

Soil Fertility, Legumes & Fertilisers: Unravelling the Mysteries

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Soils

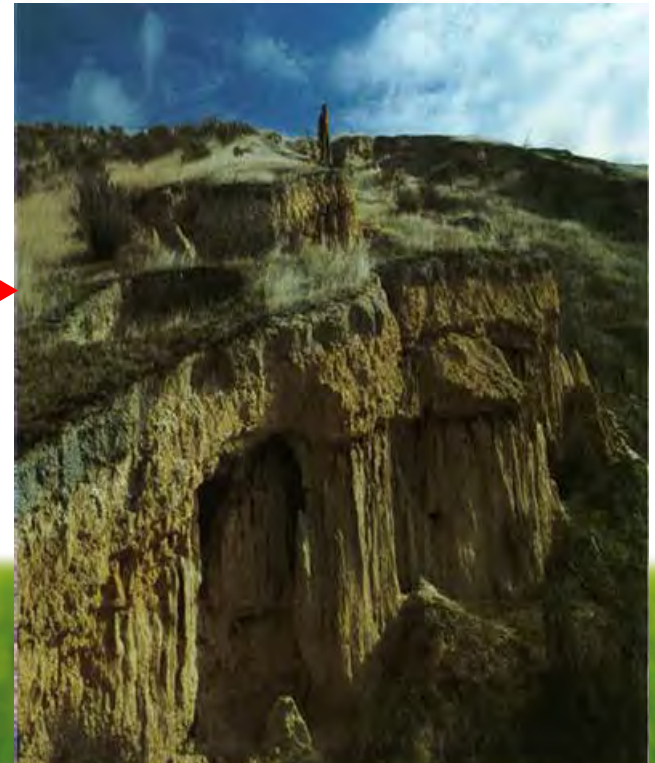
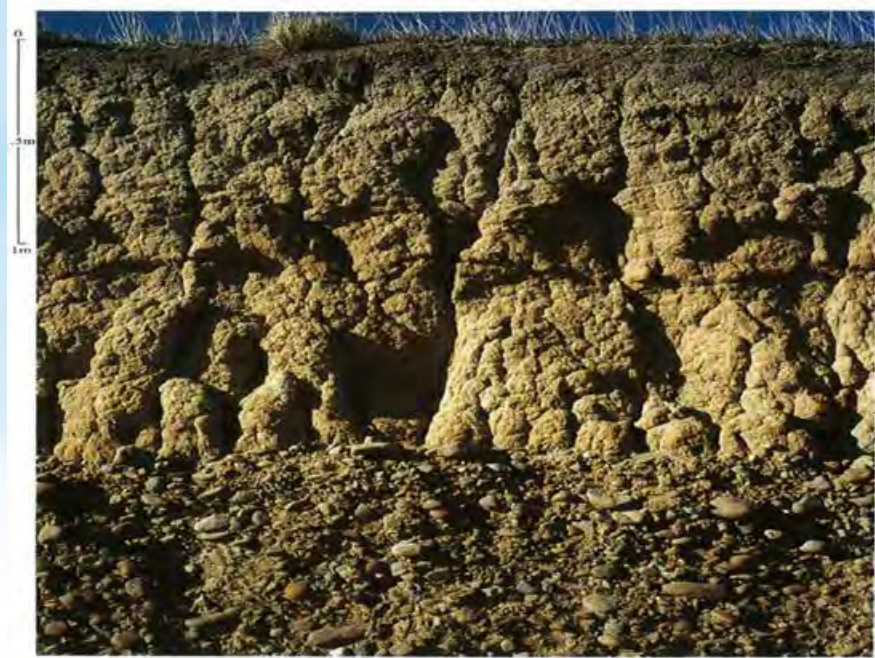


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Lowland Soils

- 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 erodable
- <http://www.marlborough.govt.nz/Environment/Land/Soils>



* 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 steepeland soils – Molesworth country, inland Marlborough



Hill Country Soils (Sounds & West)

- Complex mix of rocks: greywacke, schist, ultra mafic – Mg rich
- Higher rainfall 'Brown' soils.
- 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?

