Soils are Alive Newsletter

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School of Earth and Geographical Sciences — The University of Western Australia

Welcome...

This newsletter considers the issue of the cycling of phosphorus from organic matter in soil.

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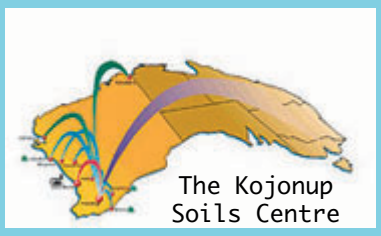
Plant material contains all the nutrients the plant takes up while it is alive. Therefore, these nutrients can be recycled back to the next plants - but any nutrients removed in produce would need to be replaced.

The Kojonup Soils Centre NEWS

The Kojonup Soils Centre has been established to promote knowledge of soil to the farming community and others interested in this important natural resource.



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.

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How important is soil organic phosphorus?

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Almost everyone knows about phosphorus (P). It is as important to plants as nitrogen (N) and is the 'star' of ATP (Adenosine Triphosphate), the molecule involved in energy supply within every living cell. It is used it to generate the energy required for growth.

If we check the database of scientific journal articles on phosphorus, 97-98% of articles discuss the inorganic component in soils. Very little information is found on the potentially large pool of phosphorus present in the soil's decaying plant, animal and microbial residues.

Macro Nutrient and chemical symbol	Plant Requirement	Source
Carbon (C) Oxygen (O) Hydrogen (H)		Air and Water
Nitrogen (N) Potassium (K) Phosphorus (P)		Inorganic fertiliser and organic matter
Calcium (Ca) Magnesium (Mg) Sulphur (S) Chlorine (Cl)	Decreasing Concentration	Gypsum, limestone, dolomite, fertilisers

Source: http://www.bettersoils.com.au/module2/2_6.htm

There is no doubt, however, that soil scientists have paid more attention to inorganic P than that available in the soil organic matter, known as soil organic P.

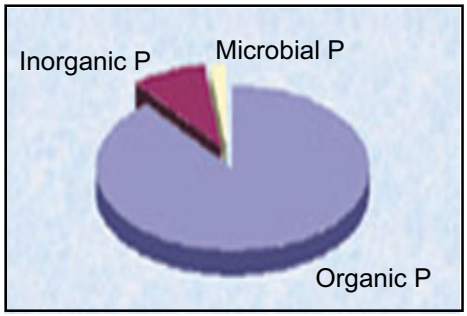

Fig 1: Typical proportions of different forms of P found in soil

Why is soil organic phosphorus important?

- It can be transformed into inorganic P through biochemical processes, making it readily available for plant uptake.
- Many plants can establish a mutual symbiosis with mycorrhizal fungi or produce root exudates called phosphatases. Both these activities, and those of certain soil microorganisms, result in the change of organic P to inorganic P.
- In highly weathered soils such as lateritics (Ultisols and Oxisols) and

forest soils, organic P can be up to 80% of the total P present in the soil.

The P in soil organic matter can become an important pool for plant growth with the use of management techniques such as residue application and mulching.

Organic phosphorus is being neglected because:

- Only inorganic P in the soil solution is readily available to be directly absorbed by plants.
- Soil organic P is a complex area of research, despite the availability of sophisticated (but expensive!) equipment.
- Inorganic P fertilizers are abundant and inexpensive.

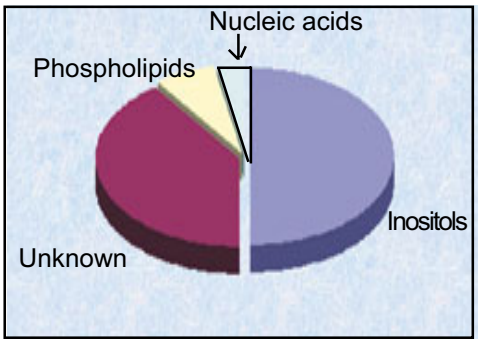

Fig 2: Soil organic P classification

Organic phosphorus classification and factors affecting its existence:

About half of the chemical make-up of organic P has been identified so far.

Inositol-P, which makes up about 50% of soil organic P, is the most studied and exists in complex forms in the soil. It may bind with soil carbohydrates and proteins.

Phospholipids can be up to 7% of the total organic-P in the soil. They may accumulate in plant debris or micro-organisms. Phospholipid synthesis and degradation is very rapid.

Nucleic acids and their derivatives comprise about 3% of organic-P.

The factors affecting the transformation of organic P to inorganic P are:

- inorganic P supply, and
- soil temperature, moisture, aeration, and pH.

These factors will affect the availability of organic P for plant uptake because as the level of inorganic P in the soil increases, the population of micro-organisms capable of breaking down organic P will be reduced.

Sources of organic phosphorus:

Organic matter is incorporated into the soil as plant, animal and microbial residues, all of which decay at varying rates. In terms of availability of P, the most beneficial type of organic matter will be one that does not degrade too rapidly, but that provides a steady supply of phosphorus into the soil solution. Degradation relates to the C:N ratio, such that sources of organic matter with a low C:N ratio will degrade faster than those with a high carbon content. In a study we conducted, lucerne provided the most amount of organic P to the soil, followed by peat and then wheat hay. However, although peat provides less phosphorus than lucerne, it has a higher C:N ratio and is more resistant to degradation.

The ideal source of organic P would therefore be a mixture that combines quantity of P with persistence in the soil, such as lucerne and peat.

In a related study, adding fresh organic matter to a soil was shown to increase the amount of P available for plant uptake.

If soils are low in P, the soil's organic matter acts as a sink, locking up any available phosphate. If fresh organic matter is added, decomposition of organic matter can occur, releasing phosphate for plant use.

Fig.3: Vineyard management practices such as use of cover crops and straw mulching will enhance biological activity in the soil and increase the amount of nutrients, such as P and N, available for plant uptake.

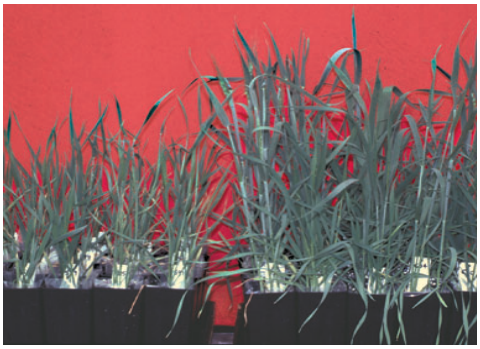

Fig 4: In wheat plants suffering from P deficiency (above left), reduction in shoot growth via reduced leaf number and size is the most obvious effect. Plants on the right have an adequate P supply. (Photo courtesy L. Osborne, UWA)

What does the future hold for organic phosphorus?

Knowledge of organic P is becoming especially important in tropical areas. Over-population in some places is forcing the reclamation of marginal land and any available soil P will be in high demand by crop plants.

Despite being marginal in other respects, however, these soils do contain large pools of organic phosphorus that will have to be managed properly to ensure sustainability. Governments need to implement programs to improve soil organic matter management, locate new strains of mycorrhizal fungi and micro-organisms capable of transforming organic P to inorganic P, and find further species of plants capable of transforming organic P.

These initiatives are not only important to the tropics, but are becoming of world-wide importance as we strive to find alternative, more 'environmentally sound' ways to manage our resources.

Knock Knock! Science is finding more ways to unlock the doors to soil organic phosphorus as we speak....