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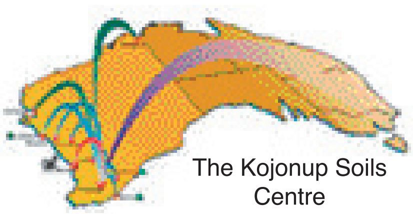
Australian Soil Club

Welcome

Welcome to the third issue of the Australian Soil Club Newsletter. The ASC is developing slowly, but surely, and it was exciting to meet a number of members recently in Young, NSW. (Please see article, this issue.) We hope to further develop activites like this for members and welcome any suggestions for visits or topics of interest. Due to a number of events around Australia in 2004, the possibility of including ASC activities could be arranged.


The Kojonup Soils Centre

The ASC is now affiliated with the new Kojonup Soils Centre for administrative purposes. The Kojonup Soils Centre is based in Kojonup, Western Australia, for the purpose of disseminating information about all aspects of soil, especially in the farming community, so it will be a valuable association for the Australian Soil Club.

In this issue:

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Soil Club visit to Young, NSW

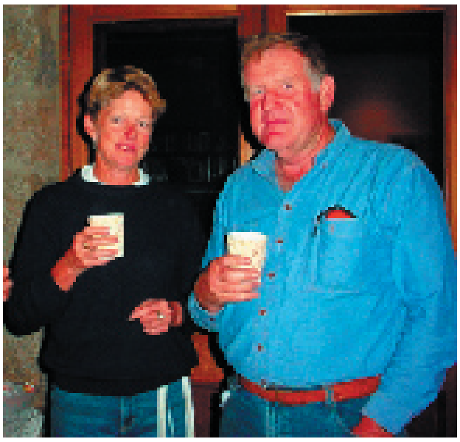
Fifty people attended a seminar in Young, NSW recently, to further their knowledge on the importance of biological fertility to soils and the physical, chemical and biological indicators of soil health. Professor Lyn Abbott, from The University of Western Australia presented the seminar in response to a request by ASC member Mrs Rhonda Daly.

Professor Abbott's research in the field of soil science and plant nutrition spans 30 years. Much of her research has been about arbuscular mycorrhizal fungi.

More recently, soil biology research at the University of Western Australia has been focusing on how best to use information about soil organisms for soil management on farms and in vineyards. Various research projects are funded by GRDC, RIRDC and GWRDC and the overall aims are to convert complex scientific information into practical information for use by land managers.

Information about soil organisms is only relevant in the context of soil physical and chemical processes and one of the purposes of the Australian Soil Club is to attempt to clarify the interconnections between these components of soil fertility.

In this issue, information about soil texture is provided (page 4). Soil texture has a great impact on the habitat of soil organisms. Therefore, understanding how the textures of different soils influence soil biological activity is an important research area. Any factor that affects soil texture will affect soil organisms to some extent. However, soil organisms can also have an effect on the arrangement of some soil particles through the exudates produced by fungi and bacteria and also by activities of soil animals.


Kerry Russell of Greenthorpe (near Young) and Richard Jones of Grenfell at the ASC Seminar in Young.

Members' soil info requests

As the Australian Soil Club develops further, we will endeavour to provide information on topics specifically requested by members. In our next issue, we will be addressing the popular issue of soil testing. Other topics identified by members have included:

straw and stubble management, soil compaction and hard setting soils, nutrient management and recognition of deficiencies, soil moisture issues and management, liming, organic fertilisers, acidity, salinity, soil electrical conductivity, increasing organic matter.

If you have topics that you would like addressed in this newsletter, please email organic@agric.uwa.edu.au or send your request to the address listed on this page,

Soil Analysis by Infrared Spectroscopy

By Dr Craig Russell, Research Fellow, Centre for Natural Resource Management, Albany, Western Australia, and Les Janik, Infrared Analytical Services Pty Ltd.

New technologies that provide rapid analysis of soil properties are in urgent need across the globe. Such technologies will promote the quantitative assessment of large-scale land management problems, and satisfy the environmental and economic need to manage agricultural land at a much smaller scale and promote the more efficient use of agricultural inputs.

Infrared spectroscopy is one such technology that has shown great promise for this cause. It is used routinely for the rapid characterisation of a wide range of materials and is currently used in Australia in the areas of grain quality and leaf tissue testing, food chemistry and mining. The technology is based on the fact that individual materials are defined and therefore identified by their reflectance or absorbance of infrared light.

