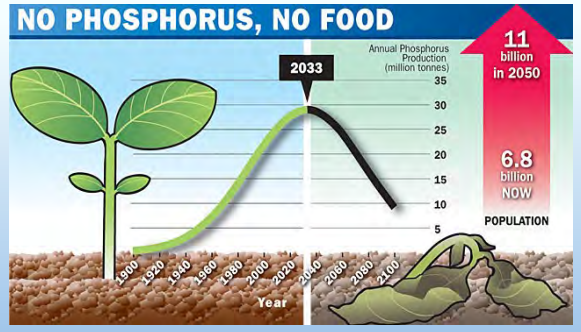
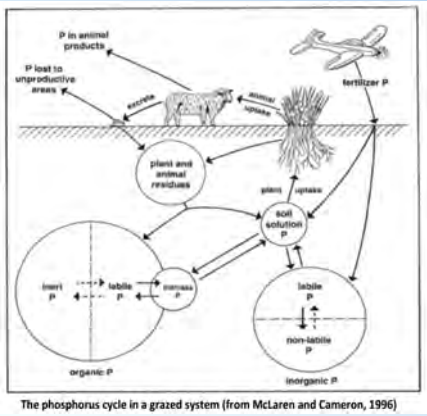


Phosphorus (P)

The Fuel of Life

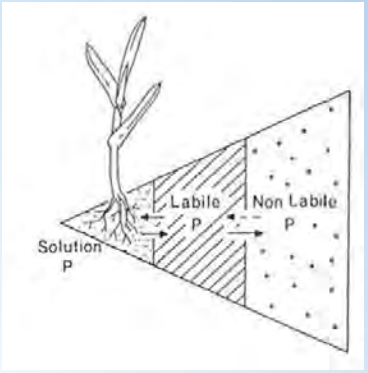
The Phosphorus Cycle



The phosphorus cycle in a grazed system (from McLaren and Cameron, 1996)

Phosphorus Losses:
- P leaching losses are low.
- Topsoil erosion causes significant loss.
- P removal through products.
- P lost to unproductive areas.
- P immobilisation.

Phosphorus Gains:
- P fertilisers.
- P from parent material.
- Mineralised P.
- Returns from animal faeces.



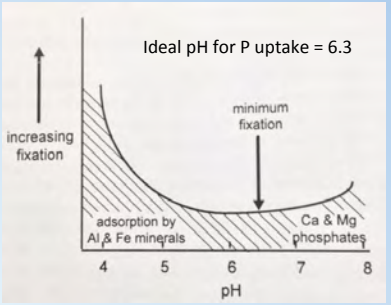
Soil P exists in three forms:
- Solution P
- Labile (Active) P
- Non Labile (Fixed) P

Plants take up P from the soil solution, as orthophosphates ($H_2PO_4^-$ in acid soils, and HPO_4^{2-} in alkaline soils). As plants use up solution-P, some of the labile P moves into the soil solution to maintain equilibrium.

Phosphorus Forms in the Soil

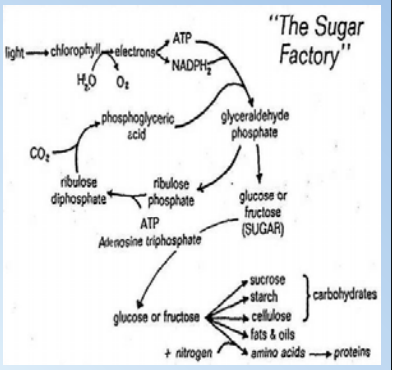
The Problem with Phosphate

Phosphate anions are strongly attracted to soil cations like **calcium**, **iron** and **aluminium**, where they tend to form **insoluble** compounds that are not plant available.



Why do plants need phosphorus?

- Essential part of ATP (Adenosine Tri-Phosphate) – the primary energy source for plant metabolic reactions.
- Forms part of DNA and RNA
- Component of all cell membranes
- Involved in all plant processes, including photosynthesis and nutrient transfer.



ATP = the energy currency of all cells

P in the Plant is Essential for . . .

1. Vigorous early **root** growth
2. Vigorous **shoot** growth
3. Effective **pollination**
4. **Seed** formation & viability

Soluble phosphate fertilisers often form insoluble compounds prior to stages 3 and 4.

P Deficiency in Plants

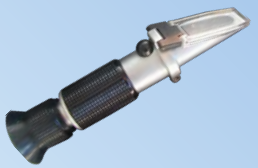
- **Stunted** shoot & root system
- Leaves lack lustre
- **Yellowing**
- Blue green or **purplish** leaves
- Symptoms appear first in **older** leaves

(P is very mobile in the plant)

Visually healthy plant but significantly stunted

Refractometer = total dissolved solids

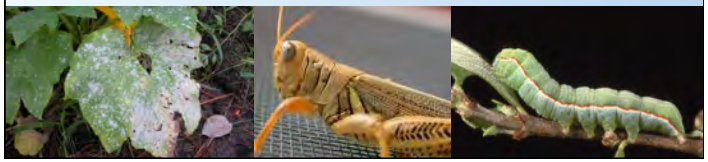
- A **good guideline** to **P levels** as sugars can not be produced without phosphate.
- The **higher the brix the stronger the plant,** with good energy reserves to fuel any demand response (e.g. pest attack, onset of flowering or a growth spurt on a sunny day after rain).
- Taste, Nutrition, Colour, Size, Shelf Life.



