maize seedlings. *F. oxysporum* isolated from *A. theophrasti* was pathogenic to wheat and maize seedlings. *F. semitectum* from *A. theophrasti* was very pathogenic to wheat seedlings and moderately pathogenic to maize seedlings. Tancic et al. (2009) determined moderate pathogenicity of *F. semitectum* to maize seeds.

F. solani isolated from *S. arvensis* had very high disease index of wheat seedlings (100 out of 100), whereas on the other hand very low disease index of maize seedlings. *F. solani* isolate from *C. album* was pathogenic to wheat seedlings and apathogenic to maize seedlings. *F. sporotrichioides* 1 and 4 isolated from maize debris had very high disease index of wheat seedlings, isolate 1 was pathogenic and isolate 4 apathogenic to maize seedlings. *F. subglutinans* isolated from *A. theophrasti* was very pathogenic to wheat and maize seedlings. *F. subglutinans* from *C. album* was pathogenic to wheat and maize seedlings. In our research *F. venenatum* proved to be highly pathogenic to wheat and maize and according to available literature we determined that this is the first report about the pathogenicity of *F. venenatum*. Isolates *F. verticillioides* 305 and 102 from *A. githago* and *C. album* were very pathogenic to wheat seedlings. On the other hand isolate 102 was apathogenic to maize seedlings and had lower disease index than the control, showing positive influence of *F. verticillioides* on maize seedlings germination and growth. Svitlica et al. (2008) investigated pathogenicity of *Fusarium* spp. to maize cobs and *F. graminearum* isolated from weed *S. halepense* was the most pathogenic. Jenkinson and Parry (1994) tested *Fusarium* isolates from weed and, out of 77 isolates, 75 were pathogenic to wheat seedlings. The most pathogenic isolates in their research were *F. avenaceum, F. culmorum* and *F. graminearum.*

Pathogenicity of isolates which belong to the same species can be significantly different. Manka (1989) investigated pathogenicity of 30 isolates of *F. culmorum* to wheat seedlings and determined that their pathogenicity varied from apathogenic to very pathogenic. Simmilar results were obtained by Chelkowski et al. (1995) for isolates of *F. verticillioides*. Different pathogenicity of six isolates of *F. graminearum* was studied by Asran and Buchenauer (2003), and determined statistically significant differences in pathogenicity of different isolates. It is in accordance with results of Nagy and Bagiu (2000), Ledenčan et al. (2001) and Jurkovic et al. (2002). Tancic et al. (2009) examined differences in pathogenicity of *Fusarium* spp. originating from maize kernels and wheat grains and determined inter- and intraspecies variability regarding the effects on maize seed germination. Some authors have proven that plant pathogens isolated from weeds are often more pathogenic compared to ones isolated from cultivated plants. Akinsanmi et al. (2007) determined that passage through alternative hosts changes the fitness of *F. graminearum* and *F. pseudograminearum.* They concluded that one passage through alternative hosts reduces pathogenicity, but at the same time provides better ability for colonisation of primary host. This could explain the lack of symptoms on alternative hosts. It is important to emphasize that our samples were surface sterilized and that weed did not exibit disease symptoms, which could mean that isolated *Fusarium* species live inside these plants as endophytes (Barrow et al. 2008.).

CONCLUSION

In this research we have determined pathogenicity of 30 *Fusarium* spp. isolated from weed and plant debris to wheat and maize seedlings. The most pathogenic *Fusarium* species in all pathogenicity tests was *F. graminearum*, isolated from *A. retroflexus*, *A. theophrasti* and *C. album*. In conclusion we can say that *Fusarium* spp. isolated from weed and plant debris from agricultural fields can be pathogenic to wheat and maize and that there is inter- and intraspecies variability in their pathogenicity.

REFERENCES

1. Akinsanmi, O.A., Chakraborty, S., Backhouse, D., Simpfendorfer, S. (2007): Passage trough alternative hosts changes the fitness of *Fusarium graminearum* and *Fusarium pseudograminearum*. Environmental Microbiology 9(2): 512-520.
2. Asran, M.R., Buchenauer, H. (2003): Pathogenicity of *Fusarium graminearum* isolates on maize (*Zea mays* L.) cultivars and relation with deoxynivalenol and ergosterol contents. Journal of Plant Diseases and Protection 110(3): 209-219.
3. Barrow, J.R., Lucero, M.E., Reyes-Vera, I., Havstad, K.M. (2008): Do symbiotic microbes have a role in plant evolution, performance and response to stress? Communicative & Integrative Biology 1(1): 1-5.
4. Booth, C. (1971): The Genus *Fusarium*. Commonwealth Mycological Institute Kew, Surrey, England.

