Wrocław University of Environmental and Life Sciences, Wrocław, Poland

THE EFFECT OF NITROGEN FERTILIZATION ON THE COLONIZATION OF SUGAR BEET ROOTS BY FUNGI

E. Moszczyńska, E. Pląskowska, K. Matkowski and M. Łobczowski

Abstract

Studies at Pawłowice, near Wrocław, in 2004–2006 had the objective of evaluating the effects of two nitrogen fertilization systems on the colonization of sugar beet roots by fungi, particularly pathogens. Four Swedish cultivars of sugar beet (‘Alyssa’, ‘Nabucco’, ‘Esperanza’ and ‘Isolda’) were grown. Nitrogen fertilizer (urea) was applied to each plot (i) before sowing, at 80 kg N per 1 ha, or (ii) before sowing, at 80 kg N per 1 ha, and after sowing (top dressing), at 40 kg N per 1 ha. The additional top dressing did not affect the density or diversity of fungi in sugar beet roots. Mostly *Fusarium* species were isolated from the non-disinfected roots, especially in 2005. As well as *Fusarium*, *Penicillium* and *Tichoderma* species were also frequently isolated from the surface of sugar beet roots. *Fusarium oxysporum* was the dominant species in 2004 and 2006, *F. sporotrichioides* in 2005. Only the single isolates, mostly of *Fusarium*, *Penicillium* and *Trichoderma* species, were obtained from disinfected sugar beet roots in 2005–2006. The interior tissues of the four cultivars of the sugar beet were almost free of fungi in 2004.

Key words: diseases of beet roots, fungi, *Fusarium oxysporum*, fertilization with nitrogen

Introduction

Fertilizer applications to both soil and leaves are important in the growth of sugar beet. Fertilizers effect the quality of sugar beet roots and their value for processing. Urea, which is easily dissolved in water and easily absorbed by leaves, is recommended as a leaf fertilizer (Czuba et al. 1997). An adequate nitrogen supply is essential for obtaining high root yields because of the key role of nitrogen in ab-

Phytopathol. Pol. 49: 21–27

ISSN 1230-0462

sorption and accommodation of copper, the content of which is positively correlated with the sugar content in sugar beet roots through the growing season (Ławiński et al. 2002). As well as their effect on quantity and quality of the crop yield, nutrients affect the plant's reaction to infection by pathogens. Observations on the positive effects of fertilizer application to leaves, and of macro- and micronutrients in fertilizers, on plant resistance to pathogens are not, however, unequivocal (Orlikowski and Wojdyła 1991, Gąsiorowska et al. 1997).

The objective of this study was to evaluate the effects of two nitrogen fertilizer systems on the colonization of sugar beet roots by fungi, particularly pathogens.

Materials and methods

Studies were carried out at Pawłowice, near Wrocław, in 2004–2006. Field experiments were established in plots arranged in four randomized replicate blocks. Material consisted of four Swedish cultivars of sugar beet: 'Alyssa', 'Nabucco', 'Esperanza' and 'Isolda'. Two urea application treatments were compared: (i) before sowing, at 80 kg N per 1 ha, or (ii) before sowing, at 80 kg N per 1 ha, and after sowing (top dressing), at 40 kg N per 1 ha. At the end of the growing season three sugar beet roots were collected from each treatment of the experiment for mycological analysis. Fungi were isolated from non-disinfected and disinfected (NaOCl; 0.5% available chlorine, for 1 min) roots, pieces of which were placed on potato dextrose agar (PDA) acidified with citric acid (12 ml/l of 0.5% citric acid).

Results

Pre-sowing application of urea did not effect the density or diversity of the root mycobiota of the sugar beet in 2004 or 2006 (Figs. 1, 2). Mostly *Fusarium* species were isolated from the non-disinfected roots. *Fusarium* species were isolated most frequently in 2005. As well as *Fusarium* and *Penicillium* also *Trichoderma* species were frequently isolated from the surface of sugar beet roots. An antagonistic effect of *Trichoderma* towards *Fusarium* species in beet roots was observed.

