Soils are Alive Newsletter

2000 No. 2

Welcome.....

This is the second issue of our ***Soils are Alive*** Newsletter. This time we take a look at arbuscular mycorrhizal (AM) fungi, and summarise some of the research that has been conducted at The University of Western Australia.

A brief comment on biological indicators of soil fertility

Is it possible to find useful biological indicators of the fertility of soil? Research in the Centre for Land Rehabilitation at The University of Western Australia is addressing this question. Scientists have not been able to identify simple measures of soil biological fertility that can be used routinely by farmers to assess the biological state of their soil. This is in contrast to physical and chemical measures that are more easily used in the field.

A more sophisticated approach is required so that we can incorporate measures of the biological state of soil into decision-making processes. This will help identify farming practices that are ecologically sustainable. Issues related to these ideas will be discussed in future issues of the ***Soils are Alive*** Newsletter.

Acknowledgements

This Newsletter was established with support from the Ian Potter Foundation which is also supporting the development of a website on soil health that will be available soon.

The Land Management Society (LMS) initiated the ***Know Your Soil Biology:Soils are Alive*** workshops that we present throughout Western Australia.

LMS Website: http://www.lmsinfo.com

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Arbuscular Mycorrhizal Fungi

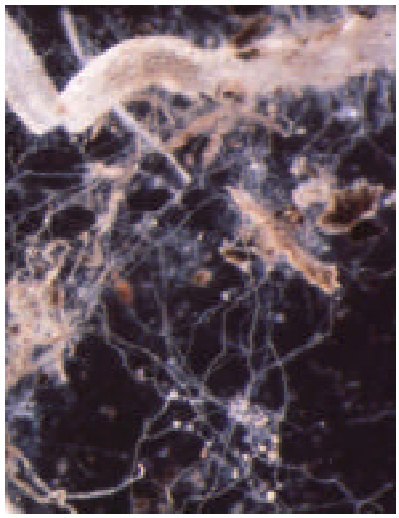
by Associate Professor Lyn Abbott

What are they?

A mycorrhiza (pronounced 'my-kor-rye-za') is a specialised association that forms between fungi and roots. The word mycorrhiza actually means 'fungus root' and the majority of plant species can form these associations. Mycorrhizal associations are generally beneficial to both the plant and the fungus and nutrients are exchanged from one partner to the other.

Arbuscular mycorrhizas are the most common type of mycorrhiza. They are formed by a group of fungi that are usually present in all soils. About 150 species have been described, but there are still many unnamed species throughout the world. It is interesting that very similar AM fungi occur on different continents.

AM fungi form close associations with most agricultural plants. The fungus forms thin strands in the soil that look like threads (see figure below). These are called hyphae (pronounced 'high-fee'). A network of underground hyphae connects roots of one plant with roots of other plants.



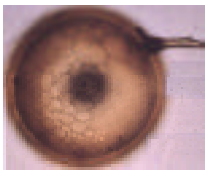
The network of hyphae (thin white lines) helps to stabilise soil particles so the fungi actually help to improve the physical fertility of soil. Hyphae are also important for exploring the soil to extract phosphorus and so can reduce fertilizer requirements.

Can mycorrhiza survive in soil when plants are absent?

AM fungi can survive for long periods in soil, even when the soil is dry or frozen. Some AM fungi survive as pieces of hyphae in dead roots or in soil. However, AM fungi are not able to grow for long periods in the absence of a host plant. Hyphae grow from spores or from within root fragments in soil when conditions are suitable, but they must make contact with a host plant to obtain the carbon and energy they need for long term growth.

Examples of spores of three species of AM fungi from Western Australia. Spores of AM fungi vary in size from 30 to 500µm.

500µm is half a millimetre



Gigaspora decipiens

Acaulospora laevis

Glomus mosseae

AM fungi take up and transfer phosphorus from soil through their hyphae into the plant. This phosphorus can increase plant growth if the soil is phosphate-deficient.

Important agricultural plants that do not form mycorrhizas are lupin and canola. We don't know the reasons for this. Wheat forms mycorrhizas but to a lesser extent than clover or pasture grasses.