The advantages of infrared techniques over other analytical techniques include:

(a) minimal sample preparation

(b) a short turn around time at the laboratory

(c) the need for only basic infrastructure

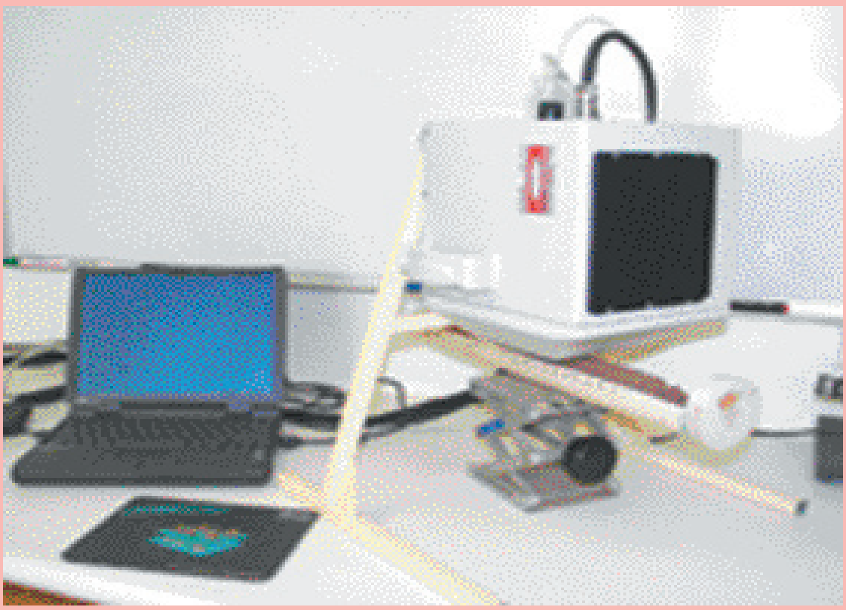
(d) minimal training of staff

(e) simultaneous determination of several constituents in every sample and

(f) the ability to analyse samples remotely. ie spectra are acquired electronically and can therefore be transported electronically.

All of these advantages contribute to a reduced cost of analysis. Consequently, infrared spectroscopy is being rapidly adopted across Australia's primary industries.

Recent laboratory research has demonstrated the capacity of infrared spectroscopy to predict soil physical, chemical, and biological properties. Quantitative predictions of several important soil properties have been made. These properties are important in assessing soil fertility, agricultural practices and land degradation. They include:



A portable infrared spectrometer set-up to scan soil cores for instantaneous predictions of soil carbon. (Photo courtesy L. Janik)

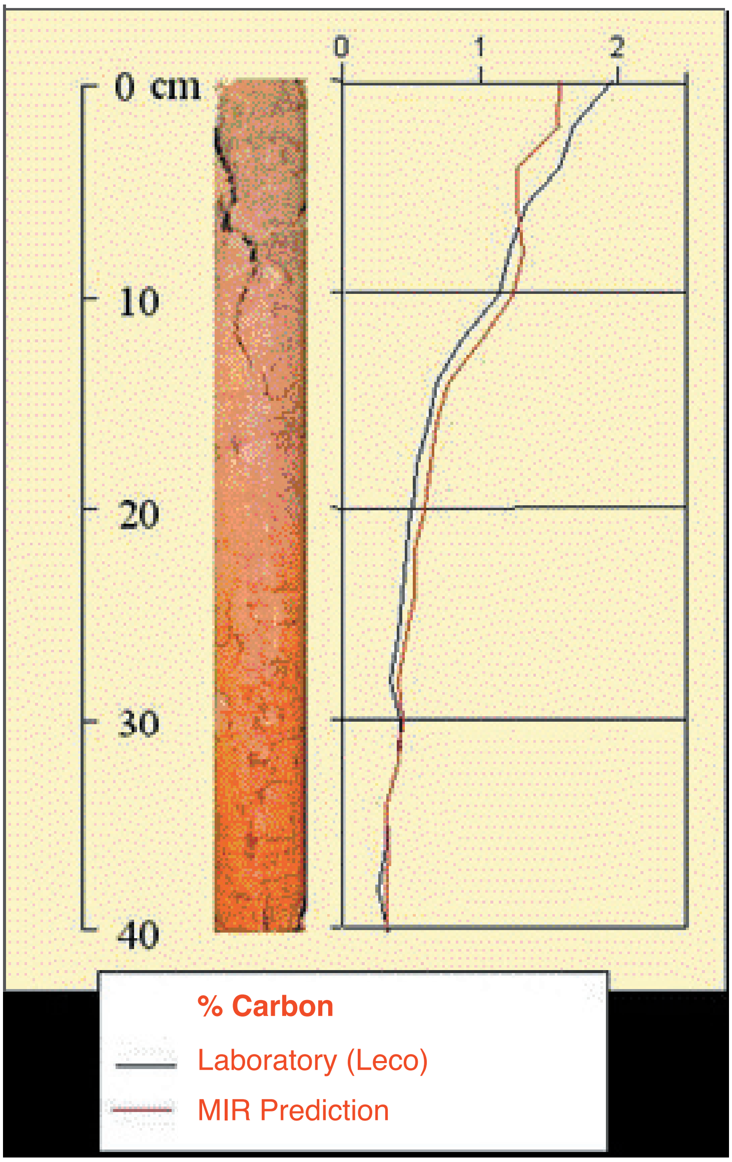
a) organic carbon: Soil organic carbon is an indication of soil organic matter content, which acts as both a source and sink for nutrients. Soil organic carbon is linked to soil chemical, physical and biological health, and is strongly correlated with soil nitrogen supply.

