A lime movement experiment, Walcha NSW

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Introduction

Acid soils continue to be one of the main soil degradation, fertility and pasture production limitation issues on the Northern Tablelands of NSW. Previous surveys have shown that many Northern Tablelands soils, particularly those derived from granite bedrock, are acid and can have high levels of soluble aluminium at depth (Crocker and Holford 1991, Duncan and Crocker 1998, Harris and Duncan 1999, Edwards and Duncan 2002). Recent producer surveys have indicated that soil acidification is one of the top five soil problems that they are concerned about. In fact, 88% of producers recently surveyed in the Armidale district rated soil acidification as a major soil fertility problem on their property (C Edwards, unpublished data).

Lime is the primary tool for correcting soil acidity; however there is little information on the rate of lime movement through different soil types of the Northern Tablelands. Two recent research findings (Edwards 2004, Harris and Duncan 2001a), provide limited information on lime movement through granite derived soils near Tenterfield and at Wollun, 25 km north-west of Walcha.

A replicated experiment was established at Walcha where there was also a paddock-scale demonstration. This experiment complemented the demonstration site and a similar experiment located at Tenterfield (Harris and Duncan 2001a). This paper reports the effect of topdressed lime on soil pH and soluble aluminium at depth on a fine granite soil over 6 years at the Walcha site. The paper also reports the effect of lime on pasture production and quality.

Methods

The experiment was located at 'Ruby Hills', 15 km south of Walcha on the Northern Tablelands of NSW. The pasture was dominated by tall fescue (*Festuca arundinacea* Shreb. cv. Demeter), yearlong natives (*Austrodanthonia* spp. and *Microlaena stipoides)* and Yorkshire fog (*Holcus lanatus*). Subterranean (*Trifolium subterraneum*) and white clover (*Trifolium repens*) were present when rainfall permitted. The site consisted of a soil with a $pH_{(Ca)}$ 4.5 at 0-10 cm depth and a $pH_{(Ca)}$ 4.4 at 10-20 cm. At the start of the experiment aluminium levels of 10% were common in the 0-10 cm depth and up to 30% at 10-20 cm. Cation Exchange Capacity ranged from 4.34 meq/100g (0-10 cm) to 2.45 meq/100g (10-20 cm).

The experiment consisted of four lime treatments (nil, 1.75, 2.5 and 3.75 t/ha) with four replications. The treatments were arranged in a randomised complete block design.

One surface application of lime was made to an existing pasture as described above in February 2002. Fertiliser was applied annually according to soil test results. Soil samples were taken prior to the application of lime and then annually until 2004 at two depths (0-10 cm and 10-20 cm). Further soil samples were taken in January 2006 and December 2008. All soil samples were analysed for $pH_{(Ca)}$ and exchangeable cations. The experiment was defoliated with a rotary mower when plant height reached between 10 cm and 25 cm. Botanical composition and herbage mass were assessed 14 times using the Botanal technique (Toothill *et. al.* 1978). A grab sample was taken from each treatment and bulked across the 4 replications on three occasions May 2002, April 2003 and December 2008 to determine pasture digestibility and crude protein.

Results

Soil pH

After six years, lime still has a measurable effect on soil pH in the top soil (0-10 cm), (Figure 1). At this depth, there was a linear relationship between lime rate and increase in pH for the initial two years. In the sub-soil zone (10–20 cm) lime had less effect although there was some minor differences in pH for the 2.5 and at 3.75 t/ha treatments (Figure 1).

Exchangeable Aluminium

After six years, applied lime still had a measurable effect on soil aluminium in the 0-10 cm depth. In December 2008 under lime, percentage of aluminium in the soil was 5% or below compared to 20% for the nil treatment. However, at depth (10-20 cm) aluminium was still quite high (>30%) for all treatments.

Pasture Herbage Mass and Quality

The site was not grazed but was periodically mown to a residual herbage mass of 1000 kg/ha. In October 2002 and May 2006 there was a noticeable feed deficiency (< 500kg DM/ha) – particularly for a site that is not grazed. This was typical of the district at a time when lengthy dry periods were experienced. Based on the data collected from this site no significant difference in pasture yield between the treatments was evident.

The only noticeable difference in botanical composition over the experimental period has been the reduction of Yorkshire Fog in all plots. This is more likely to be due to dry seasonal conditions than to treatment. There was a small increase in the amount of *Microlaena* in the limed plots.

Feed quality was only measured on three occasions (May 2002, April 2003 and December 2008) due to limited funding (Table 1). In April 2003 digestibility in the lime treatments was higher (by 5% to 8%) than in the nil treatment. This corresponded to a slight increase in clover. There were no differences in crude protein levels.

