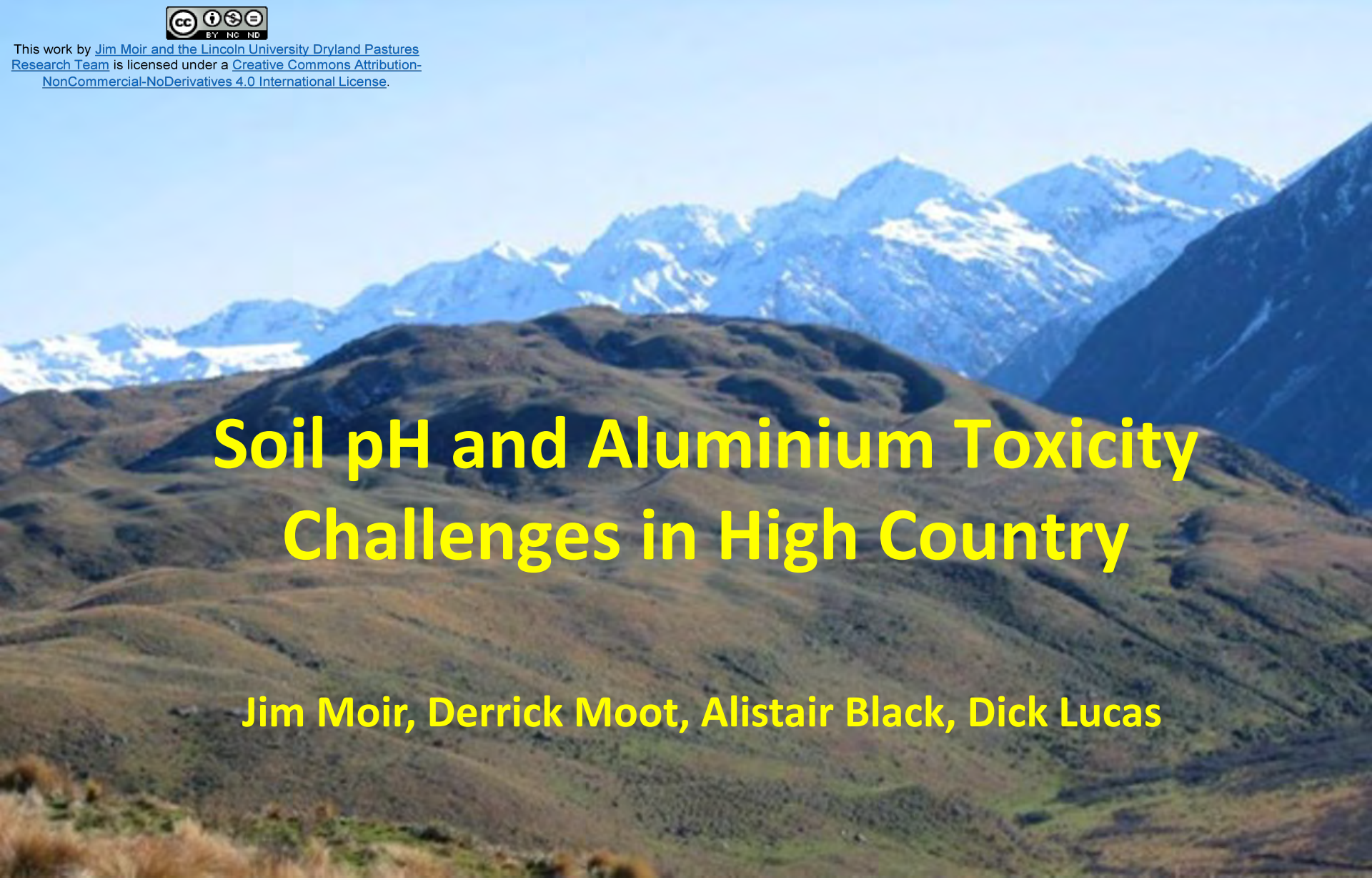

Soil pH and Aluminium Toxicity Challenges in High Country

Jim Moir, Derrick Moot, Alistair Black, Dick Lucas

Lincoln University
Te Whare Wānaka o Aoraki
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Soils of the Mackenzie District

- ‘Pallic’ (rainfall < 700mm) or ‘Brown’ (Rainfall > 1000 mm) soils
- Formed form glacial till or out wash (Greywacke/Schist), and loess
- Moraines near the lakes e.g. ‘Tekapo’ (500-800 mm Rainfall) or ‘Cass’ (1000-1500 mm Rainfall) soils
  - 40-70 cm loess over till
- Mostly glacial outwash plain/terraces in the central Mackenzie Basin e.g. ‘Fork’ and ‘Mackenzie’ soils
  - Shallow stony soils

Soils of the Mackenzie District

Tekapo moraine

‘Tekapo’ soil

‘Fork’ soil

Soils are variable over short distances!