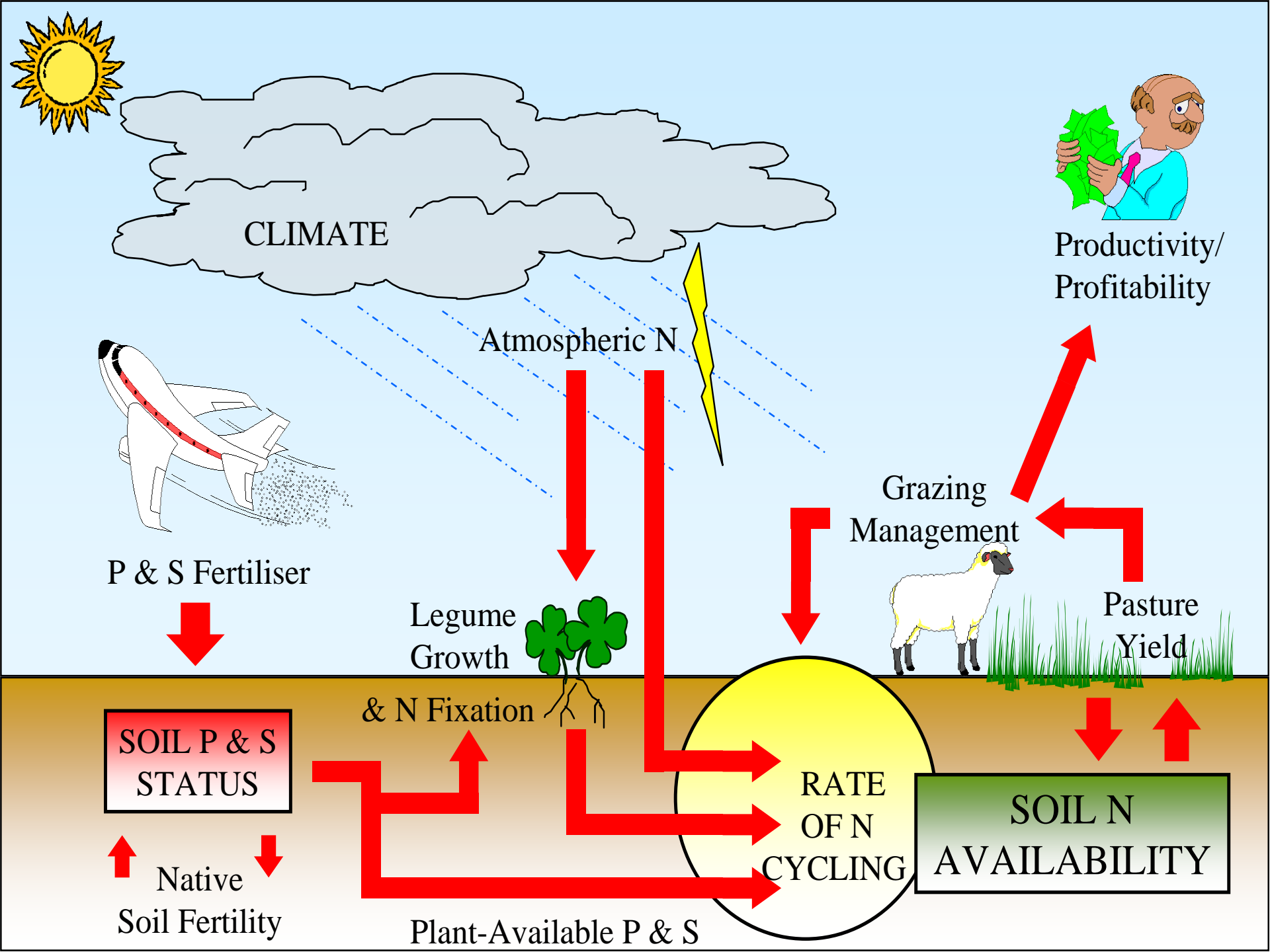


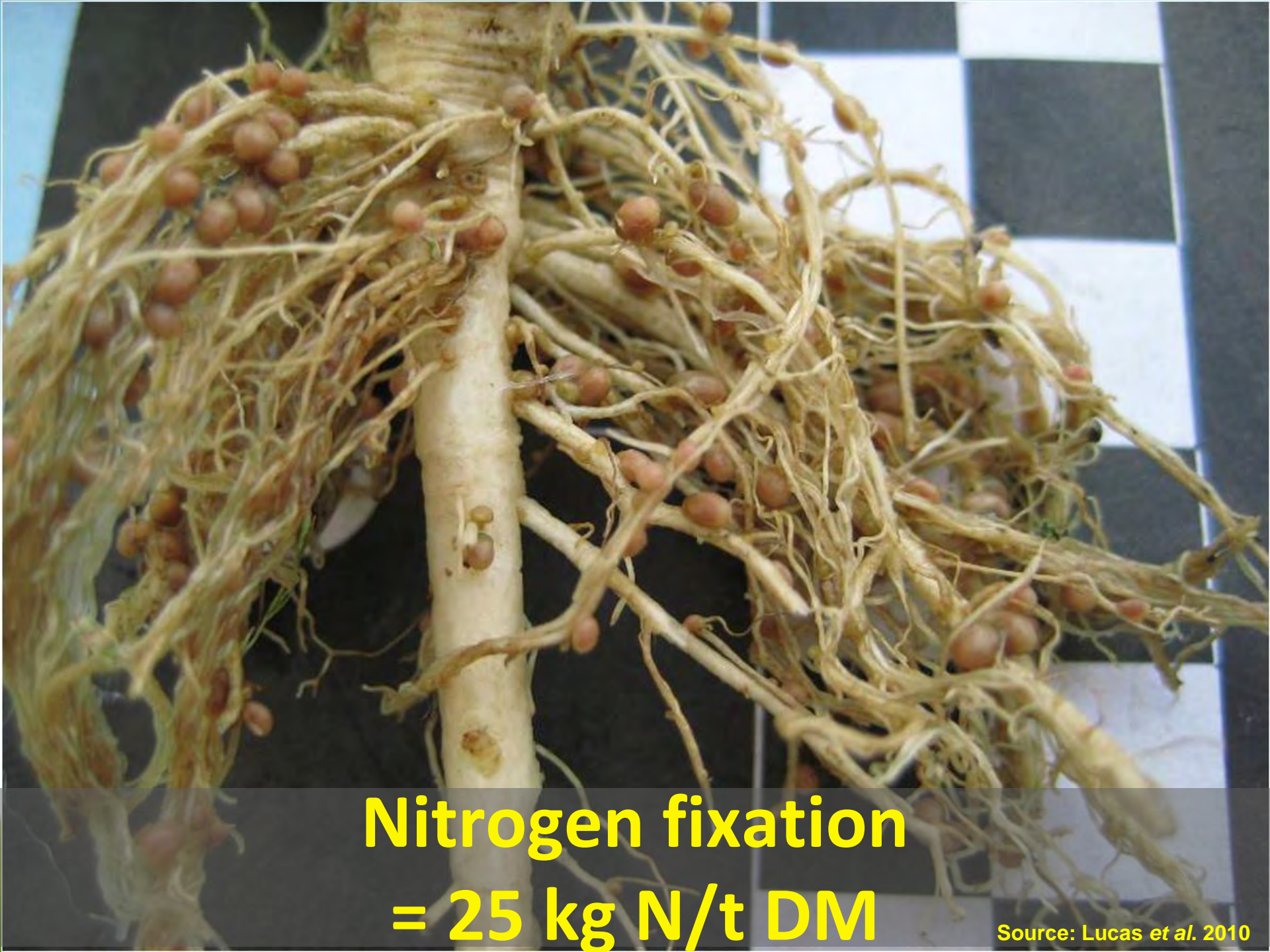
Why Superphosphate?



