Vol 1 • No 1 *January 2003*

Australian Soil club

## Welcome

Welcome to the first issue of the Australian Soil Club newsletter.

Professor Lyn Abbott

The club has been established in response to the growing interest by land managers in their soils and how they can be managed for sustainable productivity.

We are inviting all those interested in learning more about soils to join the club and benefit from the sharing of information between landowners and researchers.

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### In this issue:



### In the next issue:

- Comparison of soil types across Australia
- Testing physical characteristics of soil
- Soil pH levels and land management

### Acknowledgements

The soilhealth.com web site was established with support from the **Ian Potter Foundation**.

### Mission statement

To provide information about soil that is relevant to all land users.

# Soil care for future generations

**Maintaining soil health so future generations can continue to farm profitably is a major issue facing land managers.**

Obvious warning signs such as erosion, soil compaction and encroaching salinity as a result of traditional farming practices has led to the field of research devoted to managing soils for sustainability.

Professor Dan Yaalon, a leading soil scientist from Hebrew University, Jerusalem, advocates a new wave of thinking about 'soil care'.

He believes soil management needs to focus on the sustainability of soil for future generations, rather than just its short-term productivity.

The soil care concept highlights soil as a valuable natural resource and that ecologically sound management practices need to be considered along with economical and social issues.

Professor Yaalon said the protection of soil organisms and the selection of management systems that maintain and improve soil quality and productivity would form the basis of good farming practices.

### Managing soil organisms

Integral to maintaining soil health is managing soils to sustain their biodiversity.

Soil organisms contribute to soil health and fertility by breaking down organic matter and releasing nutrients into the soil, maintaining soil structure and increasing the efficiency of nutrient uptake by plants.

Soils contain many organisms, both plant and animal, that interact with one another, often in mutually beneficial ways. Agricultural practices can alter soil conditions and change the habitat of these organisms and the way in which they function. ■

Lyn Abbott

**Salinity is one of the major challenges facing researchers and landowners.**

# Membership can benefit your soils

**The Australian Soil Club club aims to develop a national network of land managers interested in increasing their knowledge of soils and sustainable management practices.**

Members will have access to the latest information and research into physical, chemical and biological aspects of soils.

The club is an initiative of Kondinin Group and Professor Lyn Abbott from the School of Earth and Geographical Sciences at The University of Western Australia.

Membership will keep land managers up-to-date with a bi-monthly newsletter and information on how to access publications, regional information sheets, seminars and workshops.

An email club to allow members to share views and experiences is also under development through the soilhealth.com web site.

To become a member fill out the subscription form on the back page and send it to the Kondinin Group. ■

Lyn Abbott

**The Australian Soil Club will provide information on managing soils to benefit all land users.**

# Nutrient cycling keeps soil healthy

**Nutrient cycling is an important process for keeping ecosystems in balance because it replenishes the nutrients used by plants.**

Organisms that live in the soil play a major role in nutrient cycling by breaking down organic matter (dead plants and animal matter) into inorganic nutrients, which are used by plants for growth.

Micro-organisms such as some bacteria and fungi use organic matter as a source of their own nutrients. As they decompose organic material, they release nutrients into the soil in forms other organisms such as plants can use. This process of converting organic nutrients into inorganic nutrients is called mineralisation.

Larger soil organisms such as earthworms and mites play a role in this process by reducing organic matter to smaller segments that are easier for micro-organisms to decompose.

Soil organisms make up only a small amount of the organic material in soil but they still equate to hundreds of kilograms per hectare. The range of organisms in the soil community is diverse and they interact in many ways.

For example, some earthworms and mites break down organic matter into smaller segments, which are more easily colonised by bacteria and fungi. Other soil animals feed on these bacteria and fungi.

So, as the population of one group of organisms increases, another will also increase and keep the number in check. After the organic material can no longer sustain growth of the first organism, the second group declines because its food supply is restricted.

