Biotic Relations between *Rhizoctonia solani* (Damping-off Pathogen) and Soil Fungal Communities from Forest Nursery

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Abstract

In forest nursery Wronczyn (central-west Poland) the occurrence of Scots pine (*Pinus sylvestris* L.) seedlings damping-off caused by *Rhizoctonia solani* Kühn is connected with a strong supporting effect of soil fungi community on *R. solani*. Both the soil fungi community isolated in June and in October 1999 supported the pathogen growth to considerable extent. In both months the support was bigger in the case of more severe isolate of the pathogen.

Keywords: *Pinus sylvestris*; dampin-off; seedlings; *Rhizoctonia*; soil fungi community

INTRODUCTION

A wide range of saprotrophic fungi inhabit soil together with soil-borne plant pathogens. The fungi (treated as communities) have phytopathological function which will be considered here as their effect on pathogen's growth. The fungal communities differ in their qualitative (the species building up the community) and quantitative (number of isolates) structure which results from soil environment conditions (MAŃKA 1995). The structure, in turn, results in the effect of fungal community on a pathogen growth.

Rhizoctonia solani is one of major damping-off fungi in Polish forest nurseries (MAŃKA 1998). In forest nursery Wronczyn (Forest District Czerwonak, central-west Poland) it occurs every year and most of *Rhizoctonia* isolates were recognized as *R. solani* (MAŃKA *et al*. 2001).

The aim of the work was to find out if the biotic relations between the pathogen and communities of saprotrophic soil fungi from the same nursery were alike in June and in October 1999.

MATERIALS AND METHODS

The samples of soil from forest nursery bed (Wronczyn, div. 6b) were taken in June 1999 and in October 1999. On the same day in 1999 also diseased Scots pine seedlings were sampled from the bed. Both soil and seedling samples were taken from places uniformly scattered along the whole bed (120 m long). The nursery site was fresh coniferous mixed forest (according to the Polish forest site typology). Scots pine transplants were produced in the bed in 1995–1997 and then in 1999–2001 – the recent history of the bed and isolation of fungi from soil and diseased seedlings is described in a work by K. MAŃKA *et al*. (2001).

Two *R. solani* isolates (Rs 401 and Rs 411) used in the work were examinated for number of nuclei in cell according to BANDONI (1979) and MIKOŁAJSKA and WACHOWSKA (1996).

The biotic relations between the pathogens and the soil fungi communities was examined with the biotic series method by MAŃKA (1974) and MAŃKA and MAŃKA (1992, 1995). In the biotic test, individual biotic effect (IBE) is evaluated, which is the effect of one isolate of a soil fungus species on the pathogen growth. The IBE is multiplied by the frequency of the species in the community which results in general biotic effect (GBE = the effect of all the isolates of the species on the pathogen growth). All the GBEs are summarized to give summary biotic effect (SBE), i.e. the effect of the entire soil fungi community on the pathogen. The SBE describes phytopathological

function of the community. Any of the biotic effects mentioned, can be positive (indicating suppressive effect on the pathogen's growth), negative (indicating supporting effect on the pathogen's growth) or neutral ("0"). Intensity of the supporting or suppressing effect is described by the absolute value of the effect.

Pathogenicity test on Petri dishes was accomplished according to ASIEGBU *et al.* (1993). Fourteen days after sowing, Scots pine seedlings were inoculated by a *R. solani* isolate and after ten days of incubation in darkness the number of dead seedlings was counted.

RESULTS

The fungal community isolated from the nursery bed soil in June 1999 consisted of 196 isolates, of which 157 (representing 15 most frequent species = 80.1% of isolates) were taken into consideration in the biotic test (Table 1). The community from October had 467 isolates, of which 403 (representing 23 species = 86.3%) were used in the biotic tests (Table 2).

In all the biotic tests *R. solani* isolates were considerably supported in their growth by both communities from nursery bed (Tables 1 and 2). Both fungal communities supported isolate *R. solani* 411 to greater extent than *R. solani* 401.

In pathogenicity test isolate *R. solani* 411 proved more pathogenic than isolate *R. solani* 401. The first one killed 100% seedlings on Petri dishes and the second one – 43% (Figure 1).