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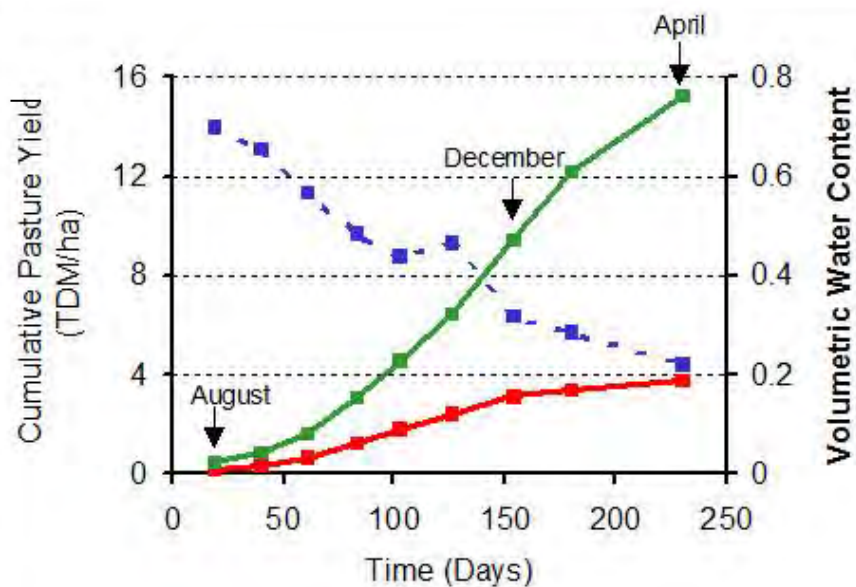
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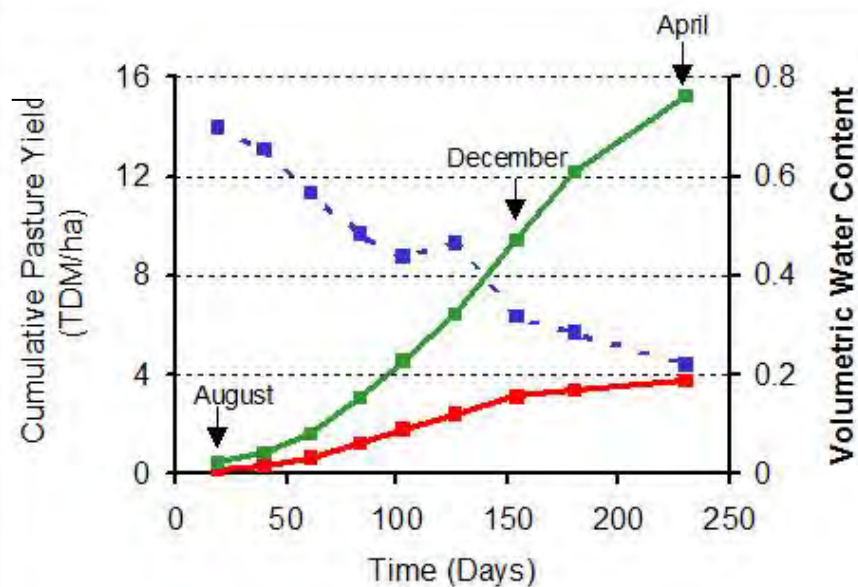