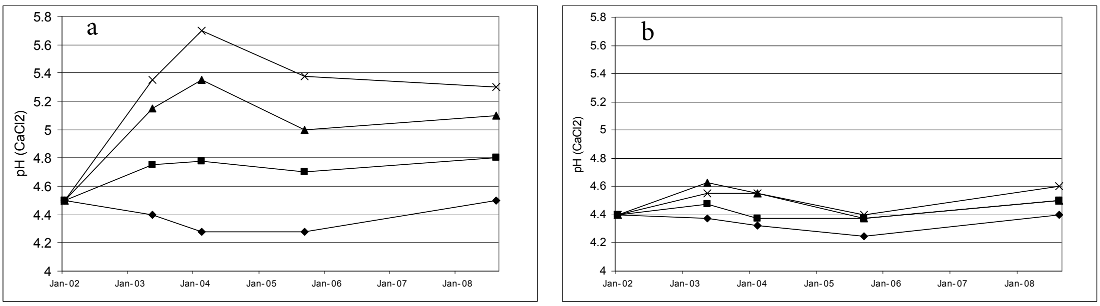

Figure 1. The effect of lime at four rates; nil (♦), 1.75 (■), 2.5 (▲) and 3.75 (x) t/ha on soil pH at two depths a) 0-10cm and b) 10-20cm at Walcha NSW.

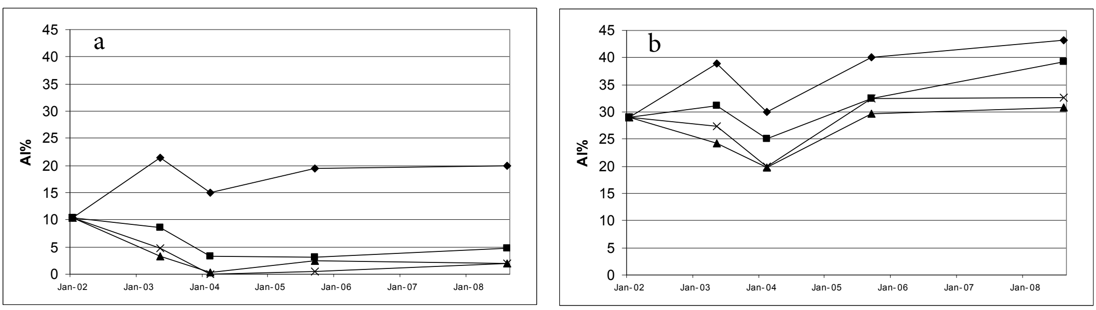

Figure 2. The effect of lime at four rates; nil (♦), 1.75 (■), 2.5 (▲) and 3.75 (x) t/ha on soil Aluminium percentage at two depths a) 0-10cm and b) 10-20cm at Walcha NSW.

Table 1 The effect of lime (nil, 1.75, 2.5 and 3.75 t/ha) on pasture quality, expressed as digestibility (%) at Walcha NSW. Samples were not replicated and were combined as grab samples.

	Nil	Lime 1.75	Lime 2.5	Lime 3.75
May 2002	60.7	61.8	60.1	62.9
April 2003	60.9	68.5	66.0	66.6
December 2008	60.0	59.0	62.0	63.0

Discussion

This experiment has shown the residual value of top-dressed lime applications in an acid soil. After six years, lime is still having a positive effect on soil pH and reducing aluminium percentages in the topsoil (0-10cm). However, there has only been a minor effect in the sub-soil (10–20 cm). The drought over much of the experimental period may have slowed the movement of lime through the profile. The low initial pH levels may have also diminished the ability of lime to affect acidity at depth. It will be important to investigate the ongoing impact that the lime application has on this site.

The pasture composition and pasture quantity results are inconclusive as to major changes attributable to lime at this site. However, some trends were evident that support data from the Tenterfield site where lime had no influence on pasture biomass but did have a positive influence on pasture quality (Harris and Duncan 2001 b).

Although this experiment has not given a clear picture of the effect of lime on pasture productivity, several demonstrations and experiments on the tablelands have shown that lime has a positive influence on livestock production (Duncan and Mitchell 2003). The economics of the application of lime on a productive perennial-based pasture that is able to tolerate these aluminium levels is questionable as there is no measurable influence on pasture production. However, there may be an impact on plant persistence and nutritive value that has not been examined in this trial. Any possible link between the correction of acid soils and the effect on pasture and livestock warrants future investigation.

Acknowledgements

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