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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 H.C. soils have low pH & can be extremely variable down the profile – difficult to manage!**

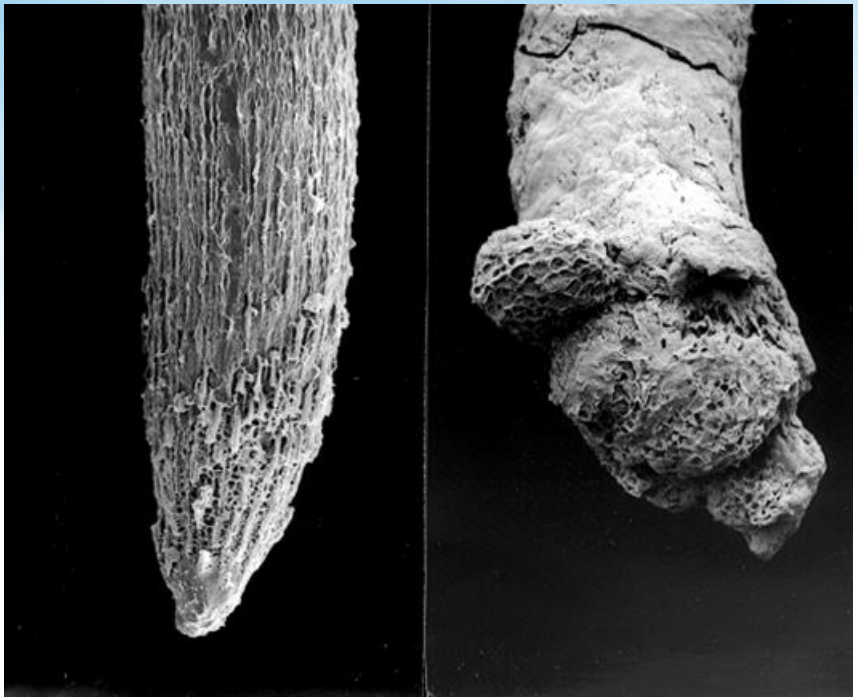
THE Issue: Aluminium Toxicity in Legumes

- Lower soil pH (more acidity) = higher Exch soil Al
- Legumes particularly sensitive to soil Al
  - Some species more that others e.g. Lucerne
- Soil Exch Al above 3 mg/kg can cause problems
  - Definate toxicity at 10 mg Al/kg & above

THE Issue: Aluminium Toxicity in Legumes

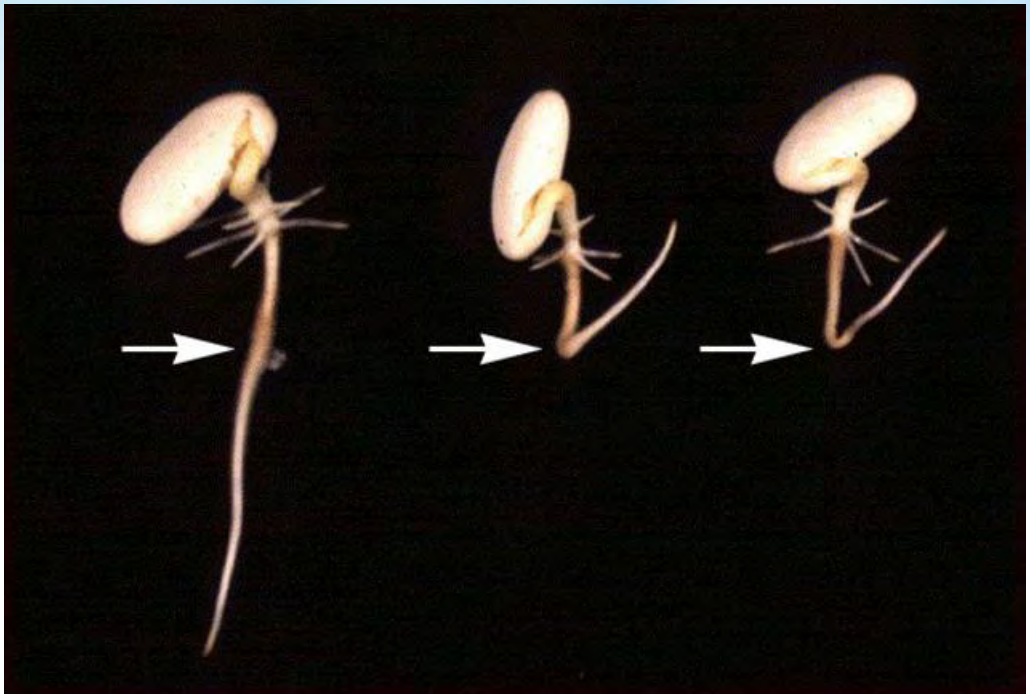
- **Can affect plants severely**
  - **Root damage**
  - **Substantial ↓ in rooting depth (depending on Al location in soil profile)**
  - **↓ in accessing soil moisture (more drought prone)**
  - **↓ in nodulation and N fixation in legumes**
  - **↓ nutrient availability**
  - **↓ yield & persistence**