**Nitrogen fixation
= 25 kg N/t DM**

Long-term Superphosphate = More Total DM, More Clover



700 mm pa



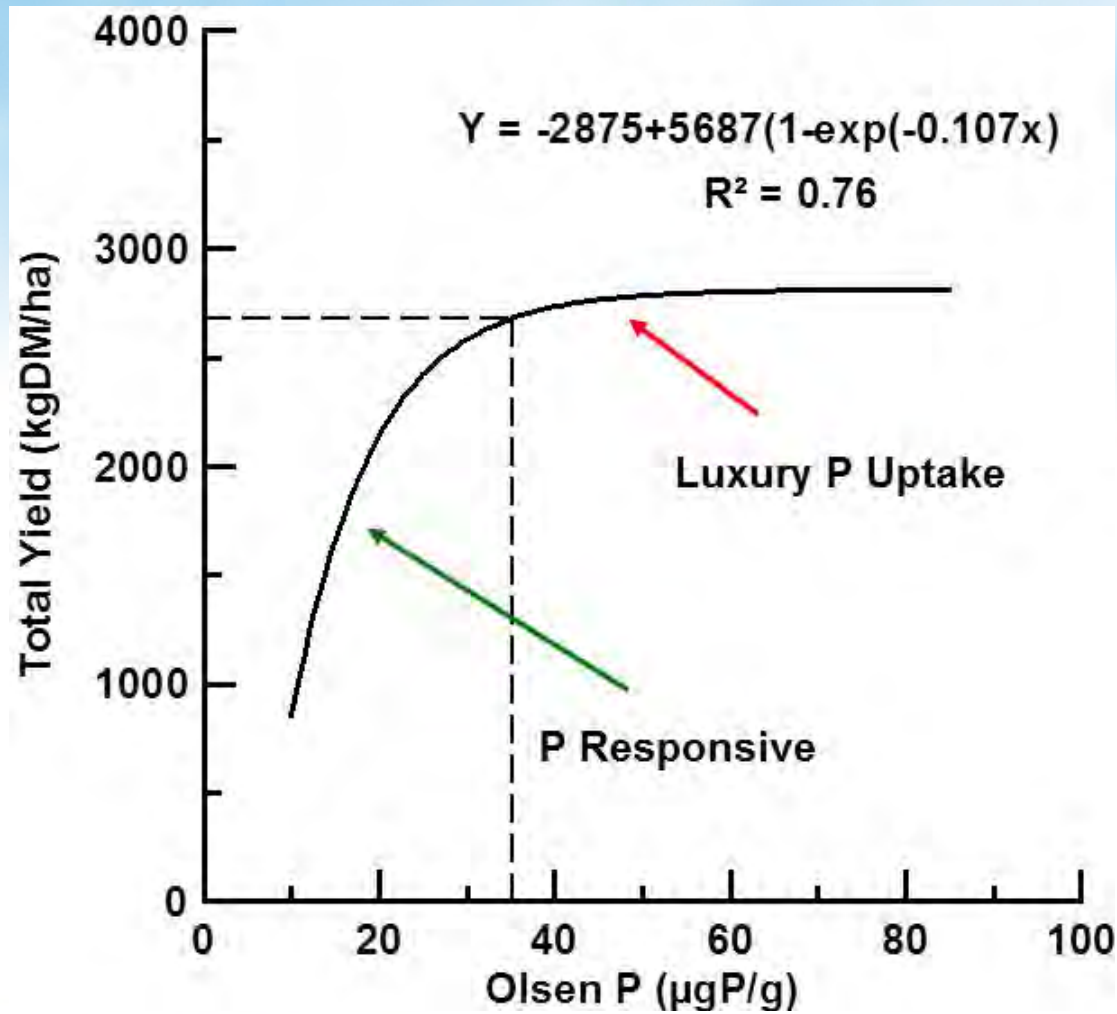
1400 mm pa

Source: Moir *et al.* 1997



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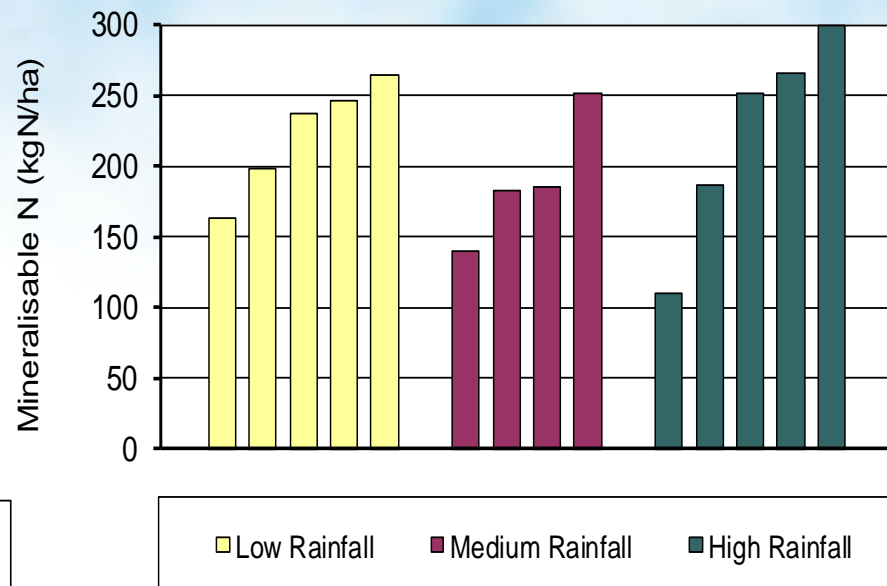
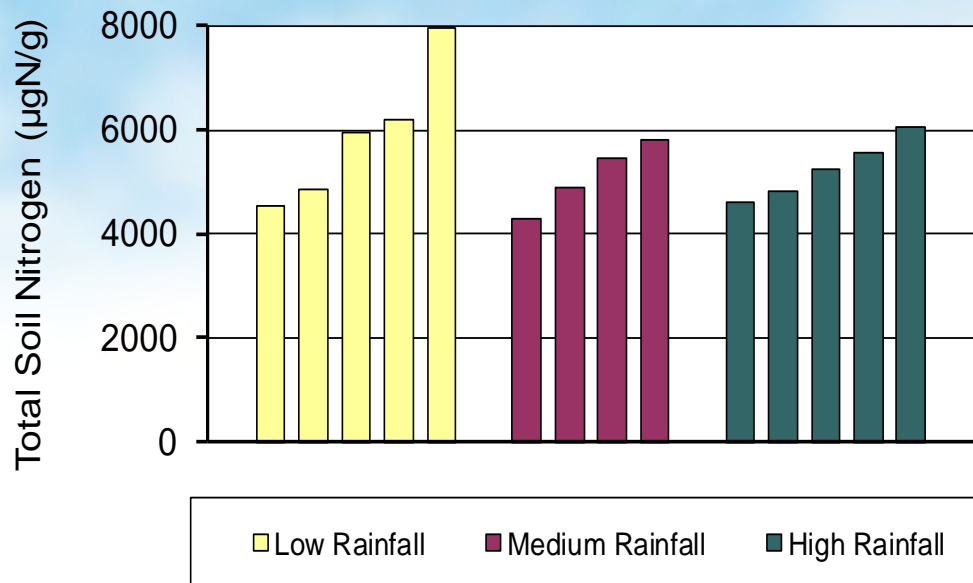
Olsen P – Predicts Growth Well (when soils are moist)



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)

**Superphosphate
WORKS!!!**

Source: Moir *et al.* 2000



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Fertiliser Witchcraft:

Can Nutrients Appear From Thin Air?