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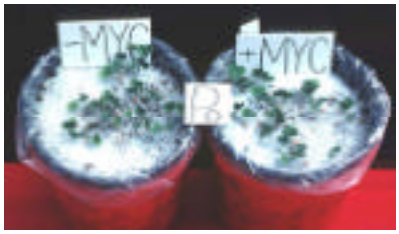
How do agricultural practices affect AM fungi?

PHOSPHORUS

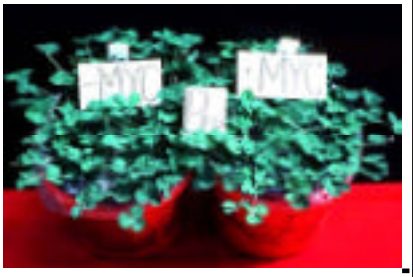
An extensive survey of wheat crops in Western Australia was funded by GRDC to determine the presence of AM fungi at early seedling stage and in spring. Most plants had low levels of mycorrhizas and this was related to high levels of phosphorus in the soil. The phosphorus in soil was extracted using the sodium bicarbonate method. Generally, the quantities of mycorrhizas were not sufficient to benefit the phosphate nutrition of the wheat.

Clover grown in soil with and without mycorrhizas (+/- MYC) at different levels of phosphorus (P). Benefits of mycorrhizas are not apparent when P is either very deficient or adequate for plant growth.



a) Soil is very deficient in P

b) Soil is deficient in P



c) Soil has adequate P

Professor Jim Graham from the University of Florida (working on a GRDC Visiting Fellowship) found that some AM fungi from soils in Western Australia actually decreased plant growth when the soil had a high level of P. This occurred even when the level of mycorrhizas formed on the roots was very low. This will be studied further in the field.

CULTIVATION

In agricultural soils in south-western Australia, cultivation does not usually affect the formation of arbuscular mycorrhizas. However in Canada, the growth of some agricultural plants was significantly restricted by cultivation, because the network of hyphae formed by the AM fungi was disrupted.

CROP ROTATION

The most significant effect of rotation on the presence of AM fungi in soils in south-western Australia is the increase that occurs during the pasture phases. This is because pasture phases include highly mycorrhizal plants like grasses, clover and other legumes and also because less phosphorus fertilizer is used. In addition, the common practice of including lupin and canola in rotations reduces the amount of AM fungi in the soil. Adding a pasture phase to the crop rotation helps to restore mycorrhizal function, increases the efficiency of phosphate fertilizer use and improves soil structure.

Mycorrhiza 'Bioassay' = AM fungi in roots after different rotations

Rotation	% root length colonized by mycorrhizal fungi	
	3 weeks	8 weeks
Pasture after wheat	41	70
Canola after wheat	0	32

HERBICIDES

Generally, applying herbicides at the recommended level does not directly affect AM fungi. There may be other effects of the herbicide if the type of plant roots in the soil is changed, for example if weeds are removed. In addition, residual herbicides can restrict root development and this could alter the length of mycorrhizal root formed. Some fungicides decreased the amount of mycorrhizas that are formed.

This research on the impact of farming systems on AM fungi was supported by the Grain Research and Development Corporation.

HORTICULTURAL PLANTS

Arbuscular mycorrhizas occur on many horticultural plants provided that excessive phosphate is not applied. Olive trees, avocado trees and grapevines all form arbuscular mycorrhizas. However, crops such as cauliflower and cabbage do not form mycorrhizas.

Ben McMillen (left) is investigating the diversity and functioning of AM fungi associated with vineyard practices with support of the Grape and Wine Research and Development Corporation.

MINESITE REHABILITATION

AM fungi associated with forest plants in WA appear to be less diverse than those often found in the more chemically fertile soils in the Northern Hemisphere. Their role in extracting phosphorus from highly deficient soils is likely to be very important although it is difficult to measure. Therefore it is necessary to return communities of AM fungi to severely disturbed sites (such as minesites) to help re-establish nutrient cycling processes.

Inoculating riplines at a WA minesite with AM fungi. Research funded through AMIRA by Australian mining companies.

The next newsletter will be about the bacteria that form nodules on legumes.

If you would like to be included in the email circulation of this newsletter, please contact **labbott@cyllene.uwa.edu.au**