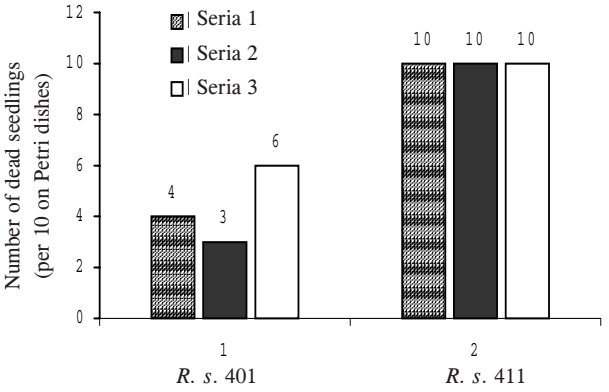

Figure 1. Pathogenicity of two *R. solani* isolates in an infection experiment

Table 1. Biotic effect of soil fungi community from Wronczyn forest nursery bed in June 1999 on the growth of two *Rhizoctonia solani* isolates

Species of fungi	Frequency	Biotic effects on			
		R. s. 401		*R. s.* 411	
		IBE*	GBE**	IBE*	GBE**
Aspergillus clavatus Desm.	33	–5	–165	–8	–264
Coniothyrium fuckelii Sacc.	19	–6	–114	–7	–133
Trichoderma viride Pers. ex Gray	17	+9	+153	+8	+136
Penicillium vinaceum Gilman et Abbott	14	–6	–84	–4	–56
Penicillium funiculosum Thom	11	–7	–77	–8	–88
Trichoderma harzianum Rifai	10	+8	+80	+5	+50
Penicillium janthinellum Giourge	10	–6	–60	–6	–60
Penicillium daleae Zaleski	9	–6	–54	–4	–36
Trichoderma sp.	7	+7	+49	+4	+28
Penicillium janczewskii Zaleski	6	–5	–30	–6	–36
Gliocladium viride Matr.	6	+6	+6	+4	+24
Penicillium chermesinum Biourge	5	0	0	–4	–20
Fusarium oxysporum Schlecht.	4	–7	–28	–7	–28
Chaetomium globosum Kunze	3	–7	–21	–8	–24
Chrysosporium pannorum (Link) Hughes	3	–6	–18	–8	–24
Summary biotic effect	157		–369		–531

*IBE = individual biotic effect

**GBE = summary biotic effect

Table 2. Biotic effect of soil fungi community from forest nursery bed in October 1999 on the growth of two *Rhizoctonia solani* isolates

Species of fungi	Frequency	Biotic effects on			
		R. s. 401		*R. s.* 411	
		IBE*	GBE**	IBE*	GBE**
Penicillium daleae Zaleski	71	–5	–355	–7	–497
Penicillium sp. 1	68	–4	–272	–5	–340
Mortierella vinacea Dixon–Stewart	50	–6	–300	–6	–300
Penicillium sp. 2	38	–5	–190	–6	–228
Penicillium sp. 3	36	–5	–180	–5	–180
Penicillium janczewskii Zaleski	29	–4	–116	–5	–145
Penicillium sp. 4	20	–4	–80	–5	–100
Penicillium sp. 5	14	–5	–70	–6	–84
Chrysosporium pannorum (Link) Hughes	11	–5	–55	–6	–66
Aspergillus clavatus Desm.	9	–4	–36	–5	–45
Trichoderma harzianum Rifai	8	+8	+64	+6	+48
Absidia sp.	7	–6	–42	–6	–42
Aspergillus sp.	6	–5	–30	–7	–30
Chrysosoporium asperatum Carm.	5	–6	–30	–6	–30
Paecilomyces sp.	5	–5	–25	–6	–25
Dematiaceae sp.	5	–6	–30	–6	–30
Trichoderma sp. 1	4	+8	+32	+7	+28
Penicillium citrinum Thom	4	–4	–16	–4	–16
Penicillium sp. 6	4	–5	–20	–5	–20
Trichoderma sp. 2	3	+5	+15	+6	+18
Mortierella sp.	3	–7	–21	–7	–21
Penicillium sp. 7	2	–5	–10	–7	–14
Chaetomium globosum Kunze	1	–6	–6	–6	–6
Summary biotic effect	403		–1773		–2125

*IBE = individual biotic effect

**GBE = summary biotic effect

DISCUSSION

The investigations were aimed at defining the relation between the qualitative and quantitative structure of two soil fungi communities and their function towards a damping-off pathogen, *R. solani*. The species is well known as a damping-off pathogen in the region (MAŃKA & GIERCZAK 1971) and it is considered a severe one (KWAŚNA 1987; MAŃKA 1998; KACPRZAK 1999). With its fast growth it is usually supported by nursery soil fungi communities (KWAŚNA 1987; KACPRZAK & MAŃKA M. 2001). That was the case also in Wronczyn in 1999 (MAŃKA K. *et al*. 2001). It is of interest that the more pathogenic isolate *R. solani* 411 was also supported to a greater extent by both fungal communities and it happens repeatedly there, as it was found in this work. The support of soil fungi community was higher in October than in June. It could be due to much better proportion between the only pathogen suppressing species (*Trichoderma* and/or *Gliocladium*) and the rest of community components in June than in October: 40/157 and 15/403, respectively. The abundance of the Fall community is in accordance with results of M. MAŃKA and FRUŻYŃSKA-JÓŹWIAK (1996), concerning biotic relations in Scots pine forest soil, which revealed the occurrence of more numerous and frequent soil fungi species in the Fall communities than in the Spring ones.

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