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Answer = NO!

100 kg P \neq 10 kg P : 1 T lime \neq 100 kg lime



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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.

$$\text{Cost/kg Nutrient} = \frac{\text{Cost/tonne fertiliser}}{(10 \times \% \text{ nutrient in fertiliser})}$$



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



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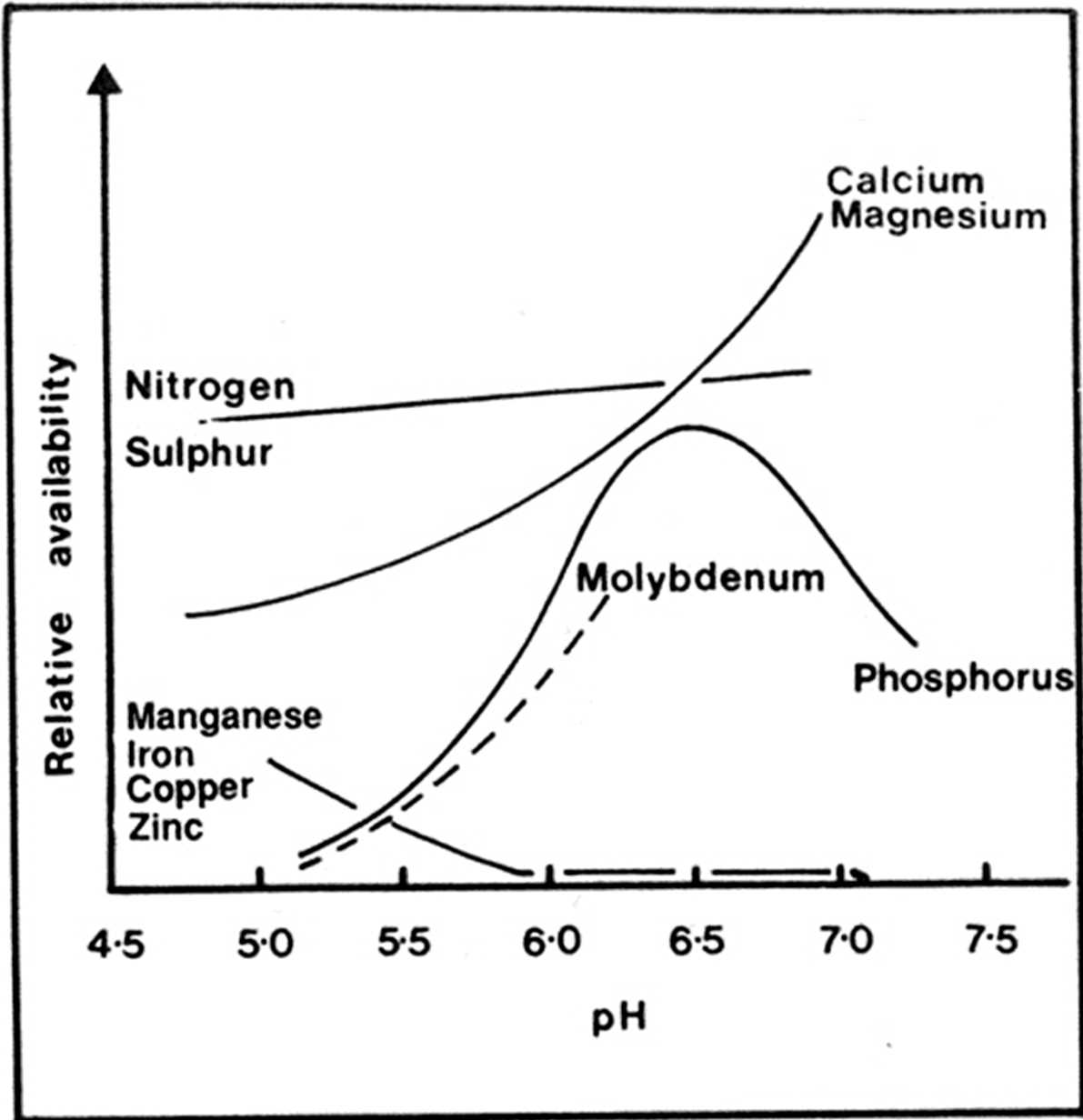
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Soil Acidity (H^+) – Formation and Issues