5. Chehri, K., Maghsoudlou, E., Asemani, M., Mirzaei, M. R. (2011): Identification and pathogenicity of *Fusarium* species associated with head blight of wheat in Iran. Pakistan Journal of Botany 43(5): 2607-2611.
6. Chelkowski, J., Visconti, A., Dokko, B., Wisniewska, H. (1995): *Fusarium moniliforme* Sheldon - Pathogenicity to Wheat Seedlings and Ability to Produce Fumonisins. Journal of Phytopathology 143(8): 491-493.
7. Ćosić, J., Jurković, D., Vrandečić, K., Šimić, B., Steindl, D. (2007): Utjecaj *Fusarium* vrsta na klijavost pšenice. Zbornik radova 42. hrvatskog i 2. međunarodnog simpozija agronoma, 654-657.
8. Ćosic, J., Svitlica, B., Šimić, B., Jurković, D., Vrandečić, K. (2009): Patogenost *Fusarium* vrsta za stabljike i klipove kukuruza. Zbornik radova 44. hrvatskog i 4. međunarodnog simpozija agronoma, 500-504.
9. Gaylarde, C.C., Bento, F.M., Kelley, J. (1999): Microbial contamination of stored hydrocarbon fuels and its control. Revista de Microbiologia 30(1): 01-10.
10. Helbig, J.B., Caroll, R.B. (1984): Dicotyledonous weeds as a source of *Fusarium oxysporum* pathogenic on soybean. Plant Disease 68(8): 694-696.
11. Inch, S., Gilbert, J. (2003): The incidence of *Fusarium* species recovered from inflorescences of wild grasses in southern Manitoba. Plant Pathology 25(4): 379-383.
12. Jenkinson, P., Parry, D.W. (1994): Isolation of *Fusarium* species from common broad-leaved weeds and their pathogenicity to winter wheat. Mycological Research. 98(7): 776-780.
13. Jurkovic, D., Cosic, J., Vrandecic, K., Ledencan, T. (2002): Pathogenicity of *Fusarium* spp. to maize seedlings. 7th European seminar „*Fusarium* – Mycotoxins, Taxonomy and Pathogenicity", Poznan, Poland, Book of Abstracts, 96-97.
14. Ledenčan, T., Šimić, D., Brkić, I., Jambović, A., Zdunić, Z. (2001): Zastupljenost i patogenost *Fusarium* vrsta uzročnika truleži stabljike kukuruza. Sjemenarstvo. 18(3-4): 155-165.
15. Leslie, J.F., Summerell, B.A. (2006): The *Fusarium* Laboratory Manual. Blackwell Professional, Ames, Iowa, USA.
16. Lević, J. (2008.): Vrste roda *Fusarium*. Cicero. Beograd, Srbija.
17. Manka, M. (1989): Patogeniczność wybranych gatunków z rodzaju *Fusarium* dla siewek zbóź. Poznan, Poland.
18. McKinney, H.H. (1923): Influence of soil temperature and moisture on the infection of wheat seedling by *Helminthosporium sativa*. Journal of Agricultural Research 26(9): 196-217.
19. Molot, P.M., Simone, J. (1967): Technique de contamination artificielle des semences de Mais pa les Fusarioses. Revie de Zoologie Agricole et Appliquee 1-3: 29-32.
20. Postic, J., Cosic, J., Vrandecic, K., Jurković, D., Saleh, A.A., Leslie, J.F. (2012): Diversity of Fusarium Species Isolated from Weeds and Plant Debris in Croatia. Journal of Phytopathology 160(2):76-81.
21. Spanic, V., Lemmens, M., Drezner, G. (2010): Morphological and molecular identification of *Fusarium* species associated with head blight on wheat in East Croatia. European Journal of Plant Pathology 128(4): 511-516.
22. Svitlica, B., Cosic, J., Simic, B., Jurkovic, D., Vrandecic, K., Purar, B., Telic, T. (2008): Pathogenicity of *Fusarium* species to maize ears. Cereal Research Communications. Volume 36.
23. Tancic, S., Stankovic, S., Levic, J. (2009): Variability of pathogenicity of *Fusarium* spp. originating from maize and wheat grains. Pesticides & Phytomedicine 24(4): 259-269.
24. Vrandecic, K., Cosic, J., Jurkovic, D., Duvnjak, T. (2003): Weeds as an inoculum source of Sclerotinia sclerotiorum. 6th Slovenian Conference on Plant Protection - Abstract Volume. Plant Protection Society of Slovenia, 26-27.
25. Vrandečić, K., Ćosić, J., Jurković, D. (2006): Pregled parazitne mikopopilacije korova u okopavinskim usjevima. 50. Seminar biljne zaštite. Glasilo biljne zaštite, 1:55.

PATOGENOST *FUSARIUM* SPP. IZOLIRANIH S KOROVA I BILJNIH OSTATAKA U ISTOČNOJ HRVATSKOJ ZA PŠENICU I KUKURUZ

SAŽETAK

U laboratoriju je ispitana patogenost trideset izolata 14 Fusarium vrsta izoliranih s korova i biljnih ostataka u istočnoj Hrvatskoj. Testovi patogenosti provedeni su na klijancima pšenice i kukuruza. Najpatogenija Fusarium vrsta bila je F. graminearum izolirana s Amaranthus retroflexus, Abutilon theophrasti i Chenopodium album. Primijetili smo značajnu varijabilnost u patogenosti za pšenicu i kukuruz između i unutar vrsta. Izolati F. solani s Sonchus arvensis i F. verticillioides s Chenopodium album bili su vrlo patogeni za pšenicu, a nepatogeni za kukuruz. Izolati F. venenatum bili su vrlo patogeni za pšenicu i kukuruz, što je prvo izvješće o patogenosti te vrste. Ovo istraživanje potvrđuje da korovi i biljni ostatci mogu poslužiti kao alternativni domaćini i kao izvor biljnih patogena.

Ključne riječi: patogenost, Fusarium spp., korovi, biljni ostatci

(Received on 12 September 2012; accepted on 5 November 2012 - *Primljeno 12. rujna 2012.; prihvaćeno 5. studenoga 2012.*)