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The changes of soil microfungal spectrum during simultaneous agricultural and forestry cultivation

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Abstract
The spruce from Modrava region (*Picea abies* Link) in young age was cultivated with potatoes (regularly changing rows of potatoes and spruce). This common cultivation was carried out in the locality of Lipová (near Kašperské Hory). We observed namely the spectrum of soil micromycetes in agricultural and forestry cultivated soils. We found great differences in the composition of the soil microflora in the both cultivated soils. Weak occurrence of the genus *Mortierella* and *Micromucor ramannianus* v. *ramannianus* was observed in an agricultural cultivated soil whereas these fungi were found regularly in forestry cultivated soils.

Key words: the Bohemian Forest (the Šumava Mts.), agriculture, forestry, soil microfungi, Zygomycetes, Ascomycetes, Deuteromycetes, *Mortierella*, *Micromucor ramannianus*

Introduction

Agroforestry is a cultivation of trees or other woody plants with crops or pasture by farmers. Agroforestry cultivation connects two simultaneous processes – the cultivation of agricultural crops and the cultivation of forest cultures. This method could be significant during the

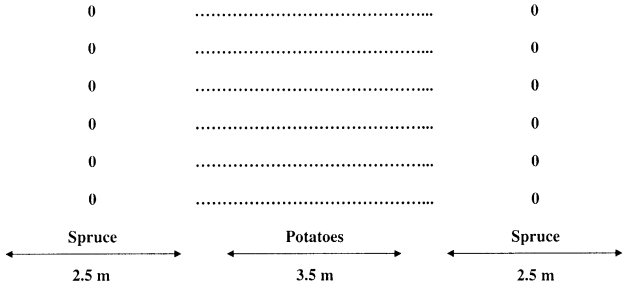

Fig. 1. – Agricultural and forestry cultivation in the Bohemian Forest (the Šumava Mts.). Locality near Kašperské Hory.

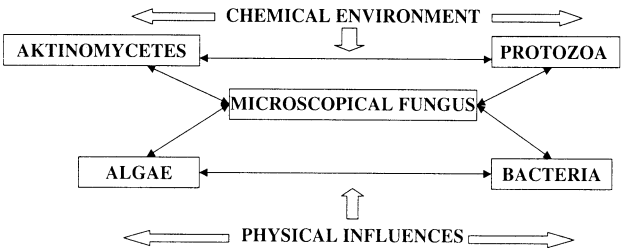

Fig. 2. – Influence of different environments on soil microorganisms.

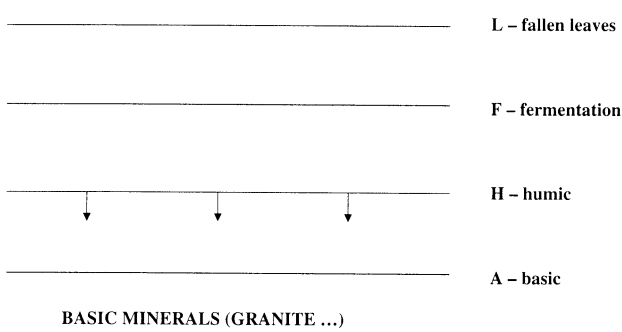

Fig. 3. – Horizons of forest soils.

reforestation of a former agricultural soil for better protection of both cultures against weather conditions. Young forest cultures (e.g. pines or spruces) and agricultural crops are cultivated in alternate strips. We met this objective cultivation before common cultivation of spruces and potatoes in the locality of Lipová near Kašperské Hory (forest management Svatobor) in the Bohemian Forest (the Šumava Mts., Fig. 1).

Already Němec & Maňan (1937) introduced the example from Slovakia (cultivation in Adamov near Holíč) where young pine cultures and potatoes were successfully simultaneously cultivated. The content of nitrates was higher in the agricultural cultivated soils than in the soils under the pines. Káš (1936) found out that the organic matter was the most decomposed after simultaneous agricultural and forestry cultivation but he didn't study soil micromycetes. Němec (1935) stated that simultaneous cultivation resulted in lower resistance of forest plants on fungal diseases and harmfull insects. This question wasn't satisfactorily solved in the past and also at present. But we were interested in the spectrum of soil micromycetes and their

differences in agricultural and forest soils. Saprophytic and parasitic fungi in the forms of conidia, ascospores, basidiospores and most of all mycelium are present in the soil. The soil fungi are in long-term interactions with chemical and physical conditions and with other microorganisms (Fig. 2) – original scheme.

Among different places there are big differences in chemical composition and also in other conditions.

Material and Methods

Soil samples were taken off to polyethylene bags in every season of the year (10 samples, except winter). We used only the samples from the horizon H–A02. Horizons of forest soils could differ in some partial horizons: horizon L – leaves (fallen leaves), horizon F–A01 – fermentation (decaying leaves), previously named horizon H–A02 (humic) and horizon A (basic) (Fig. 3).

Before the sampling we must strictly distinguish single horizons. These horizons have different physical, chemical and biological properties and they very differ from each other. The samples of an agricultural soil (width 3.5 m) were taken off the depth of 10 cm from the surface because of its high homogenity and also the samples of spruce strips (width 2.5 m). We studied the following biological, chemical and physical characteristics of forest and agricultural soils: relative humidity (in %), dry matter (in %), pH (H_2O), pH (KCl), %N, %C, basic soil respiration, potential soil respiration (with adding of glucose), ammonium nitrogen, ammonification, nitrate nitrogen, nitrification, a number of aerobic and ammonification bacteria and qualitative and quantitative analysis of soil fungi (cultivation on Czapek-Dox agar). These methods were published by Hýsek & Lochman (1994). We studied biology of the soils in the locality Lipová, near Kašperské Hory – a seed orchard of the spruce from Modrava region (*Picea abies* Link), high-mountaine ecotype from the highest part of the Bohemian Forest (forest management Modrava). The altitude of this locality was 560–575 m a.s.l., long-term annual mean temperature of the air was 7.2°C (the station of Sušice).