- **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!**

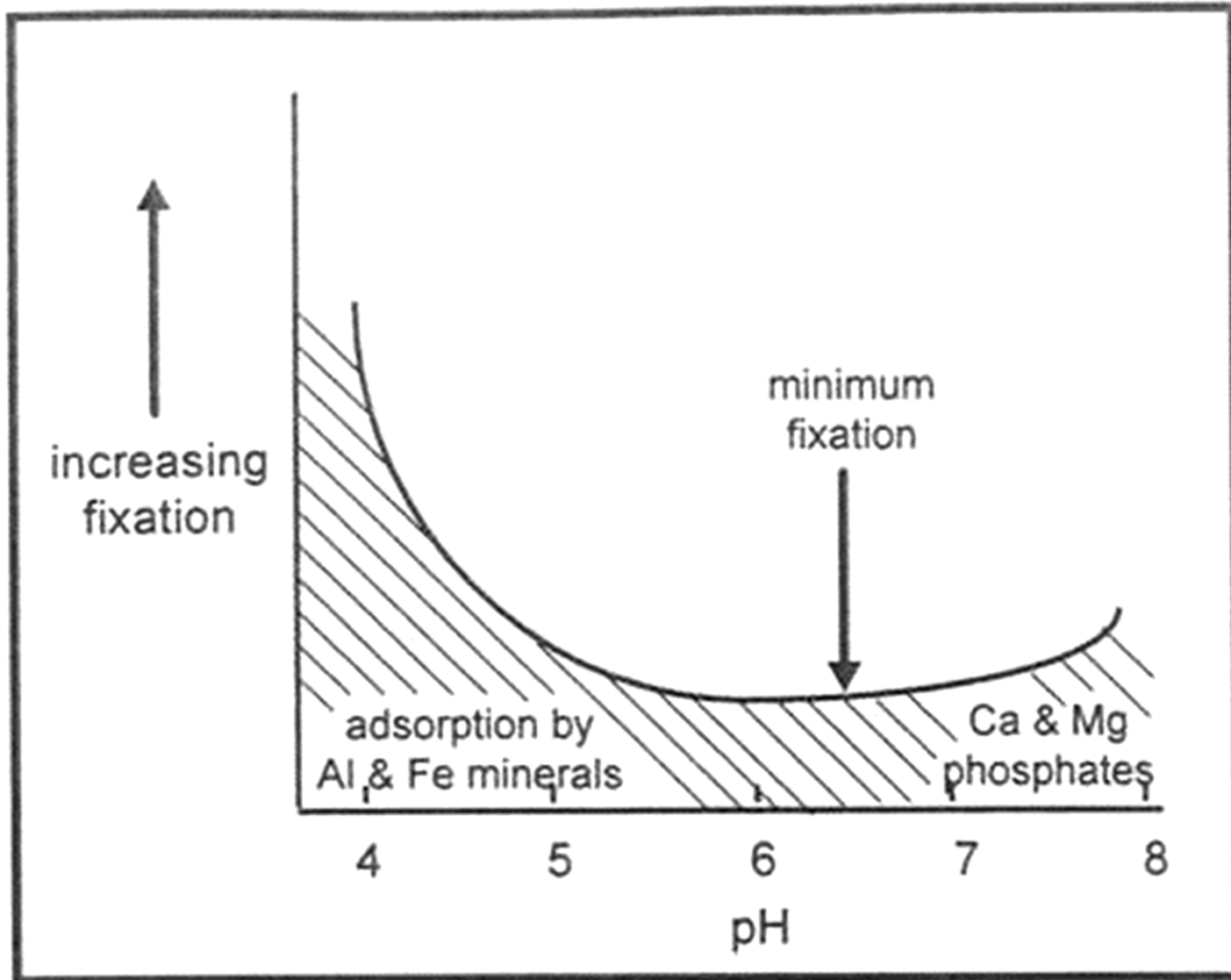


Soil pH strongly affects nutrient availability to plants



Source: McLaren & Cameron 2005

Soil Phosphorus Availability



Aluminium Toxicity & Legumes



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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

