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FEBRUARY 2006 | PRIMEFACT 32 | MASTER — MANAGING ACID SOILS THROUGH EFFICIENT ROTATIONS

MASTER — Soil acidity and lime responses

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Summary

This Primefact shows long-term trends of soil pH and aluminium (Al) at the MASTER site. Subsurface soil pH_{Ca} at 15–20 cm depth could increase by one unit over 20 years by maintaining an average soil pH_{Ca} of 5.5 in the top 10 cm. Exchangeable aluminium at 15–20 cm depth decreased from 42% to below 10% over 13 years as a result of liming.

Soil status before start

- The initial pH was around 4.1 at 0–10 cm depth and subsoil below 20 cm was also highly acidic (Table 1).
- Exchangeable Al was too high for the sensitive species, such as lucerne and barley, to grow.
- Exchangeable K was less than 0.2 cmol [+]/kg from 10–60 cm depth.

Soil deep coring in autumn

Lime application

- The initial lime was incorporated into top 10 cm of soil at 3.7 t/ha in 1992, which was 1.2 t/ha higher than the commercial liming rate.
- The target was to maintain pH_{Ca} in the top 10 cm depth at 5.5 over the 6-year liming cycle.
- The maintenance lime was top-dressed at rate 1.6–1.8 t/ha every 6 years.

Table 1. Initial soil pH_{Ca}, exchangeable cation concentrations and effective cation exchangeable capacity (ECEC) in the soil profile before treatments were imposed.

Depth	pH_{Ca}	Exchangeable cations (cmol [+]/kg)							%Al[A]
(cm)		Al	Mn	Mg	Na	Ca	K	ECEC	
0-10	4.13	0.78	0.10	0.24	0.10	1.12	0.24	2.58	31.0
10-20	4.22	0.68	0.12	0.19	0.05	0.56	0.10	1.69	42.6
20-30	4.57	0.28	0.11	0.57	0.09	1.18	0.09	2.32	15.6
30-40	4.87	0.16	0.04	1.55	0.23	2.14	0.12	4.23	4.7
40-50	4.96	0.14	0.01	3.22	0.49	3.15	0.17	7.19	2.3
50-60	5.02	0.15	0.01	4.78	0.76	3.46	0.19	9.35	1.9
60-80	5.22	0.13	0.01	6.42	1.08	3.40	0.22	11.25	1.5
80-100	5.59	0.06	0.00	8.34	1.52	3.65	0.24	13.81	0.6
100-120	6.24	0.02	0.00	10.78	2.14	4.95	0.25	18.14	0.1

[A] Percentage exchangeable Al of ECEC.

Soil pH_{Ca} changes at 0–10 cm

- On the limed treatments, pH_{Ca} in the top 10 cm depth increased from 4.1 to 5.7 the second year after liming (Fig. 1) and decreased to about 5.0 after 6 years.
- On the unlimed treatments, pH_{Ca} in the top 10 cm depth fluctuated around 4.0–4.3.

Subsoil acidity amelioration

- Soil pH_{Ca} at 15–20 cm soil depth increased 0.05 pH_{Ca} units/year by maintaining a pH_{Ca} of 5.5 in the top 10 cm depth (Fig. 2).
- The exchangeable Al at 15–20 cm depth decreased from 42% to below 10% over 13 years.
- If this rate of pH change at depth continues, acid-sensitive plant species would soon be able to fully utilise the soil to a depth of 20 cm (Table 2).
- It is estimated that about 180–200 kg/ha/year of lime has been used to neutralise acids added by the system. About 90–100 kg/ha/year has been leached to the 10–20 cm soil depth, which has accounted for the increase in pH_{Ca} in the subsurface soil.

Table 2. Aluminium sensitivity (tolerance) of some crop and pasture plants

Tolerance	Examples of pasture and crop species
Highly sensitive	Durum wheat, Schooner and Yerong barley, faba beans, Chickpeas, lucerne, medics, strawberry, Balansa, Berseem and Persian clovers, Buffel grass, Tall Wheatgrass.
Sensitive	Canola, Rosella and Janz wheat, O'Connor & Skiff barley, albus lupins, red grass (Wagga), wallaby grass (D. Linkii), phalaris, red clover, Caucasian and Kenya white clovers.
Tolerant	Brindabella barley, Swift and Sunstar wheat, Diamondbird is the most tolerant wheat, annual & perennial rye-grass, Tall fescue, Haifa white and subterranean clovers.
Highly tolerant	Narrow leaf lupins, oats, Tahara triticale, cereal rye, cocksfoot, kikuyu, paspalum, yellow & slender serradella, Maku lotus, common couch, Consul love grass.

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- Commercial sponsors: Incitec-Pivot Pty Ltd (Fertilisers) and Omya Australia Pty Ltd (Lime) since 1992.

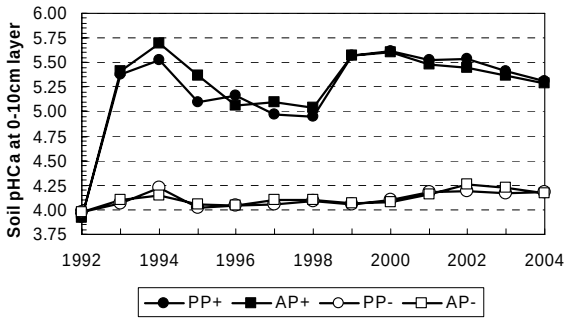

Fig. 1. Soil pH_{Ca} at 0–10 cm depth from 1992 to 2004. For limed treatments, data shown are the mean of plots which were at phase 1 in 1992. PP+ and PP–, limed and unlimed perennial pastures; AP+ and AP–, limed and unlimed annual pastures.

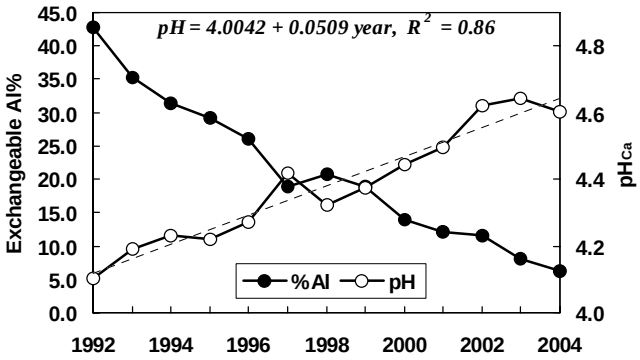

Fig. 2. Effect of lime on subsurface soil pH_{Ca} and percentage of exchangeable aluminium over time.

Further information

- Primefact 31, *MASTER — Experimental design*
- Primefact 33, *MASTER — Crop responses to lime*
- Primefact 34, *MASTER — Pasture responses to lime*
- Primefact 35, *MASTER — Sheep responses to limed pastures*
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