Communities of Bacteria and Fungi Occurring in the Rhizosphere of Winter Wheat

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Abstract

The purpose of the present studies was to establish the species composition of fungi occurring on the underground parts of winter wheat, Kobra cv. and to determine the quantitative and qualitative composition of microorganisms developing in the rhizosphere of this plant. The mycological analysis of the infected roots and the stem base of winter wheat gave 320 fungi isolates. *Fusarium* spp. were most frequently isolated, and their proportion was 64.7% of all the fungi. This genus was represented by *F. avenaceum, F. culmorum, F. equiseti, F. graminearum, F. oxysporum* and *F. solani*. Among these species the dominating ones were *F. avenaceum* (19.4%) and *F. culmorum* (38.7%). The microbiological analysis of winter wheat rhizosphere gave the highest number of total bacteria (6.32×10^6 cfu/g of d.w. of soil). The number of *Pseudomonas* pp. was 3.56×10^6 cfu/g of d.w. of soil, and the number of *Bacillus* spp. was 2.42×10^6 cfu/g of d.w. of soil. *Fusarium* spp. and *Rhizoctonia solani* dominated within pathogenic fungi isolated from the rhizosphere of winter wheat.

Keywords: winter wheat; rhizosphere; *Fusarium* spp.; *Bacillus* spp.; *Pseudomonas* spp.

INTRODUCTION

The rhizosphere soil of field crops is characterised by the greatest biological activity. The quantitative and qualitative composition of microorganisms in the root zone undergoes changes under the effect of root exudates and the compounds formed from the decay of the shelling root cells (FUNCK-JENSEN & HOCKENHULL 1984; SCHORUVITZ & ZEIGLER 1989). The substances secreted by the plant roots stimulate or inhibit the growth and development of pathogenic or saprophytic microorganisms (SUNDIN *et al*. 1990; WIELKES *et al*. 1999).

The purpose of the studies was to establish the species composition on the underground organs of winter wheat, and to determine the qualitative and quantitative composition of microorganisms developing in the rhizosphere of this plant.

MATERIAL AND METHODS

The studies were carried out in the years 1998–2000 on an experimental plot at Czesławice near Nałęczów. The plot was sown with winter wheat, Kobra cv. Samples of this plant at anthesis were taken for mycological analysis, which was performed according to the method described by PIĘTA (1985). At the same time, the rhizosphere soil of winter wheat was also sampled with an aim of performing a microbiological analysis according to the method described by MARTYNIUK *et al.* (1991).

RESULTS

As the result of the mycological analysis of the infected roots and the stem base of winter wheat, 320 fungi isolates were obtained (Table 1). *Fusarium* spp. turned out to be most frequently isolated since their proportion constitutes 64.7% of all the fungi. This genus was represented by *F. avenaceum, F. culmorum, F. equiseti, F graminearum, F. oxysporum* and *F. solani*. *F. avenaceum* and *F. culmorum* as well as *F. oxysporum* were isolated both from the roots and the stem base, and their proportion was 19.4%, 38.7% and 3.4% of all the fungi, respectively.

Within the pathogenic fungi obtained from the analysed parts of winter wheat *Rhizoctonia solani*

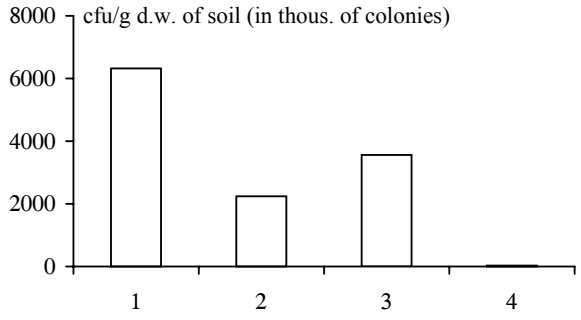
also occurred and its isolates constituted 4.7% of all the fungi. On the other hand, among the saprophytic fungi the studies isolated for example *Gliocladium* spp. (4.7%), *Penicillium* spp. (2.2%) and *Trichoderma* spp. (5%) (Table 1).

The microbiological analysis of the rhizosphere soil of winter wheat showed that in each year of the studies the total number of bacteria, the total number of fungi and the number of *Bacillus* spp. and *Pseudomonas* spp. were similar, hence Figure 1 contains the mean results of three years of studies. Among the analysed samples of rhizosphere soil the greatest number was achieved of the total number of bacteria (6.32×10^6 cfu/g d.w. of soil). The number of *Pseudomonas* spp. was a little lower and it was 3.56×10^6 cfu/g d.w. of soil, while *Bacillus* spp. constituted 2.42×10^6 cfu/g d. w. of soil. The total number of fungi was 30.4×10^3 cfu/g d.w. of soil (Figure 1).

