# Phosphorous (P)

The 'reluctant nutrient'

## The reluctant nutrient

Although plants contain only 0.2–0.4% P it is considered a major nutrient (along with N and K) and is essential for cell division and growth, photosynthesis, energy storage, energy transfer from Adenosine Diphosphate (ADP) to Adenosine Tri-Phosphate (ATP), and respiration.

Increased phosphorous in the soil increases proteins in young plants providing protection against fungal diseases. It is needed by crops for rapid seedling development, winter hardiness, efficient water use, early maturity and producing maximum yields.

Phosphorous ($P^{3-}$) is an anion and binds rapidly to the cation calcium ($Ca^{2+}$) becoming tightly bound or "locked up" and difficult for plants to access; thus earning itself the name 'the reluctant nutrient'. Only legumes can access P in this form.

## How is phosphate (P) made available to plants?

Phosphate (P) is available to plants only when it has been converted to inorganic P (either (HPO42-) or (H2PO4-)) and is present in the soil solution.

Correcting the soil pH helps to release the phosphate, but it is largely made available by the action of soil microbes, in particular the action of mycorrhizal fungi excreting the enzyme phophatase to unlock these compounds.

To maximise the release of phosphorous it's essential to create the ideal soil structure for the biology to live in. This is accomplished by correcting the base saturation elements calcium (Ca), magnesium (Mg), potassium (K) and sodium (Na) as these elements have a big influence on the soil structure and pH. The 'ideal' soil has a balanced pH of around 6–6.5 and a soil structure that holds 25% air and 25% water, the optimum environment in which the soil microbiology can thrive.

The availability of soluble P is also affected by the level of phosphate and of other nutrients in the soil. For example, if you have high sulphur (S), then you need high levels of P; and vice versa. If soil has borderline P and high zinc (Zn), then Zn can tie up P. However, if all other nutrients are in balance in the top 6 inches of soil, then it makes it possible for the crop to tolerate the high Zn.


## Phosphate fertilisers

### Superphosphate

The fertilisers' triple superphosphate and superphosphate are 'plant feeders' – providing a feed of readily available or unbound phosphate to the plant. These are made by treating rock phosphate with sulphuric and phosphoric acids to make water-soluble plant-available forms of P. But these will revert back to being "locked up" within 30 to 60 days as it re-binds with calcium in the soil.

These fertilisers revert because superphosphates are extremely acid – around pH 3.0. When added to a soil of pH 5.5 to 7.5, they are rapidly neutralised by the phosphorous binding to calcium in the soil. The rate of reversion depends on the amount of organic material present, the soil pH and the amount of free calcium in the soil.

### Diammonium and monoammonium phosphate

Diammonium phosphate and monoammonium phosphate will provide plant-available phosphate over a longer time-frame. Although phosphoric acid is also used in the manufacture of these fertilisers, the fertiliser pH is only around 6.5, so it is far more stable when applied to the soil.

### Rock phosphate

Rock phosphate releases soluble phosphate slowly. A slightly acidic soil will assist with this process. Unless it's finely ground, only legumes can access the phosphate from applied rock phosphate in the first year. It takes a second year to release enough soluble P for a wheat crop and it's not until the third year that the soluble phosphate will become totally available from this source.

### Composts and manures

Phosphate applied to soils in manures or composts can leach downwards if there is sufficient water. But generally phosphate needs to be placed where it can feed the plant roots once the soil dries out – either on the top of the soil or worked into the top 6-7 inches where soil microbes are active to keep it in forms available to plant roots.

It is desirable to add more P fertiliser than the bare minimum required by the crop to avoid limiting crop yield. Having a reserve of phosphorous in the soil ensures there is enough to feed both the plant and the soil microbes, with excess remaining for microbes to slowly convert to plant available forms.

If soil is worked while it's wet and becomes compacted, this prevents plant roots penetrating the soil to access P, and it's possible for the plant to have a P deficiency. In this case adding starter phosphorous or a liquid starter can be beneficial.

## Phosphorous (P)

**In plants**:

- The 'reluctant nutrient' as it gets attracted to Ca and becomes locked up.
- An energy provider vital for photosynthesis, cell division and growth, respiration and energy storage.
- An 'usher' of nutrients into the plant.
- Phosphorous will be suppressed by high zinc, and vice versa.

**In animals**:

- Component of catalysts which enable biochemical reactions of carbohydrate and proteins; so any P deficiency has serious implications.
- P (along with Ca and Mg) is important for 'hidden' processes within the body – in bones, teeth and the soft tissues.
- Phosphate can be mobilised from bone reserves when P is deficient in the diet and this can mask any deficiencies in animals. Problems with crop growth may be the earliest indicator of a P deficiency.
- Lack of P can cause fragile bones, decreased milk production and reduced egg production in poultry.
- Is a component of RNA and DNA, so is required for protein synthesis.
- Important for energy metabolism.
- Has a role in the absorption of fats and sugars from the intestine and in the release of glycogen from muscles.
- Phosphorous is a component of cell membranes.

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