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Arbuscular mycorrhiza as part of sustainable agriculture

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Arbuscular mycorrhizal symbiosis is formed between plant roots and arbuscular mycorrhizal fungi (AMF). AMF are found in almost all soils. The fungi live inside plant roots where they obtain photosynthetically-fixed carbohydrates from the plant. They also produce hyphae that grow out into the soil, acting as an extension of the plant root system and, thereby, increasing the volume of soil from which nutrients can be obtained. AMF improve the growth of plants through increased uptake of available soil phosphorus (P) and other non-labile minerals essential for plant growth. They stabilise soil aggregates by producing glomalin, a glycoprotein that binds soil particles, and alleviate plant stress caused by biotic and abiotic factors. Although AMF have enormous potential to enhance crop productivity and quality, they do not always function optimally in modern high-input agriculture and horticulture. Thus, crop and soil management practices have a great impact on indigenous AMF. Here we present some results from two studies of mycorrhizal functioning in conventional vs. organic agriculture and also of the impact of various standing crops.

Mycorrhizal traits were studied in two large field experiments conducted at MTT Agrifood Research Finland, Laukaa, Central Finland. Relative mycorrhizal effectiveness (RME), in terms of ability of AMF to increase growth, was determined in a bioassay. AMF spores were extracted from soil, and species richness and diversity were determined. The Shannon-Wiener index (SWI), which combines both species richness and evenness, was calculated. Alongside with the AMF traits, a large number of other soil properties were also studied. One of the field experiments was a long-term cropping system experiment, while the other one was a short-term preceding crop study. The cropping system experiment established in 1982 included conventional (CONV) and organic (ORG) plots. During the study period 2000-2002, strawberry was grown on the whole experimental area. In the other experiment, we studied the impact of three years of cultivation of eight crops with different degrees of mycotrophy, including mycorrhizal (strawberry, rye, timothy, onion, caraway) and non-mycorrhizal hosts (turnip rape, buckwheat, fiddleneck). In both experiments we studied the impact of amendment with highly humified peat (H8-9 on von Post's scale) on mycorrhizal traits.

In the cropping system experiment, the ORG plots exhibited higher RME values than the CONV ones in each of the three study years, but the difference was statistically significant only in 2001. In contrast, the numbers of AMF spores in soil were lower in ORG than in CONV. No differences in AMF species richness between cropping systems were observed, but the SWI was slightly higher in ORG than in CONV. In the preceding crop experiment, host plant had a clear impact on mycorrhizal traits. Strawberry and caraway in particular maintained high AMF effectiveness in soil, while the RME values were lower in the non-host crops. In addition, strawberry in particular strongly increased the numbers of AM spores detected in soil. In this experiment, as also in the cropping system experiment, peat amendment had a negative impact on the RME and AMF spore numbers. The study showed that management practices like cropping system and crop rotation have a clear impact on the traits of indigenous soil AMF.