Aluminium Toxicity - Root Damage



Wheat

(Al 5 mg/kg, pH 5)



Pea

Roots dipped in Al Sol^{n} at arrow

Lucerne - Horizontal root growth

Glenmore Station Tekapo

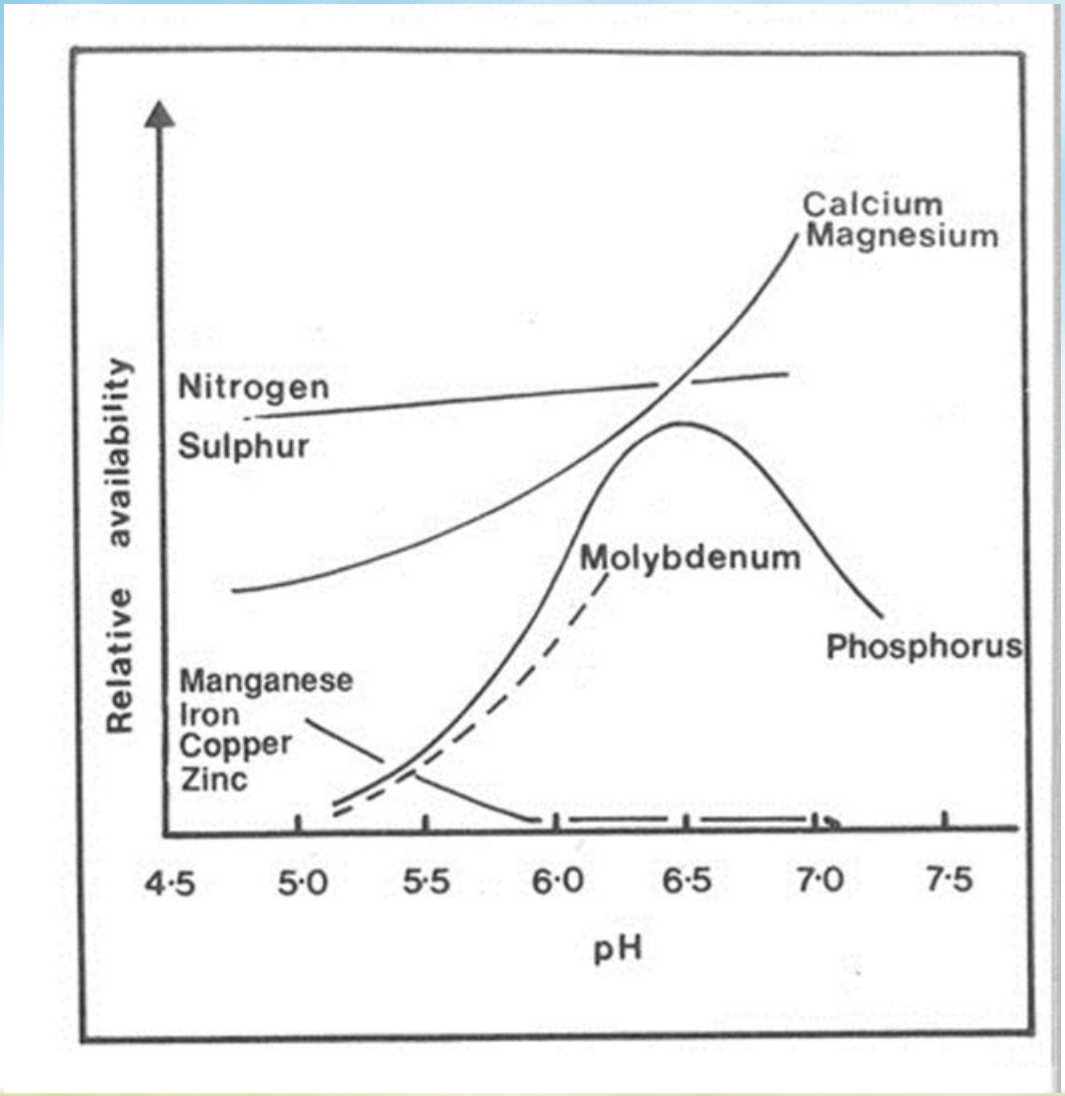
Central Canterbury High Country

Lucerne: Lees Valley, Nth Canterbury

Canterbury Plains

Central Canterbury High Country

Soil pH also strongly affects nutrient availability for plants



RESULTS

Glenmore Station

Sample (Native, 0 Lime)	pH	Exch Al (mg/kg)
GMO 0-20 cm	4.9	7.4
GMO 20-40 cm	5.1	7.1
GMO 40-60 cm	5.1	8.9
GMO 60-80 cm	5.3	9.7
GMO 80-100 cm	5.3	8.0

2011 Lime Rate Trial:

Lime (t/ha)	Soil depth (cm)	pH	Olsen P (mg/L)	Sulphate S (mg/kg)	ExchCa (QTU)	Exch Mg (QTU)	Exch K (QTU)	Exch Na (QTU)	Exch Al (mg/kg)
0	0-7.5	5.0	13.7	18.7	5.7	15.7	6.3	3.3	5.0
	7.5-15	5.3	-	-	-	-	-	-	5.0
3	0-7.5	5.5	36.0	23.3	10.0	12.3	4.7	3.3	2.2
