Soil Fertility, Legumes & Fertilisers: Unravelling the Mysteries

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Soils
Lowland Soils

- Recent alluvial soils from greywacke (pallic)
- Floodplains & high river terraces*/downlands, 600-700 mm
  - Wairau & Awatere valleys (faults), Seddon soils
- Wither hills (Wairau valley) = loess over conglomerate
  - Weakly consolidated, highly erodible

* Loess covering underlying gravels, and rock (sandstone, siltstone, conglomerate, limestone)
Dry Inland (‘intermontane’) Basins

- > 300 m a.s.l. (500-700 mm rainfall)
- Rain shadow
- Glacial fans, terraces, outwash plains, moraines; lakes common
- Soils stony/gravelly, from greywacke
- pH/nutrients good, low leaching
- Gentle slopes, low erosion
- e.g. Hurunui & Haldon steepland soils – Molesworth country, inland Marlborough
Hill Country Soils (Sounds & West)

- Complex mix of rocks: greywacke, schist, ultra mafic – Mg rich
- Above 200 m: weakly weathered gravels
- Below 200 m: old strongly weathered soils
  - Acidity, podzolization, gleying, high clay (50%!)
- Moutere gravels – clay cemented gravels
  - e.g. Spooner hill soils
Why Fertilize?

Why Superphosphate?
Nitrogen fixation
= 25 kg N/t DM

Source: Lucas et al. 2010
Long-term Superphosphate = More Total DM, More Clover

Source: Moir et al. 1997

700 mm pa

1400 mm pa

Source: Moir et al. 1997
Olsen P – Predicts Growth Well (when soils are moist)

\[ Y = -2875 + 5687 \left(1 - \exp(-0.107x)\right) \]

\[ R^2 = 0.76 \]

Source: Moir et al. 2000
Long-term Superphosphate = More Soil N

- Soil Total and Mineralisable (plant available) N levels increased markedly with higher long-term SSP inputs (Wairarapa hill country)

Source: Moir et al. 2000
Fertiliser Witchcraft:
Can Nutrients Appear From Thin Air?
Answer = **NO!**

100 kg P ≠ 10 kg P : 1 T lime ≠ 100 kg lime
Always calculate fertiliser on a nutrient weight basis ($/kg)

Manufacturers/retailers must, by law, supply information on the concentrations (%) of (N—P—K—S) in fertilisers.

e.g. Single superphosphate is (0-9-0-12).

The choice of fertiliser depends on:
1. Nutrients it contains
2. Concentration of nutrient
3. Form of nutrient
4. Rate nutrient becomes available to plants
5. Cost /kg of nutrient
6. Risk of damage to sensitive plants.

Cost/kg Nutrient = \[
\frac{\text{Cost/tonne fertiliser}}{10 \times \% \text{ nutrient in fertiliser}}
\]
Remedies to Ward off Fertiliser Witchcraft:

- Where is the hard science?
  - Published in credible international scientific journals?
  - Is it applicable to NZ farming systems?

- Stick to basic principles, not “creative accounting”
  - e.g. ‘Cation base saturation ratios’?!

- Practice good soil sampling, basic soil analyses, and back up with herbage analyses if required.
Soil Acidity, Nutrient Availability & Liming
Soil Acidity (H+) – Formation and Issues

• A natural process – soils ‘weather’ (develop over time)
  ➢ Older soils = more weathering = higher acidity (lower pH)

• Acidity develops by:
  ➢ Leaching of ‘base’ ions (+climate/rainfall)
  ➢ H⁺ ion release by plant roots
  ➢ Microbial activity (organic acids formed)
  ➢ Al hydrolysis when aluminosilicate soil minerals are weathered
  ➢ Elemental S fertiliser

• Many hill and high country soils have low pH & can be extremely variable down the profile – difficult to manage!
Soil pH strongly affects nutrient availability to plants.

Source: McLaren & Cameron 2005
Soil Phosphorus Availability

Source: McLaren & Cameron 2005
Aluminium Toxicity & Legumes
THE Issue: Aluminium Toxicity in Legumes

- Lower soil pH (more acidity) = higher Exchangeable soil Al

- Legumes particularly sensitive to soil Al
  - Some species more than others e.g. Lucerne

- Soil Exch Al above 3 mg/kg can cause problems
  - Definite toxicity at 10 mg Al/kg & above
Lucerne: Lees Valley, Nth Canterbury

Canterbury Plains

Central Canterbury High Country
THE Issue: Aluminium Toxicity in Legumes

• Can affect plants severely
  - Root damage
  - Substantial decrease in rooting depth
    (depending on Al location in soil profile)
  - Decrease in accessing soil moisture (more drought prone)
  - Decrease in nodulation and N fixation in legumes
  - Decrease in nutrient availability
  - Decrease in yield & persistence
Aluminium Toxicity - Root Damage

Wheat
(Al 5 mg/kg, pH 5)

Pea
Roots dipped in Al Soln at arrow
Lucerne - Horizontal root growth

Glenmore Station Tekapo

Central Canterbury High Country
Relationship Between Soil pH & Exchangeable Soil Aluminium

Source: Moir & Moot 2010
Different Legume = Different pH tolerance

Source: Moir et al. 2011
QUESTIONS?
References