b) pH: Soil acidity is Australia's greatest land degradation issue, and is currently limiting our agricultural production. Techniques that promote the measurement of soil pH, the determination of the rate of lime required to achieve an acceptable pH, and the quality of lime products, will greatly aid the management of soil acidity.

c) iron and aluminium oxide content: Soil iron and aluminium oxides bind phosphate that may otherwise be displaced from the soil rooting depth. Displaced phosphate is not only a loss in potential crop productivity, but in many regions results in the eutrophication of wetlands and waterways. Cheaper determinations of iron and aluminium oxide content will promote better phosphorus management and help alleviate nutrient pollution.

Other soil properties that have been predicted with infrared technology are total nitrogen, carbonate, lime requirement, cation exchange capacity and soil texture (ie percentage sand, silt and clay).

Infrared technology offers the potential of a more precise and standardised soil testing service. Soil analyses derived from standard chemical methods from different laboratories, or at different times from the same laboratory, can be difficult to compare. This can be due to operator error and, or, differences in analysis conditions across laboratories, or even across batches within a laboratory. Infrared techniques will support the further development of precision agriculture by providing information at higher spatial resolutions cheaper and faster. They may also be available for on site analysis in the near future.



Soil carbon along a soil core, the standard laboratory test compared with that predicted by mid infrared (MIR) spectroscopy. (Image courtesy L. Janik)

Current research: Mid infrared and near infrared spectroscopy

Two infrared techniques are currently available for soil analysis, but their specific advantages and complimentarity have never been determined. These techniques are mid infrared (MIR) and near infrared (NIR) spectroscopy, and they are currently employed on separate instruments.

From a theoretical standpoint, MIR spectroscopy may be superior to NIR spectroscopy because it detects fundamental features as opposed to their overtones, and is sensitive to quartz. MIR soil absorption spectra are intense and display numerous peaks that can be readily identified, good for both qualitative and quantitative interpretation. NIR soil absorption spectra are of low intensity and exhibit few distinct peaks, yet these spectra have also been proven good for quantitative purposes.

Nevertheless, infra-red theory would suggest there are advantages in utilising both spectral regions. MIR energy absorption is linear for low energy absorbing properties, good for the detection of minor constituents. NIR energy absorption is linear for high energy absorbing properties, good for the prediction of major constituents.

Furthermore, due to the recent rapid adoption of NIR technology globally, NIR instruments are able to scan larger soil samples and are currently better supported with specialised software for calibration development than MIR instruments. Another advantage of NIR is that the same instrument can be used for plant and organic resource quality analyses (ie grains, fodder, green and animal manures, organic residues), as is currently available across Australia on instruments purchased for cereal chemistry assessment.

Australian scientists are seeking to explore the strengths and weaknesses, and thereby the best mix of these two infrared technologies for the routine purpose of soil testing. This knowledge will also be of significance in evaluating the usefulness of dual purpose instruments that may soon be commercially available.