	7.5-15	5.2	-	-	-	-	-	-	5.9
5	0-7.5	5.4	32.7	37.0	8.7	11.7	5.3	3.0	2.6
	7.5-15	5.2	-	-	-	-	-	-	4.9

Omarama Station

Auger samples:

Sample	pH	Exch Al (mg/kg)
0-20 cm	5.7	1.8
20-40 cm	5.7	2.1
40-60 cm	5.7	3.5
60-80 cm	5.8	4.2
80-100 cm	6.0	1.7

Sample	pH	Olsen P (mg/L)	Sulphate S (mg/kg)	Exch Ca (QTU)	Exch Mg (QTU)	Exch K (QTU)	Exch Na (QTU)	Exch Al (mg/kg)
0-7.5 cm	5.9	16	<1	3	34	9	8	1.4
7.5-15 cm	5.6	12	2	<1	19	4	6	7.1

Ben Dhu Station (Omarama)

Auger samples;

Sample/Depth	pH	Exch Al (mg/kg)
1: 0-20 cm	5.2	12.2
1: 20-40 cm	5.6	4.5
1: 40-60 cm	5.6	2.5
1: 60-80 cm	-	-
2: 0-20 cm	5.3	8.4
2: 20-40 cm	5.4	9.2
2: 40-60 cm	5.6	8.0
2: 60-80 cm	-	-
3: 0-20 cm	5.9	0.7
3: 20-40 cm	5.5	1.9
3: 40-60 cm	5.6	1.8
3: 60-80 cm	-	-

*Note; Sample '1' = Deer fence block, '2'=Back block, '3'=Established Lucerne block

