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From production to application of arbuscular mycorrhizal fungi in agricultural systems: a multidisciplinary approach

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Performance of AM fungi in peat substrates in greenhouse and field studies

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Growing media based on light peat are commonly used in horticultural production. Although peat possesses a range of positive properties, it may also incur problems. Structural problems are common in long-term use. Light peat has a very low anion exchange capacity resulting in leaching of nitrate and phosphorus. Peat lacks beneficial symbiotic arbuscular mycorrhizal fungi (AMF) which are important to crops in sustainable systems. However, several studies have shown a negative impact of peat on AMF. Peat has been found to inhibit AMF colonisation, but this effect could be reduced by adding 25% of soil or sand to the substrate. *Hypnum* peat has been less inhibitory to AMF than *Sphagnum* peat. In a study including several peat types, an interaction between peat type and AMF strain was also observed. The real reasons behind the incompatibility between peat and AMF are still not known in detail, but biological or chemical properties have been suggested as possible reasons for the phenomenon. The impacts of peat on mycorrhizal traits has been studied in several field and greenhouse experiments at MTT Agrifood Research Finland.

Material and Methods

Field studies

Mycorrhizal traits were studied in two large field experiments conducted at MTT Agrifood Research Finland, Laukaa, Central Finland. Mycorrhizal effectiveness, 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 and organic 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 and non-mycorrhizal hosts. In both experiments the impact of amendment with highly humified peat (H8-9 on von Post's scale) on mycorrhizal traits were studied.

Greenhouse studies

The effects of light and dark *Sphagnum* peat and dark *Carex Bryales* peat, as well as their mixtures with minerals like sand, pumice, vermiculite, perlite, clay or zeolite on AMF function were studied in three short-term experiments carried out in 2006 and 2007 with daisy as a host plant. In all experiments, a commercial AMF inoculum "Myko-Ymppi" (from MTT) was mixed with the various substrates at a rate of 5%. At harvest, shoot fresh and dry weight as well as AMF root colonisation were estimated.

Results

In the field experiments, AMF traits were affected by cropping systems and preceding crops but also by peat amendment. Peat had a negative impact on mycorrhizal effectiveness and AMF spore numbers, but did not affect species frequency or the Shannon-Wiener diversity index.

In the pot experiments, light *Sphagnum* peat clearly suppressed the function of AMF, resulting in less growth in AMF-inoculated plants and low AMF root colonisation. In mixtures with clay, AMF root colonisation was higher, but the effect of AMF on growth was still negative. However, AMF did not usually affect plant growth negatively when decomposed *Sphagnum* or *Carex Bryales* peat was used. AMF root colonisation of daisy was also very high in these peat quatities. Compared with peat alone, the functioning of AMF was improved, especially in peat mixtures with clay or pumice. In mixtures of light and dark peat the effect of AMF inoculation was very similar to that obtained in light peat alone.

Conclusions

Negative interactions between peat and AMF were noticed after use of peat in mineral field soil as well as in potting mixes with peat for use in greenhouse cultures. This negative phenomenon can at least partly be overcome by using decomposed peats and potting mixes of peat and mineral components, in particular clay. Since peat is commonly used in horticulture, and will probably be so for a long time, this incompatibility phenomenon is one of the real bottle necks for utilization of AMF in greenhouse and nursery production. It stands clear that deeper studies are needed for finding the reasons behind the phenomenon. The COST Action 870, WG3, could provide a unique possibility for organising a joint study in this matter.