The proportion of pathogenic fungi obtained from winter wheat rhizosphere was 10.3% (Figure 2). *Fusarium* spp. and *Rhizoctonia solani* dominated within the group of pathogenic fungi. *Fusarium* spp. were most numerously represented by *F. culmorum* and *F. oxysporum,* and their proportion was 3.4% and 3.2%, respectively, of all the fungi.

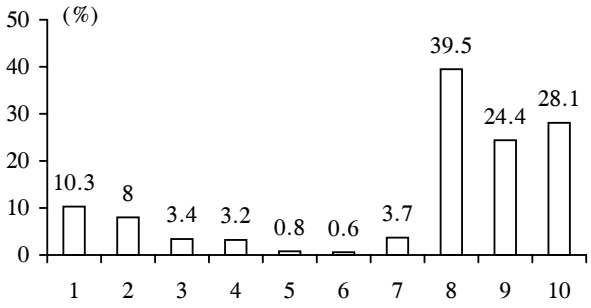
Table 1. Fungi isolated from infected roots (a) and stem base (b) of winter wheat

Fungus species	Number of isolates							
	1998		1999		2000		Total	
	a	b	a	b	a	b	a	b
Acremonium roseum (Oud.) W. Gams	–	–	1	1	–	–	1	1
Acremonium strictum W. Gams	1	1	–	1	1	–	2	2
Alternaria alternata (Fr.) Keissler	–	3	2	1	1	4	3	8
Aureobasidium pullulans (de Bary) Arnaud	10	2	6	4	5	5	21	11
Bipolaris sorokiniana (Sacc.) Shoern.	–	2	–	1	–	–	–	3
Drechslera graminea (Rabenh. ex Schl.) Shoem.	–	–	–	1	–	–	–	1
Epicoccum purpurascens Ehr. Ex Schl.	1	2	–	2	–	2	1	6
Fusarium avenaceum (Corda ex Fr.) Sacc.	1	23	2	25	3	8	6	56
Fusarium culmorum (W. G. Sm.) Sacc.	29	36	10	14	9	26	48	76
Fusarium equiseti (Corda) Sacc.	–	–	–	2	–	–	–	2
Fusarium graminearum Schwabe	–	–	–	5	–	–	–	5
Fusarium oxysporum Schl.	2	3	2	2	–	2	4	7
Fusarium solani (Mart.) Sacc.	–	1	–	2	–	–	–	3
Gliocladium catenulatum Gilman et Abbott	5	2	1	3	2	2	8	7
Penicillium decumbens Thom	–	–	–	3	–	–	–	3
P. verrucosum Dierckx var. *cyclopium* (Westling) Samson, Stolk et Hadlok	–	2	1	1	–	–	1	3
Rhizoctonia solani Kühn	3	3	2	4	2	1	7	8
Trichoderma hamatum (Bon.) Bain	–	1	2	–	3	–	5	1
Trichoderma harzianum Rifai	1	–	1	–	–	–	2	–
Trichoderma koningii Oud.	1	1	–	–	3	–	4	1
Trichoderma viride Pers. ex S. F. Gray	–	1	1	1	–	–	1	2
Total	54	83	31	73	29	50	114	206



1 – total number of bacteria, 2 – number of bacteria *Bacillus* spp., 3 – number of bacteria *Pseudomonas* spp., 4 – total number of fungi

Figure 1. The number of bacteria and fungi in winter wheat rhizosphere (mean from the years 1998–2000)



1– total of pathogenic fungi, 2 – *Fusarium* spp., 3 – *F. culmorum*, 4 – *F. oxysporum*, 5 – *F. solani*, 6 – *R. solani*, 7 – *Glyocladium* spp., 8 – *Penicillium* spp., 9 – *Trichoderma* spp., 10 – other of saprophytic fungi

Figure 2. Participation of fungi isolated from rhizosphere of winter wheat (total from the years 1998–2000)

Conclusions

1. The roots and the stem base of winter wheat were infected by *Fusarium* spp., especially by *F. avenaceum* and *F. culmorum*. *Rhizoctonia solani* proved to be a little less harmful.
2. Winter wheat had a stimulating effect on the development of rhizosphere bacteria, especially on *Pseudomonas* spp. The proportion of *Fusarium* spp. in winter wheat rhizosphere was remarkably smaller than the proportion of *Penicillium* spp. and *Trichoderma* spp.
3. *Pseudomonas* spp., *Penicillium* spp. and *Trichoderma* spp. as microorganisms antagonistic towards pathogenic fungi could have significantly affected the smaller number of phytopathogens in the rhizosphere of winter wheat, in this way improving the phytosanitary condition of the soil for the next plant.

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