Lime - Ten years topdressing

Bruce Clements[A], Graeme Kelso[A] and Ian Vimpany[B]

NSW Agriculture
[A]*PO Box 1386, Bathurst NSW 2795*
[B]*Formerly PO Box 72, Alstonville NSW 2477*

Soil Acidity has been recognised as a problem on the Central Tablelands for many years. Some producers were first alerted to soil acidity and began spreading lime in the 1970's (Kingham 1993). Most of these early lime applications were incorporated into the soil and incorporation was and still is normally recommended for the most effective and quickest response to lime (Fenton *et al.* 1993). The problems with lime incorporation are that around 70% of the tablelands is non-arable, existing pastures are destroyed (many producers want to topdress lime onto existing pastures), and pasture re-establishment costs at least $200/ha.

Methods

A series of trials to investigate the value of lime topdressing on the Central Tablelands was established in 1987. Three sites were chosen in the Bathurst (alt. 700 m) and Oberon (alt. 1100 m) districts, representing a range of climates and moderately acid soil types. Two sites were based on granitic soils and the third on a slate/shale soil type. All sites had 125 kg/ha of superphosphate applied annually and were overseeded with subclover in 1987.

The treatments consisted of agricultural lime topdressed onto pastures at various rates. Some treatments only received the initial applications in 1987, while others were annually topdressed with smaller amounts of lime. Treatments were:

- 2500 kg/ha initial application only
- 5000 kg/ha initial application only
- 125 kg/ha annual application
- 250 kg/ha annual application

Soil samples were taken from each plot in 1987 prior to the application of lime, and then annually until 1992 (5 years) and again in 1997 (10 years). Samples were taken at various soil depths to monitor the effect of lime movement (2.5 cm intervals to 15 cm and then 7.5 cm intervals to 30 cm). All soil samples were tested for pH ($CaCl_2$) and exchangeable cations.

Results and discussion

The two granite soil sites had the greater speed of movement and depth to which the lime effect was detected. The other site (slate/shale soil) showed little overall effect of lime to depth. The higher clay content at this site may be restricting lime movement (Fenton *et al.* 1993) or there may be lower biological activity (worms, *etc.*) assisting lime movement to depth (Scott *et al.* 1997).

The 125 kg/ha annual lime treatment has not as yet shown any movement to depth at any site (*i.e.* the only pH change is in the surface 2.5cm). The 5000 kg/ha of lime treatment showed rapid movement of lime to a greater depth than the 2500 kg/ha treatment at all sites, and this effect has been maintained up to 10 years after lime was applied.

The speed of movement and depth of lime effect for both the 250 kg/ha annual lime topdressing and the 2500 kg/ha initial topdressing are shown in Table 1 for one of the more responsive sites. The treatment where 2500 kg/ha lime was applied in 1987 showed rapid movement of lime to the maximum depth sampled by year 2 at all sites. By the fifth year, this lime effect was still obvious. By year 10 the lime effect was almost gone at all sites, although still evident to 5cm at one site. This agrees in general with the published figures for a lime effect lasting 10-15 years (Vimpany and Michalk 1993).

Table 1. Effect of 2500 kg/ha lime applied in 1987 or 250 kg/ha applied annually on soil pH ($CaCl_2$), 1987-1997

Lime rate (kg/ha)	Depth (cm)	pH				
		1987[A]	1988	1989	1992	1997
			1 year	2 years	5 years	10 years
250[B]	0-2.5	5.2	5.3	**6.3**	**6.3**	**6.4**
	2.5-5	4.6	4.6	4.7	**5.1**	**5.4**
	5-7.5	4.4	4.4	4.5	4.6	**5.1**
	7.5-10	4.5	4.4	4.5	4.4	**5.0**
	10-12.5	4.6	4.5	4.4	4.4	4.9
	12.5-15	4.7	4.6	4.4	4.4	4.7
	15-23	4.8	4.7	4.6	4.6	4.7
2500[C]	0-2.5	5.3	**6.9**	**6.7**	**5.8**	4.9
	2.5-5	4.4	**6.1**	**6.2**	**5.5**	4.4
	5-7.5	4.3	**5.0**	**5.2**	**5.2**	4.4
	7.5-10	4.4	4.6	**4.8**	**5.0**	4.5
	10-12.5	4.5	4.5	4.6	4.8	4.6
	12.5-15	4.6	4.5	4.6	4.8	4.7
	15-23	5.5	4.7	4.7	4.8	4.7

[A] Prior to lime application; [B]Applied annually; [C]Applied as single amount in 1987; Values shown in larger bold type are >0.3 pH units higher than the 1987 pH.

The 250kg/ha annual application had little or no response in pH below the surface until around year 3, and only at the more responsive sites. At the non-responsive site, no effect was detected at year 5. However by year 10 (2500 kg/ha in total) a lime effect could be shown to 10-12.5cm at both responsive sites, and to a depth of 7.5cm in the least responsive site (*i.e.* deeper than for one application of 2500kg). This indicates that smaller applications of lime could eventually achieve a similar response to one large application. The 250 kg/ha annual lime rate is well above the annual lime requirement to neutralise acidification, especially at the lower pH of these soils (Fenton 1993).

Conclusions

These demonstrations show that on certain soil types, topdressed lime (≥2.5 t/ha) moves relatively rapidly to depth, but on other soils, movement is slower and will not produce a liming effect to any great depth. Smaller annual applications, while probably not economic, showed good movement of lime to depth by 10 years, and demonstrate the feasibility of reducing soil acidity or preventing acidification or re-acidification through smaller more frequent applications of lime. This may open up new possibilities and techniques for the application of liming products to acid soils.

References

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Does chicory tolerate soil acidity?

Brett Upjohn[A] and David Michalk[B]

[A]*NSW Agriculture, Capper St., Tumut, NSW 2720*
[B]*Agricultural Institute, Forest Road, Orange, NSW 2800*

Chicory (*Chicorium intybus*) is a perennial herb with potential to produce large amounts of quality feed during spring, summer and autumn. Potentially, chicory also offers considerable advantages over annual forage crops in the management of rising water tables and nutrient leaching due to its deep tap-root. The New Zealand cultivar "Grassland Puna" has been promoted widely in NSW as a possible replacement for lucerne in some situations, particularly where soils are acidic. However, there is little information currently available that defines the relationship between chicory production and soil pH. This information would be useful to help producers plan pasture development programs for acid soils. A pot experiment was undertaken at the Orange Agricultural Institute to test the acid soil tolerance of chicory when compared to lucerne.

Methods

Soil that has previously been used extensively by NSW Agriculture for acid soil research was obtained from a Binnaway (NSW) property. This soil has low pH (4.3 in surface soil), low phosphorus (11 mg/kg Colwell P) and high aluminium saturation (41%). Puna chicory and Genesis lucerne were sown into pots previously treated with agricultural lime applied at equivalent rates of 0 (control), 0.5, 1.0, 1.5, 2.0 and 4 t/ha. The lime was only applied to the top half of the pots so root growth patterns could be determined. An additional treatment (2/2) where lime was applied at the equivalent rate of 2 t/ha to all soil in the pot was included to determine if this improved the growth of either species. Each of the 14 treatments was replicated 4 times. Lucerne seed was inoculated prior to planting. A balanced liquid fertiliser was applied at a rate to promote maximum plant growth.

Plants were sown in the first week in June and harvested after 91 days growth. Top growth was weighed and the leaf area and weight determined. After top growth was harvested, the pots were opened and the soil divided into top and bottom portions and samples taken to determine pH and measure rooting depth. Roots were extracted by washing away the remaining soil, and dried and weighed.