Jill Clapperton

**Earthworms help break down soil particles, making it easy for bacteria and fungi to decompose plant matter.**

Photos: Graham Osler

**Soil mites help recycle nutrients by breaking down organic matter into smaller components for micro-organisms to decompose. Mites are less than one millimetre in length.**

In New South Wales, a recent Rural Industries Research and Development Corporation project found up to 23 Oribatid soil mite species in some soils. In contrast, only six species were found in a study of West Australian soils. This difference may be due to differences in soil type and climate.

### Managing organic matter

Land management practices that conserve and enhance organic matter and soil organisms will help sustain soil health.

Organic matter stabilises soil structure by binding particles together to form aggregates, which reduce erosion and provide a habitat for soil organisms.

During organic matter decomposition, micro-organisms may tie up soil nutrients temporarily, which would otherwise be leached or eroded from the surface layers.

The decomposition rate and therefore nutrient availability is determined by the carbon-to-nitrogen ratio of the organic matter and the activity of soil organisms. Organic matter with a high C:N ratio is usually less degradable because of its high level of complex molecules.

A lot can be learnt about the dynamics of organic matter by examining the 'active' fractions of plant residues. The active fraction includes the partially decomposed 'light fraction', which might still resemble sections of stems or roots.

The total amount of organic matter in soil changes very slowly (many farmers may have noticed the carbon percentage (C%) in their soil samples does not change significantly from year to year).

The level of soil organisms is sometimes used to indicate changes in the active fraction of soil because they are sensitive to changes in their environment. ■

## Nitrification

**Soil bacteria also play a vital role in the nitrification process, which releases ammonium from organic matter and transforms it into nitrate, which can be used by plants.**

**The bacteria responsible for nitrification exist mostly in the top few centimetres of the soil profile.**

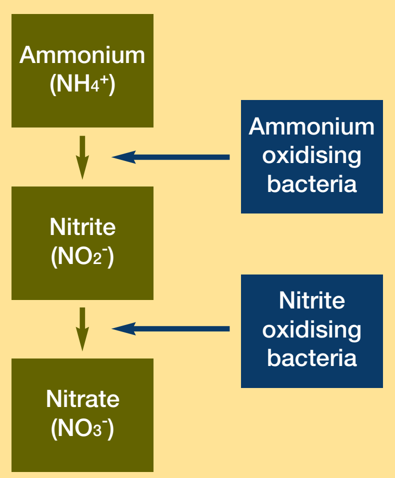
**The bacteria work as a team. One group of bacteria, called ammonium oxidising bacteria, convert ammonium ($NO_4^+$) into nitrite ($NO_2^-$). The second group, called nitrite oxidising bacteria, convert nitrite into nitrate ($NO_3^-$).**

**Unlike many other micro-organisms, nitrifying bacteria do not need to break down organic matter to obtain the carbon they need for growth. Like plants, they obtain carbon from the atmosphere. Organic matter is a source of nitrogen for nitrifying bacteria. The nitrogen is present as protein within the plant residues.**

**Because of this reliance on nitrogen in organic matter, there is a close association between mineralisation of organic matter and nitrification. Therefore, increasing organic matter levels can affect the activity of these bacteria.**

**By adopting agricultural practices that increase soil organic matter levels, it is possible to make the use of nitrogen fertiliser more efficient.**

**FIGURE 1 Nitrification in action**



# Are your plants phosphorus efficient?

**Farmers will soon be able to predict the level of arbuscular mycorrhizal (AM) fungi present in their soils, which will help determine how efficiently plants take up phosphorus.**

Arbuscular mycorrhizal fungi aid nutrient uptake by forming special associations with the roots of most agricultural plants.

The fungi grow inside roots and extend into the surrounding soil, forming a large network of mycelium, which is made up of fine strands of fungi called hyphae.