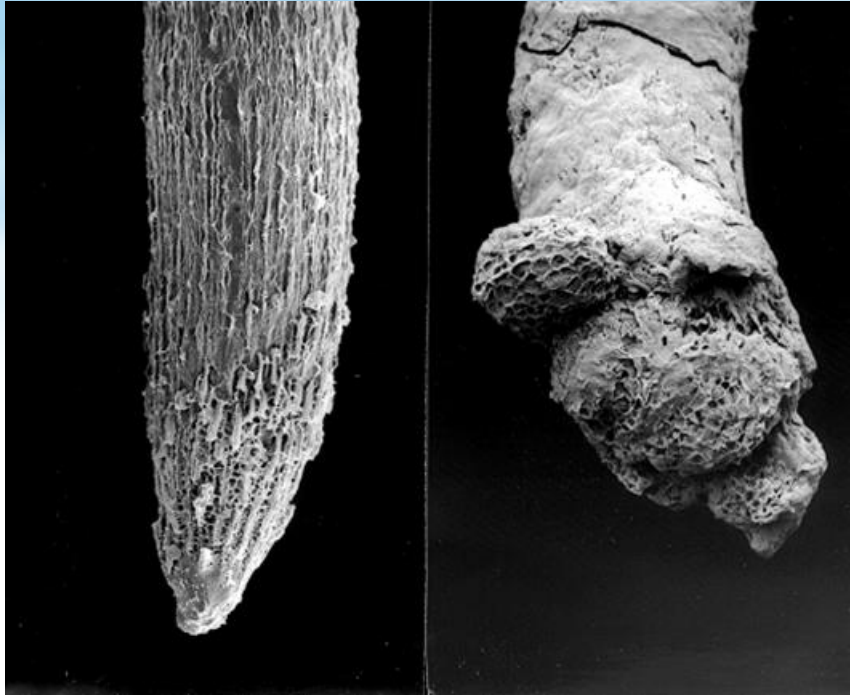


THE Issue: Aluminium Toxicity in Legumes

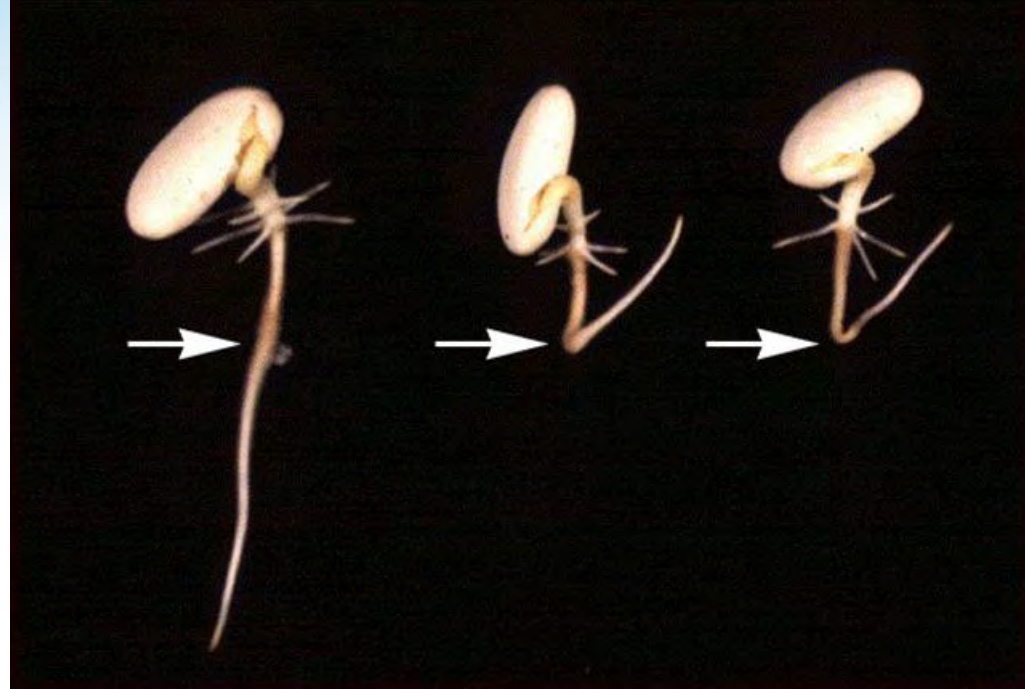
- **Can affect plants severely**
 - **Root damage**
 - **Substantial ↓ in rooting depth**
(depending on Al location in soil profile)
 - **↓ in accessing soil moisture (more drought prone)**
 - **↓ in nodulation and N fixation in legumes**
 - **↓ nutrient availability**
 - **↓ yield & persistence**