Only the single isolates of *Fusarium, Penicillium, Trichoderma* and *Phoma* species, and *Alternaria alternata* were obtained from disinfected sugar beet roots in 2005–2006 (Fig. 2). Only two isolates of *Fusarium* and one isolate of *Phoma* were obtained from the interior sugar beet root tissues in 2004, indicating a very small amount of colonization by mycobiota.

Fusarium oxysporum was the dominant species in 2004 and 2006, while *F. sporotrichioides* was the most frequently isolated species in 2005 (Figs. 3, 4). The latter was absent in beet root tissues in 2004 and 2006.

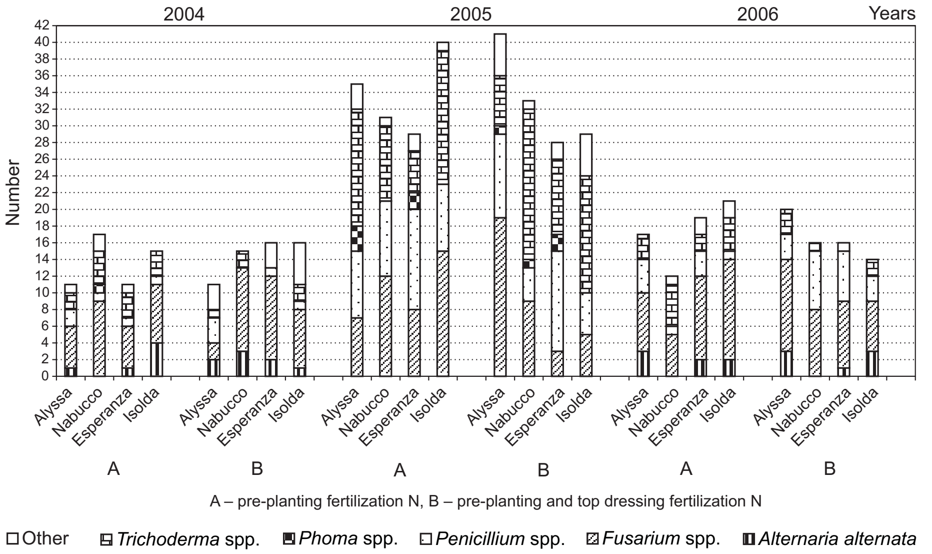

Fig. 1. Fungi isolated from non-disinfected root of sugar beet

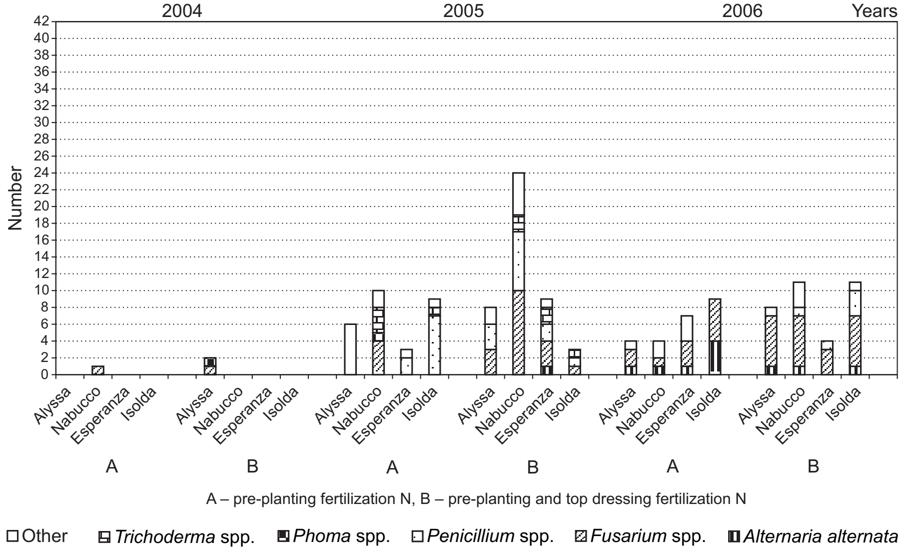

Fig. 2. Fungi isolated from disinfected root of sugar beet

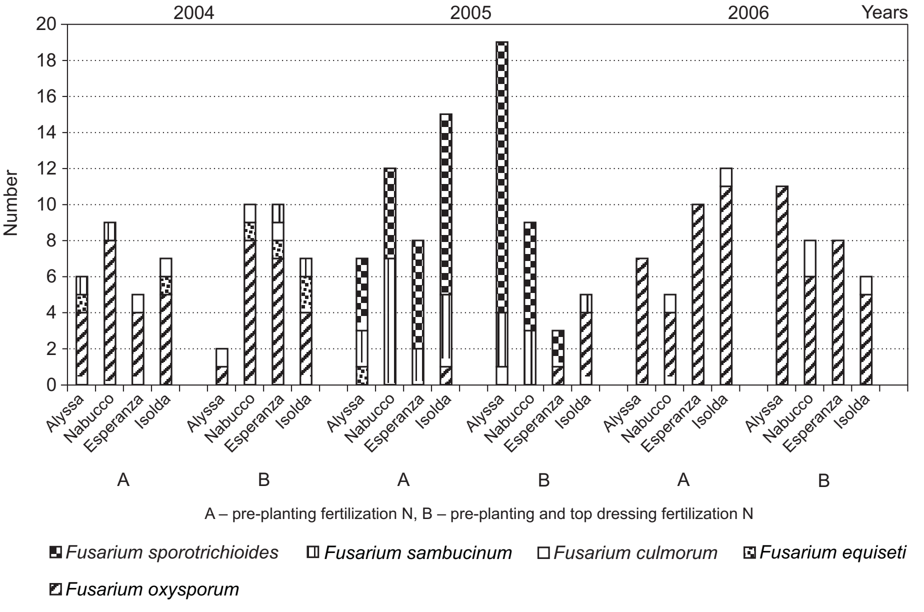

Fig. 3. Species of *Fusarium* genus isolated from non-disinfected root of sugar beet