Table 1. – Quantitative spectra of genera and species of microscopical fungi after agricultural and forest cultivation in the Bohemian Forest (the Šumava Mts.) in years 1991–1992.

Autumn 1991			
Potatoes after harvest		Spruce	
Taxa of fungi	**Cultivation**	**Taxa of fungi**	**Cultivation**
Acremonium sp.	15%	*Aspergillus* sp.	10%
Mortierella sp.	10%	*Mortierella* sp.	20%
Micromucor ramannianus v. *ramannianus*	10%	*Micromucor ramannianus* v. *ramannianus*	50%
Paecilomyces farinosus	5%	*Paecilomyces* sp.	5%
Papulaspora sp.	5%	*Penicillium glabrum*	10%
Penicillium glandicola	5%	*Scopulariopsis brevicaulis*	2%
Periconia macrospinosa	8%	*Scopulariopsis* sp.	1%
Rhizopus stolonifer	5%	*Stachybotrys* sp.	2%
Mycelia sterilia	37%		

RESULTS

We evaluated the spectra of soil micromycetes in the agricultural and forestry cultivated soils during the season of one year (the soil before the cultivation of agricultural crops, the soil in the cultivation, the soil after the cultivation, Tables 1–3).

We found out the differences in the spectrum of micromycetes in the both types of the soil. The fungi *Micromucor ramannianus* v. *ramannianus* and *Mortierella* sp. were found only irregularly in an agricultural soil while they were found out regularly in a spruce soil. The basic idea of our work was that the soil is settled by different micromycetes during the cultivation and that it depends on natural factors of the soils (e.g. the interactions of the root exsudates with the soil organisms etc.). The samples were taken out from the same depth of 10 cm.

Table 2. – Quantitative spectra of genera and species of microscopical fungi before agricultural and forest cultivation in the Bohemian Forest (the Šumava Mts.) in years 1991–1992.

Spring 1991			
Potatoes after harvest		**Spruce**	
Taxa of fungi	**Cultivation**	**Taxa of fungi**	**Cultivation**
Acremonium sp.	10%	*Acremonium* sp.	10%
Botrytis sp.	5%	*Humicola grisea*	10%
Curvularia sp.	5%	*Mortierella* sp.	20%
Gliocladium sp.	5%	*Micromucor ramannianus* v. *ramannianus*	40%
Gilmaniella sp.	10%	*Mucor fragilis*	10%
Chrysosporium sp.	5%	*Mucor piriformis*	10%
Mortierella sp.	10%		
Penicillium sp.	5%		
Penicillium thomii	5%		
Rhizoctonia solani	20%		
Scopulariopsis sp.	5%		
Mycelia sterilia			

Table 3. – Quantitative spectra of genera and species of microscopical fungi before agricultural and forest cultivation in the Bohemian Forest (the Šumava Mts.) in years 1991–1992.

Summer 1992			
Potatoes after harvest		**Spruce**	
Taxa of fungi	**Cultivation**	**Taxa of fungi**	**Cultivation**
Aureobasidium pullulans	20%	*Absidia spinosa*	5%
Mortierella sp.	10%	*Acremonium* sp.	10%
Hormiscium sp. (*Torula*)	10%	*Hormiactis* sp.	5%
Monilia sitophila	10%	*Mortierella* sp.	20%
Penicillium chermesianum	10%	*Micromucor ramannianus* v. *ramannianus*	50%
Rhizopus arrhizus	20%	*Penicillium thomii*	5%
Mycelia sterilia	20%	*Mycelia sterilia*	5%

The fungi growth was on artificial media (Czapek-Dox agar) at a temperature 24°C. Most colonies of *Micromucor ramannianus* v. *ramannianus* produced red pigment. The knowledge of the spectrum of soil micromycetes enables to identify the characteristics of different site types. A brief description of the spectrum in agricultural soil (potatoes): This soil type is characterised by different saprophytic fungi like: *Acremonium* sp., *Cephalosporium* sp., *Paecilomyces* sp., *Penicillium* sp., *Scopulariopsis* sp., *Aureobasidium* sp., *Monilia* sp. A brief description of the spectrum of microfungi in an forest soil: *Mortierella* sp., *Micromucor ramannianus* v. *ramannianus, Penicillium* sp.

Discussion

Agroforestry is a common cultivation of trees with crops by farmers. In our case simultaneous cultivation of spruce and potatoes, among others, was carried out to clear the soil of weeds, to utilize better the nitrogen in the soil with farm crops, to provide a better access of forest plant roots into lower layer of a soil (water supply). Some authors discussed the possible combination of agroforestry and grazing, others defined agroforestry as dependent on the types of trees and soils (Němec 1935, Němec & Maňan 1937, Káš 1936).

We evaluated the differences between an agricultural and a forest soil by the presence of typical soil micromycetes (*Micromucor ramannianus* v. *ramannianus*, *Mortierella* sp.). It seems that the conditions of forest soils are different (other type of root exsudates) and long-term conditions for the establisment of the fungal spectrum. Therefore, this spectrum may be very typical for a single tree and different for agricultural crops.

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