Brix to Control Insects

INCREASED PEST & DISEASE RESISTANCE

- P provides **fuel** for energy expensive plant defence systems.
- This includes **anti-fungal agents** and production of **biochemicals** which are distasteful to insects.
- Phosphate is essential for sugar production and increased **sugar levels** are unattractive to insects. i.e it can convert to poisonous alcohols in their bodies.



The Decline of Mycorrhiza

- The recent trend toward soil-life testing has revealed a dramatic decline in **mycorrhizal fungi** (VAM / AMF).
- What is responsible for this decline?
- **Over-cultivation, long fallows, harsh farm chemicals** and **high availability of fast release phosphate fertilisers** during sowing / early growth results in reduced mycorrhizal colonisation of plants.

Ravaging the Root Zone

Study the roots to evaluate the **biological impact** of harsh fertilisers.

- Look for fuzzy coating around the roots and how it holds onto the soil.
- This **fuzzy coating** represents billions of fungi and bacteria and their sticky exudates and hyphae effectively hold the soil to the roots.

Six Phosphorus Management Strategies to Reduce Costs

- Depending on soil type, some fast release P fertilisers may only deliver ~ 25% of their P component before locking up.

1. Stabilise P with Humates

- Humates complex with phosphates forming **phosphate humates**.
- This complexing process minimises the P **lock-up** rate, and increases the plant available P.
- Humates also contain **fulvic acid** which stimulates microbes that release locked up P in the soil.

2. Select the most appropriate and cost effective input

QUICK RELEASE

- **MAP** – alkaline soils
- **DAP** - acid soils
- **SUPER** - single, double, triple
- **MKP** (mono potassium phosphate)
- **PHOS-LIFE ORGANIC™**
- **GUANO**

SLOW RELEASE

- **HARD ROCK PHOSPHATE**
- **SOFT ROCK PHOSPHATE**
- **GUANO**

Choosing the Right Phosphate

- Use **slow release** forms for long term soil availability.
- Use **soluble P** to kick-start the system at planting.
- **Fertigate** and **foliar** spray as required throughout the growing season to boost crop health.

Acid treated phosphate is only ever needed for crop initiation in **field crops** and **vegetables**. It is rarely required in **orchard** and **pasture** situations

Combining Soluble and Slow Release

- **DAP/MAP** with humates plus **Guano Granules** or a similar soft rock phosphate alternative.

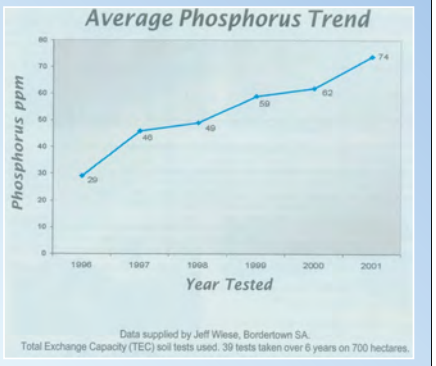
Rationale:

- The acid phosphate is buffered and stabilised by the humates.
- The Guano / SR offers citrate soluble and slow release phosphate so there is a complete release pattern throughout the crop cycle.
- **Soil life** is both protected and stimulated with this fusion approach.

Life-Force Base Blend Trial

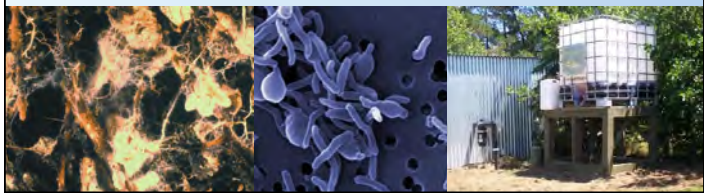
Annual P input 4 ppm from 300 kg/ha/yr Life-Force Base Blend - expect P increase by 24 ppm, assuming no removal/losses.

The rise in phosphate from 29 ppm to 74 ppm, is a result of the **biological solubilisation** of phosphate.



3. Use P solubilising inoculums

- Apply **Nutri-Life Bio-P™** and brewed **Nutri-Life 4/20™.**
- **Liquid inject** or **seed treatment** with microbes at planting to solubilise P in root zone (ensure there are still adequate soil P levels).
- **Apply** microbes **regularly** throughout the season.
- AMF release P solubilising **exudates** and increase the plant root zone, allowing greater access to P and other nutrients.



4. Stubble Digestion to Increase Phosphorus

- **Stubble** contains masses of food which can be utilised to build microbial populations.
- Most soils are deficient in **cellulose digesting fungi**. The introduction of these creatures can be tremendously productive.
- These fungi are the key to building **soil carbon** and they release a suite of organic acids which **solubilise** locked up phosphorus in the soil.

5. Use Fulvic Acid to Solubilise P

- Fulvic acid a **natural acid** extracted from brown coal.
- Fulvic acid will **solubilise P.** It breaks apart phosphate complexes with **acidity** and it promotes phosphate **solubilising bacteria**.
- Apply Fulvic Acid (or humate granules for dry amendments) through **liquid inject** at planting or **fertigation** throughout the growing season.

6. Using Legumes To Access Locked-up P

- **Legumes** offer much more than just nitrogen fixation.
- They are constantly releasing **acids** which break the bond between calcium and phosphate, and hence become a major tool to deliver plant available phosphate.
- **Inter-planting** or **rotational cropping** legumes with cereals is a very productive strategy.