Glossary

electromagnetic spectrum:
the complete range of wavelengths and frequencies of electromagnetic radiation extending from gamma rays to the longest radio waves including visible light.*

infrared: specific wavelengths on the electromagnetic spectrum that heat an object they strike.*

infrared spectroscopy: the spectral analysis of compounds using radiation in the infrared region.*

Spectra: plural of spectrum

Eutrophication: excessive algal bloom, accumulation of nutrient in sediments, and low levels of dissolved oxygen in an ecosystem.** In recent years, this process has been accelerated by an increase in environmental pollution from such sources as detergents containing phosphorus, the leaching of fertilisers, sewage and toxic dumping, and heated water from the cooling systems of power plants and other industries.

Internet Sources:

*http://www.sgia.org/glossary

**http://www.peel.wa.gov.au/content/thePDC/strategy/environment_objectives.cfm

Soil Structure and Soil Texture: How do they affect Soil Health and Fertility?

Soil texture is an approximation of the relative quantities of sand, silt and clay particles in a soil. Soil structure is a measure of the arrangement of these soil particles and the spaces between them.

Soil structure is somewhat dependent on soil texture. Good soil structure is present when the soil forms stable aggregates or cohesive groups of particles. This produces numerous pore spaces, which encourage root penetration and easy passage of water, nutrients and air and which also assist the growth of micro-organisms.

Types of soil structure

There are two main types of structureless or non-structured soil:-

a) single grain – like sands, and

b) massive – like compacted clays.

There are four main types of soil structure:-

a) crumb structure – which has small rounded aggregates of soil particles loosely adjoining other aggregates. This soil is therefore porous and permeable, yet retains moisture. It is the most ideal soil structure.

b) prismatic structure – which forms aggregates in columns with flat tops and separated by deep cracks. Aggregates usually form larger units called clods. Permeability is variable – better around the deep cracks and poorer inside columns.

c) blocky structure – aggregates are blocky and soil is moderately permeable.

d) platey structure – flat horizontal laminated aggregates like alluvial floodplain soil. Drainage and permeability are poor.

Good soil structure is one of the major factors for soil health and therefore, sustainable soil fertility. Sustainable soil fertility can be defined as the correct balance of chemical, organic, biological and structural conditions within the that will produce high yields over an extended time frame, using minimal inputs.

Soil texture is not easily changed whereas soil structure can degrade or improve very quickly through various agricultural practices. The tendency of the soil structure to become unstable is related to soil type, texture (finer texture - higher tendency), water content and soil chemistry. Some soil chemistry factors that adversely affect soil structure include soil sodicity, acidity and salinity. The decline of soil structure will exacerbate the decline in soil health and fertility. Soil pores become smaller or less numerous which restricts water, air and nutrient movement. Therefore porosity, drainage and plant root growth are reduced. This can lead to an increase in either soil density or structural instability or both, especially in clayey soils. Sometimes a surface crust may form, inhibiting seedling growth, preventing water penetration and increasing erosion.

Photo: A Duplex soil - structureless sand over a gravelly loam subsoil at Wubin, WA (courtesy B. Gilkes)

Improving soil structure

The good news is that all these changes are reversible. The actions required to improve soil structure depend on the individual soil conditions including stability of the soil structure. There are various options to improve soil structure, including some physical and chemical techniques such as:-

a) maintaining continued plant cover on land by using appropriate stocking rates;

b) use of cultivating discs to elevate dispersive subsoils to the surface;

c) deep ripping of compacted soils or layers;

d) use of minimum tillage practices especially when soil is wet;

e) stubble retention and green manuring to increase organic content and reduce compaction and erosion;

f) use of gypsum on sodic soils.

Many topics have been mentioned in this brief summary on soil structure. Some of these topics will be further explained in future issues of the **Australian Soil Club**.

Reference

FARM MONITORING HANDBOOK by Hunt, N and Gilkes, B. (1992) Farm Monitoring Handbook. The University of Western Australia. (contact: soilsci@cyllene.uwa.edu.au)

Annual membership of the Australian Soil Club is $33 ($40 for overseas subscribers). If you would like to receive further information about the Club, please email Jen Slater: organic@agric.uwa.edu.au