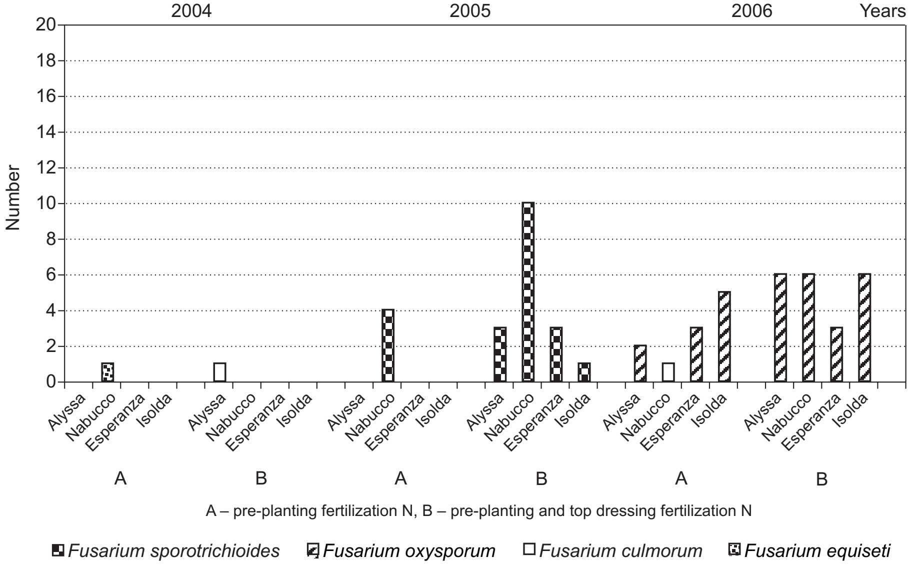

Fig. 4. Species of *Fusarium* genus isolated from disinfected root of sugar beet

Discussion

The additional top dressing did not affect the density or diversity of fungi in sugar beet roots. Mostly *Fusarium* species were isolated from non-disinfected roots. *Fusarium* species were isolated most frequently in 2005. This may have resulted from the relatively high rainfall in May and June 2005. *Fusarium* species were isolated less frequently in 2004 and 2006, which had both very low rainfall and temperatures about 2°C higher than the long-term average. Similar variations in *Fusarium* species density on sugar beet roots in 2002–2003, which had uneven and lower rainfall, were reported by Moszczyńska et al. (2006).

Fusarium oxysporum was the dominant species on roots of sugar beet. This finding is in accordance with observations of Harveson and Rush (1998), who reported that Fusarium root rot caused by *F. oxysporum* is a serious root pathogen damaging to sugar beet production in the USA. In Poland Moszczyńska et al. (2006) found *F. oxysporum* to be the greatest threat to sugar beet roots. The high frequency of *F. oxysporum* in all treatments in 2004 and 2006 may have been an effect of temperature, which was higher than the long-term average. According to Furgał-Węgrzycka (1984), *F. oxysporum* is a thermophilic species and infects plants more intensively at higher temperatures and lower moisture levels. Increased virulence of *F. oxysporum* at higher temperatures was observed also in the USA; irrigation treatment, however, had no effect on disease incidence or severity (Harveson and Rush 1998). Fusarium root rot caused by *F. oxysporum* may become a problem for the sugar beet production in Poland in the near future.

Fusarium sporotrichioides was the most frequently isolated species in 2005. This species was absent in beet root tissues in 2004 and 2006. Only single isolates of *F. culmorum* were obtained from the surface and interior tissues of sugar beet roots. Huber and Watson (1970) recommended urea as the source of nitrogen because urea limits the occurrence of *F. culmorum*.

As well as *Fusarium*, *Penicillium* and *Tichoderma* species were also frequently isolated from the surface of sugar beet roots in 2005. The antagonistic effect of *Trichoderma* towards *Fusarium* species in beet roots was also observed in 2005. Fungi of the genus *Trichoderma* with activity towards pathogenic species of *Fusarium* may be useful in limiting their density (Gromovykh et al. 1999). *Phoma* species, which are potentially pathogenic on sugar beet, were isolated only sporadically.

There were fewer fungal species and isolates obtained from the interior tissues of beet roots than from the surface in 2004–2006. These results support the observations of Moszczyńska et al. (2006).

Conclusions

1. Top dressing with urea fertilizer, additional to pre-sowing application, did not affect the colonization of sugar beet root tissues by *Fusarium* species.

2. *Fusarium oxysporum* was found to be the greatest threat to sugar beet root production in 2004 and 2006.

