Agroscope, Competence Division for Plants and Plant Products

# Arbuscular mycorrhizal fungi as microbial indicators to characterize soils and their use intensity

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## Objectives

During the last 20 years, we studied the diversity of the Arbuscular Mycorrhizal Fungi (AMF; Mucoromyceta) in a series of natural and agricultural soils, in different continents, under different climatic conditions, and subjected to different farming and soil tillage practices. In this presentation, some general conclusions are drawn on our findings.

**Fig.1** Vesicular-Arbuscular Mycorrhiza. Molecular analyses are needed to identify AMF fungi without laborious spore isolation from the soils. (Photo: Mike Anderson Corazon-Guivin, 2019)

## Materials and Methods

Arbuscular mycorrhizal fungi were isolated from soils and identified by spore morphology as described in Baltruschat et al. (2019). Multiple fungi were also characterized by molecular analyses as described in Oehl et al. (2019). AMF systematics currently comprise three classes, 16 families & 48 genera (Baltruschat et al. 2019).

**Table 1** AMF species richness in natural and agricultural ecosystems

| Soil type | Natural ecosystems | Natural systems | Organic farming/ Low input | Reduced tillage systems | High-input systems |
|---|---|---|---|---|---|
| Calcaric Leptosol Oehl et al. 2010 | Grasslands | 27-33 | 20-25 | | 21-23 |
| Calcaric Regosol Oehl et al. 2003 | Grasslands | 24-31 | | | 22-24/13 |
| Calcaric Chernosem Baltruschat et al. | | | 26-33 | 23-27 | 16-19 |
| Haplic Luvisol Oehl et al. 2003, 2004, 2005, 2009 | Grasslands | 26-32 | 25-31 | 25-33* | 22-24 (IP Suisse) 16-19 (Conv.) |
| Humic Cambisol Oehl et al. 2010 | Grasslands | 32-39 | | | 21-25 |
| Vertic Cambisol Säle et al. 2015 | Grasslands | 38 | 33-33 | 28-32 | |
| Cambisol/Luvisols Maurer et al. 2018, * | Grasslands | 33-35 | 26-30 | 25-27 | 20 |
| Ferralsol (semi-humid to semi-arid) Tschabi et al. 2008 | Sudan and Guyana savanna | 28-38 | 15-19 (Yam fields) | | 5-10 (Cotton fields) |
| 'Moist' Ferralsol (semi-humid) Pontes et al. 2017a | Cerrado savanna forest | 26-33 | | 24-26 | 15-21 (-28) |
| Ferralsol (semi-arid) Pontes et al. 2017b | Caatinga dry savanna | 44 | 29-36 | | |
| Ferralsol (semi-arid) Marinho et al. 2019 | Caatinga dry savanna | 51-56 | 25-42 | | |

## Introduction

AM fungi are an important component of fertile soils, as e.g. they improve plant growth and health, stabilize soil aggregation and retain macro- and micro-nutrients in the upper soil layers. Currently, > 300 species are known worldwide. This number is rapidly increasing, since many detected species have not yet been described, for others only sequence types were so far obtained, while steadily new sequence types emerge in the data bases.

**Fig.2** Illustrations of AM fungal spores/species with different indicator value in European soils.

## Results

Multiple AMF species as well as the overall AMF community structure can be used as powerful indicators in various aspects such as agricultural sustainability, soil fertility, water and nutrient budgets, or soil degradation due to over-uses or climate change. About 2-60 species were detected in natural and agricultural soils depending - among other factors - on climate, land use type and intensity, plant species diversity and specific soil parameters (Table 1). In a wide range of soils, a high AMF diversity can be found even under intensive agricultural production, as long as the majority of the fungi have suitable conditions during one vegetation period. Also herbicide and even repeated fungicide applications might then be minor factors affecting the communities in the soils. AMF diversity can, however, be dramatically decreased, especially when the hyphal network is periodically disturbed by harsh tillage practices, or when plants suffer due to increasing droughts.

## Conclusions

Many AMF species are ubiquitous. However, several AMF species are useful microbial indicator species for fertile or less fertile soils in Europe, depending on soil characteristics (especially soil pH and texture), land use intensity and climatic conditions. Other AMF species can be used as indicators in warmer, sub-tropical/tropical climates of different humidity, soil and land use conditions.

**References**

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