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



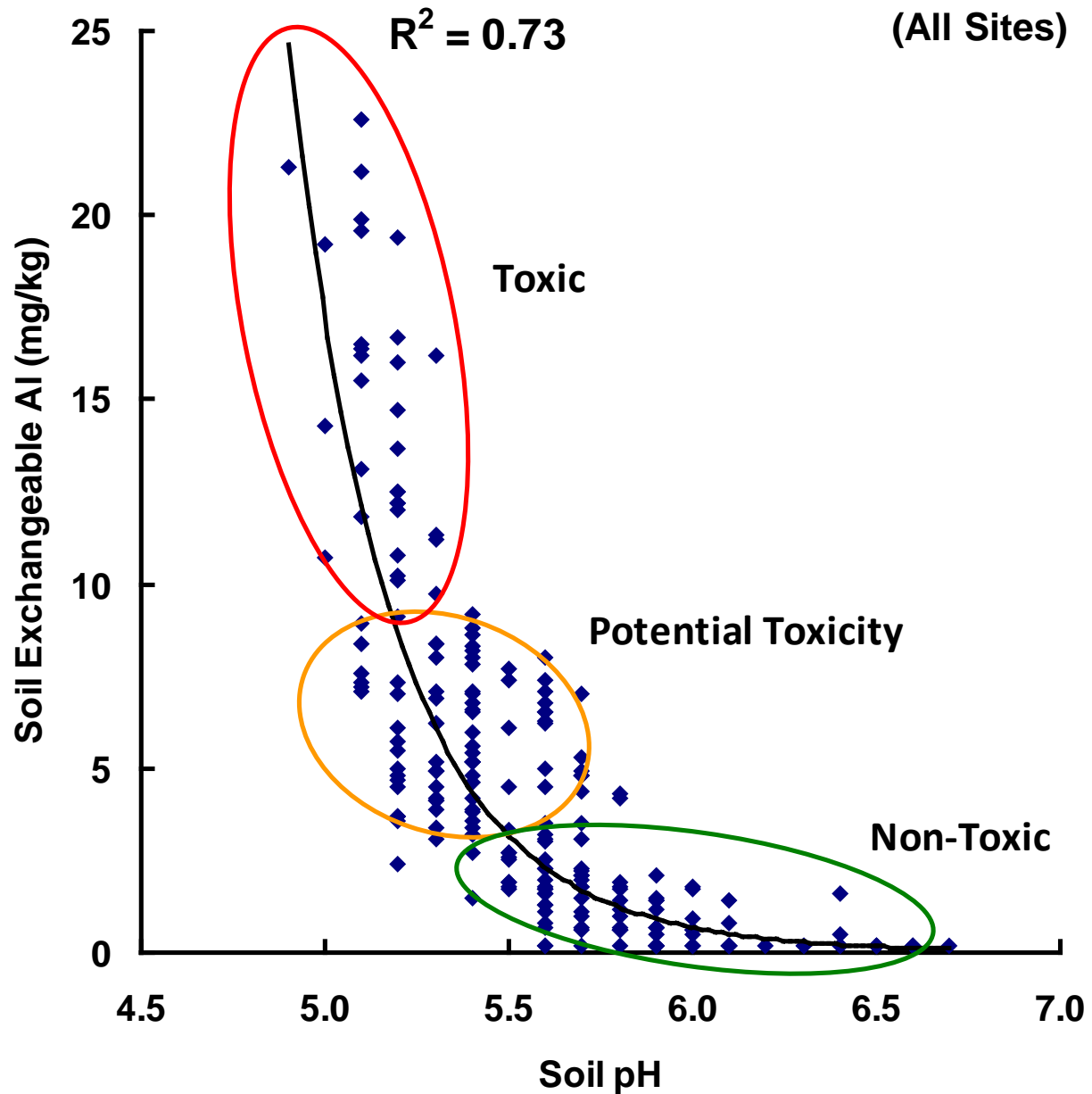
Central Canterbury High Country



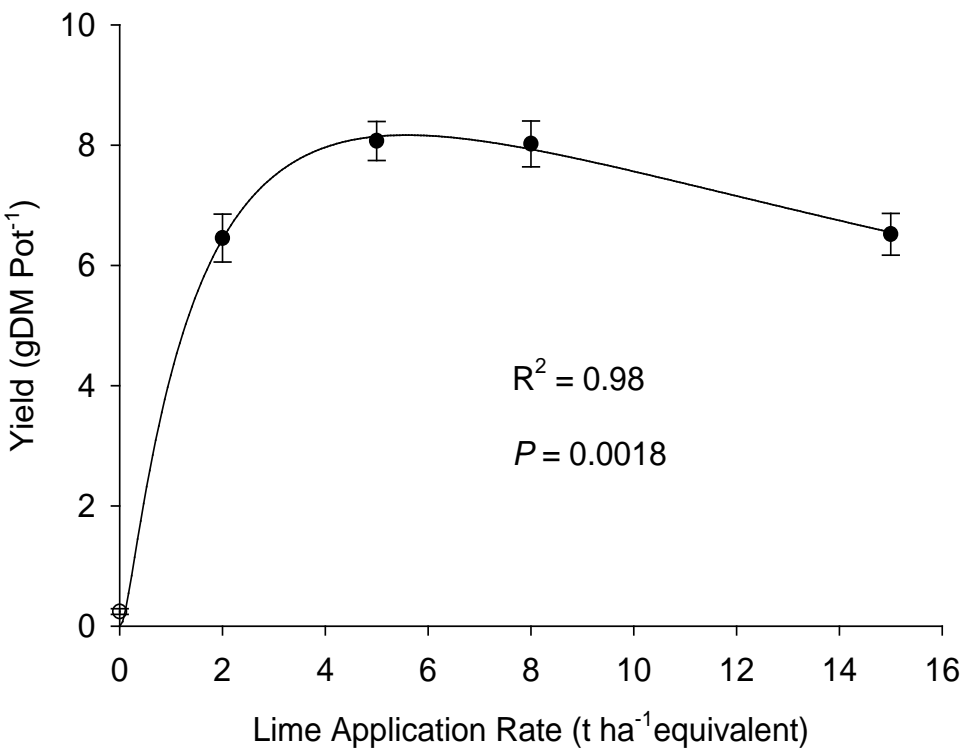
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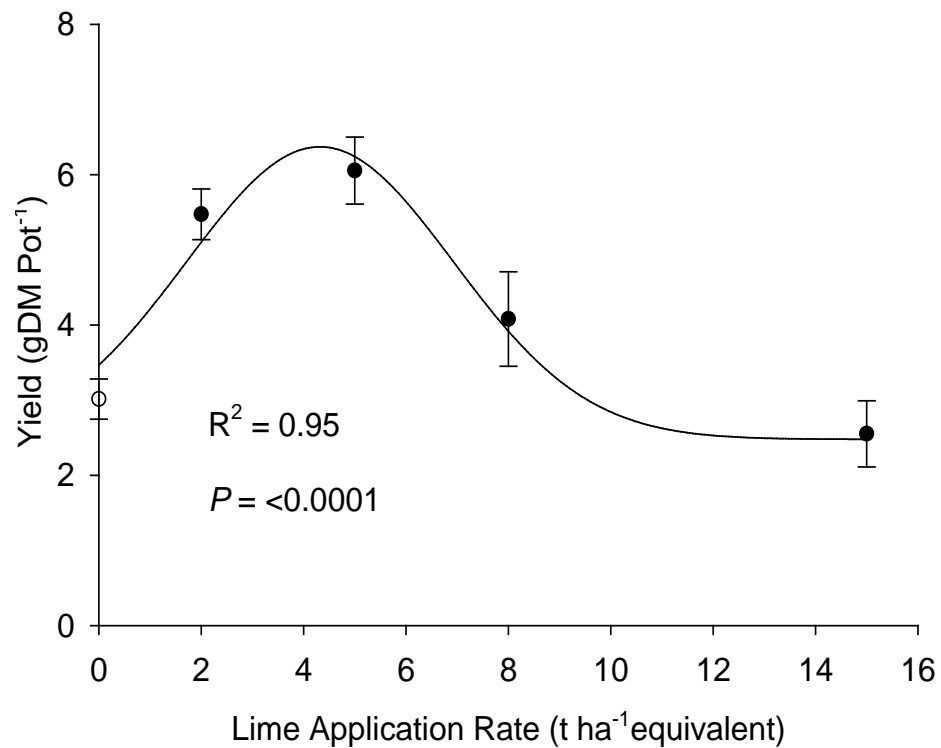
Relationship Between Soil pH & Exchangeable Soil Aluminium



Different Legume = Different pH tolerance



Lucerne



Caucasian clover

Source: Moir *et al.* 2011



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QUESTIONS?



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References

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