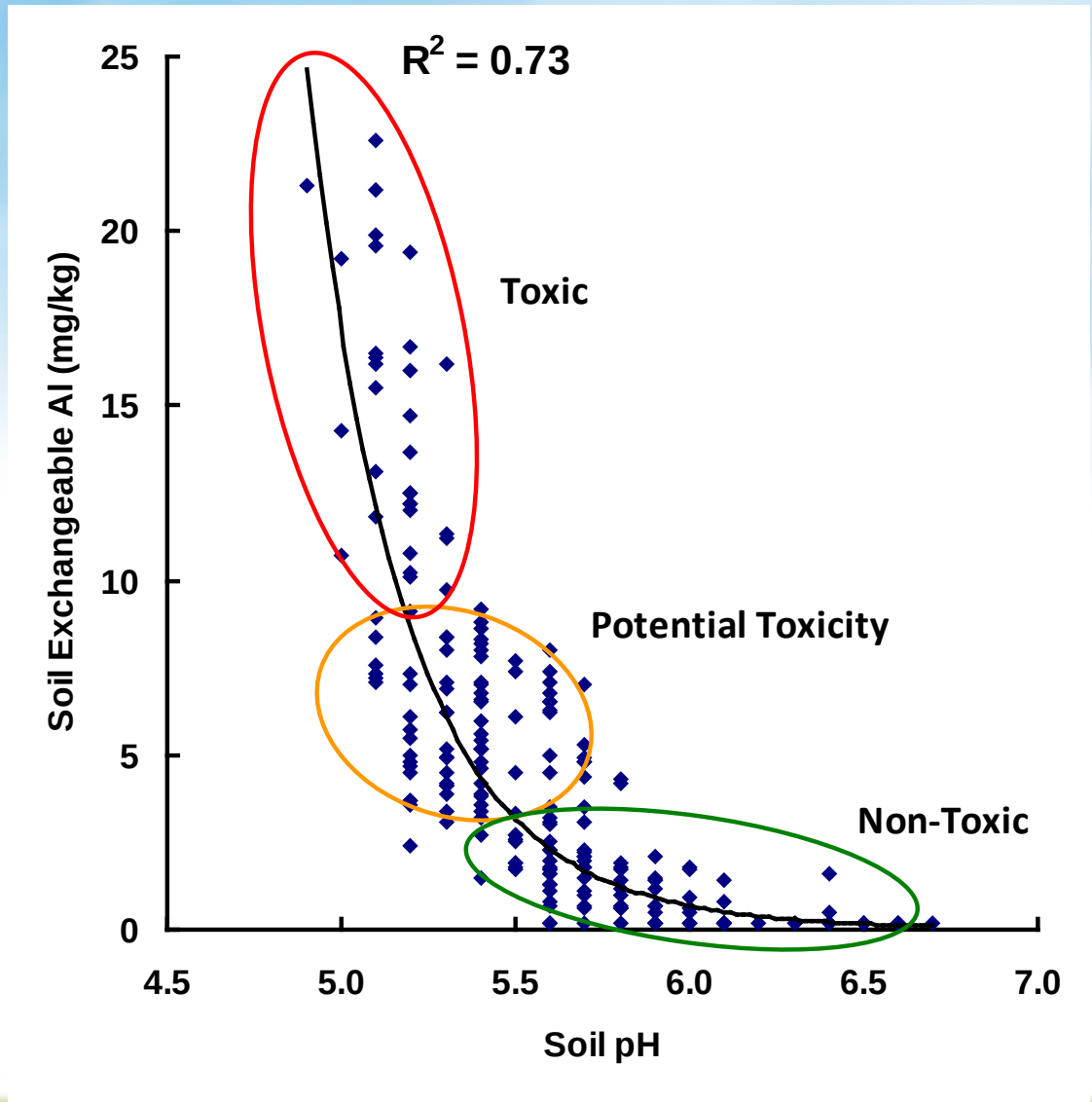
Armidale (Central Otago)

Auger samples;
***Note; Sample '1' = Hill block native, '2'= Flats native**

Sample/Depth	pH	Exch Al (mg/kg)
1: 0-20 cm	5.0	10.7
1: 20-40 cm	4.9	21.3
1: 40-60 cm	5.1	22.6
1: 60-80 cm	5.1	19.6
2: 0-20 cm	5.6	<0.5
2: 20-40 cm	5.9	<0.5
2: 40-60 cm	6.5	<0.5
2: 60-80 cm	-	-

Relationship Between Soil pH & Exchangeable Soil Aluminium

(All Sites)



Conclusions

- Soil pH is a critical issue in high country and is strongly related to levels of soil exchangeable Al
- Legumes can be strongly affected by Al toxicity
- It is critical to soil sample deep down the profile
  - How does pH / Al change down the profile?
- Low pH/high Al below the topsoil may be THE key driver of species selection

How to Soil Sample a Block:

- Select the land ‘surface’ which best represents the block
- Dig at least 3 soil ‘pits’ across the block (the more the better), well spaced apart e.g. 100 m+
- Sample soil down the profile at 20 cm intervals (e.g. 0-20 cm, 20-40 cm etc) to 1m, or until you hit gravels, bagging them as you go
- Send to your soil lab (ARL or Hills) through your fert rep to analyse all samples for pH and Exchangeable Aluminium only
  - Should cost about $30-40 per sample
- If you need to cut the cost, you can ‘bulk’ the samples i.e. all 0-20 cm samples go into the same bag…etc…..

QUESTIONS?

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