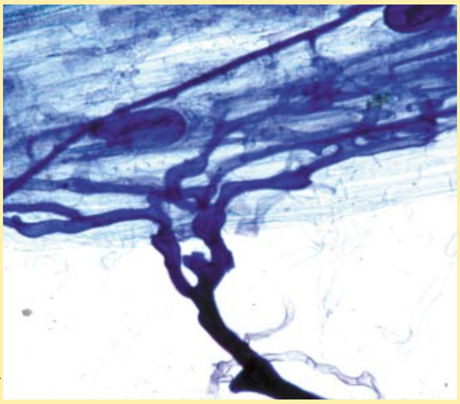
As the hyphae spread into the soil they can intercept nutrients such as phosphorus where roots do not reach.

The hyphal network also helps to improve soil structure by aiding the formation and stabilisation of soil aggregates.

AM fungi can survive in soil for long periods, even when the soil is dry or frozen. Some survive in dead roots and regrow when conditions are suitable, while others grow from spores or hyphal fragments dispersed in the soil.

The various types of mycorrhizal fungi have different structures but they act in similar ways, so a particular type of fungus does not need to be present to form an effective association with a particular plant. This contrasts with the specific association formed between particular legumes and their rhizobia for nitrogen fixation.

Researchers at The University of Western Australia are currently developing a simple model for predicting the mycorrhizal status of whole farms based on historical land use. This model uses information from tools such as soil tests and aerial surveys, which show land use (see Figure 1) to plot AM fungi levels in soils (see Figure 2).



Lyn Abbott

**Arbuscular mycorrhizal fungi grow inside roots and in soil. They increase the volume of soil plants can access to take up phosphorus.**

### Encouraging AM fungi

The best way to ensure there is enough mycorrhizal fungi present to benefit farming systems is to encourage their growth and activity through farming practices.

Many cultivation methods disrupt the network of AM fungi hyphae and reduce the growth of agricultural plants.

Adding high levels of phosphorus to soil also reduces mycorrhizal fungi.

Some plants can support more fungi than others, so crop rotations alter the level of these organisms in the soil.

Levels of mycorrhizal fungi in soil generally increase under pasture and reduce under wheat and non-mycorrhizal plants such as lupin and canola. ■

**FIGURE 1 Aerial photograph of a Wickepin farm**

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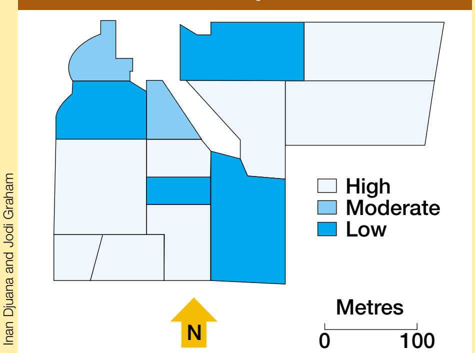
**FIGURE 2 Estimated mycorrhiza status of a Wickepin farm**




Inan Djuana and Jodi Graham

## Symbiotic nitrogen fixation

**Rhizobia are a diverse group of soil bacteria that form mutually beneficial associations with legumes and transform nitrogen from the air into a form that plants can use.**

**Specific rhizobia are available commercially for agricultural legumes because one type of rhizobia associates only with certain legumes.**

**Even if the correct rhizobia are present in soil, and legumes are well nodulated, the extent of nitrogen fixation can vary because some rhizobia fix more nitrogen than others.**

**Efficient symbiotic nitrogen fixation occurs in nodules that have formed a rich supply of a pigment called leghaemoglobin.**

**The rhizobia used in commercial inoculants are specifically selected because they are effective at fixing nitrogen and can withstand large-scale multiplication and packaging processes.**

**Nitrogen fixation by rhizobia in association with legumes contributes substantially to nitrogen inputs into many Australian soils.**

Sally Peltzer

Nitrogen is fixed in nodules that have formed on the roots of legumes such as this clover plant.

Sally Peltzer

Important to nitrogen fixation is the pigment leghaemoglobin shown in this cross-section of a lupin nodule.