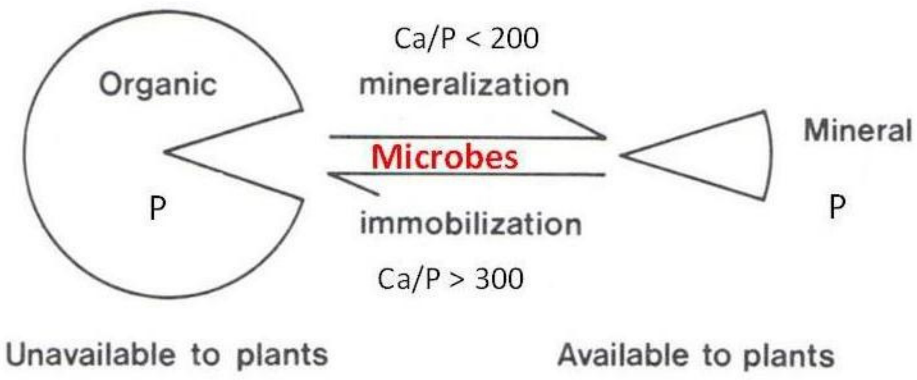
Soil Phosphorus (Part 5) – **Organic P**

The forms of phosphorus (P) that exist in a particular soil are important because of the role they play in determining the level of plant available P present in that soil at any given point in time. We discussed some of these forms in previous articles in this series. In this article, we will take a more broad brush, over view of soil P, focussing particularly on organic P (Po).

P occurs in the soil in both inorganic (Pi) and organic forms. In fact in most pastoral farming situations in NZ, about 50% (range roughly 30-80%) of the total P in the soil is in organic form. Po accumulates naturally during the process of soil development (cf Part 1 in this series). Hence, as P becomes available (weathering, fertiliser etc), biological processes are able to take place.

All plants, animals and microbes require P to grow and maintain life. Plants gain the P they require usually directly from the soil, by up-taking via their roots either of the main P inorganic anions present in the soil ($H_2PO_4^{1-}$, HPO_4^{2-}) from soil solution. Microbes get the P they require in the same way, or from feeding on other living or dead organic material. Soil animals get the P they need by feeding on other living or dead material present in the soil, whilst farm animals get the P they require by feeding on living plants or other supplementary organic food sources.

There is obviously a close relationship between the levels of Po in the soil and the amount of soil organic matter (OM) present. OM comprises both living organisms and decaying or dead organic materials, including dung. OM is a vital component of the overall soil, with many important roles to play. Much of the OM in the soil is not visible i.e. growers see the plants and are familiar with the dry matter growing above the soil but generally have little appreciation of the organic resource that exists below the soil surface, which is generally far greater than the OM present in plants growing above the soil surface.



Relationship between Organic P and Inorganic (Mineral) P

OM is crucial to good soil function and is also an important reservoir of many important soil nutrients i.e. most of the sulphur reserves present in the soil and much of the nitrogen and P are in organic form. In a soil which is functioning well - each of the chemical, physical and biological spheres are operating optimally – good levels of these macro-nutrients can be decomposed from OM and made available to the growing plant.

As is clear from the above figure, only a small proportion of the Po present in the soil is able to be mineralised and converted to plant available P. Most Po in the soil is chemically inert, and strongly bonded to the surfaces of soil/mineral particles or protected in other ways from mineralisation to Pi forms. Po in these forms is said to belong to OM that is inactive. This fraction is also described as humus and is the form of OM that plays an important role in various other important soil physical properties i.e. structure, CEC, water holding capacity etc.

The small component of the OM that is said to be active – litter, dead/decaying plant/animal material etc which has not yet been converted into humus – is a significant immediate source of soil nutrients. When a soil is functioning well i.e. good biology and good levels of available calcium (Ca) etc – then significant quantities of the nutrients held in this OM active fraction can be mineralised and made plant available. Let's consider a couple of examples:

<u>Soil 1: Dairy farm – intensive operation </u>(20-30 SU/ha)

Total P = 1500kg/ha (equivalent to the addition of 16tonnes/ha of superphosphate fertiliser [P = 9%])
Po = 50% or 750kg/ha (typically 3-5% is able to be mineralised annually i.e. Po(min))
Po(min) = 3% or **22.5kg/ha** (equivalent to the addition of <u>250kg/ha</u> of <u>superphosphate</u> fertiliser)

Soil 2: Dryland sheep/beef farm – extensive operation (5-10 SU/ha)

Total P = 500kg/ha (equivalent to the addition of 5-6tonnes/ha of superphosphate fertiliser [P = 9%])

Po = 50% or 250kg/ha (typically 3-5% is able to be mineralised annually i.e. $Po_{(min)}$)

$Po_{(min)}$ = 3% or **7.5kg/ha** (equivalent to the addition of 83kg/ha of superphosphate fertiliser)

Whilst both of the above examples are rather simplistic, and ignore a variety of other factors, they do point to the value of the Po reservoir in the soil, as a potential source of plant available P and the importance of optimising soil function to facilitate the release of some of this P reserve i.e. in the first example above (Soil 1: Dairy farm), an appreciation of the importance of these factors could lead to a significant reduction in the amount of fertiliser required, particularly where soil test data indicates good levels of plant available P are present in the soil.

Dave McKie
Soiltech Soil Scientist

soiltech
soil fertility specialists