Streszczenie

WPŁYW NAWOŻENIA AZOTEM NA ZASIEDLENIE KORZENI BURAKA CUKROWEGO PRZEZ GRZYBY

Doświadczenie polowe zostało założone w Pawłowicach koło Wrocławia, w latach 2004–2006. Badano wpływ nawożenia azotem na zasiedlenie korzeni buraka cukrowego przez grzyby. Zastosowano nawożenie azotem: 1) przedsiewnie w dawce 80 kg N na 1 ha lub 2) przedsiewnie w dawce 80 kg N na 1 ha i pogłównie mocznikiem w dawce 40 kg N na 1 ha. Badanymi odmianami buraka były: 'Alyssa', 'Nabucco', 'Esperanza' 'Isolda'. Przedsiewne + pogłówne nawożenie azotem, w porównaniu z jedynie przedsiewnym, nie wpłynęło na zróżnicowanie liczebności i składu gatunkowego grzybów w 2004 i 2006 roku. Z nieodkażonych korzeni buraka wyizolowano głównie *Fusarium* spp., które jednak, ze względu na bardzo niskie opady w 2004 i 2006 roku oraz temperaturę wyższą o 2°C od średniej wieloletniej, były izolowane nielicznie z powierzchni korzeni. W 2005 roku uzyskano najwięcej kolonii, co mogło być spowodowane wyższymi opadami w maju i w lipcu tego roku. Oprócz *Fusarium* spp. licznie były wyosobniane *Penicillium* spp. i *Trichoderma* spp. Stwierdzono antagonistyczny wpływ *Trichoderma* spp. na *Fusarium* spp. w korzeniach buraka. Dominującym gatunkiem *Fusarium* spp. w 2004 i 2006 roku był *F. oxysporum*, natomiast w 2005 roku najliczniej wyosobniono *F. sporotrichioides*, który nie był izolowany w pozostałych latach badań. Z odkażonych korzeni buraka uzyskano tylko pojedyncze kolonie *Fusarium* spp., *Penicillium* spp. i *Trichoderma* spp. W 2004 roku wewnętrzne tkanki czterech odmian buraka praktycznie nie były zasiedlone przez grzyby.

Literature

Czuba R., Sztuder H., Świerczewska M., 1997: Agrotechniczne i ekonomiczne aspekty dolistnego dokarmiania buraka cukrowego. Biul. Inst. Hod. Aklim. Rośl. 202: 131–137.

Furgał-Węgrzycka H., 1984: Stan badań w zakresie hodowli odmian bobu i bobiku odpornych na choroby. Cz. III. Fuzariozy bobu i bobiku. Biul. Inst. Hod. Aklim. Rośl. 155: 243–250.

Gąsiorowska B., Zarzecka K., Ceglarek F., 1997: Wpływ nawożenia dolistnego Ekolistem na plonowanie i wartość technologiczną buraka cukrowego. Biul. Inst. Hod. Aklim. Rośl. 202: 139–143.

Gromovykh T., Tulpanova V., Shmarlovskaya S., Gromovykh V., Makhova H., 1999: Strains of *Trichoderma* benefit for biological control seedlings pathogens. In: Annual International Research Conference on Methyl Bromide Alternatives and Emissions Reductions. US Environmental Protection Agency. http://www.epa.gov/ozone/mbr/airc/1999/38gromov.pdf.

Harveson R.M., Rush C.M., 1998: Characterization of *Fusarium* root rot isolates from sugar beet by growth and virulence at different temperatures and irrigation regimes. Plant Dis. 82, 9: 1039–1042.

Huber D.M., Watson R.D., 1970: Effect of organic amendment on soil-borne plants pathogens. Phytopathology 60: 22–26.

Ławiński H., Potarzycki J., Baer A., 2002: Wpływ systemu uprawy i nawożenia azotem na pobranie mikroelementów przez buraki cukrowe. Biul. Inst. Hod. Aklim. Rośl. 222: 101–109.
Moszczyńska E., Matkowski K., Pląskowska E., Prośba-Białczyk U., 2006: Wpływ dolistnego nawożenia azotem i magnezem na skład zbiorowisk grzybów występujących na korzeniach buraka cukrowego. Progr. Plant Prot. / Post. Ochr. Rośl. 46, 2: 609–615.
Orlikowski L., Wojdyła A., 1991: Wpływ nawożenia dolistnego na ochronę roślin ozdobnych przed chorobami. Mater. 22 Ses. Nauk. Inst. Ochr. Rośl. 27: 313–319.

Authors' addresses:

Dr. Ewa Moszczyńska, Dr. hab. Elżbieta Pląskowska, Dr. Krzysztof Matkowski, Maciej Łobczowski M.Sc., Department of Crop Protection, Wrocław University of Environmental and Life Sciences, pl. Grunwaldzki 24 A, 50-363 Wrocław, Poland, e-mail: ewa.moszczynska@up.wroc.pl

Accepted for publication: 23.08.2008