ACID SOILS AND SOIL ACIDIFICATION ON THE NORTHERN TABLELANDS OF NEW SOUTH WALES, AUSTRALIA

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DECLARATION

I certify that the substance of this thesis has not already been submitted for any degree and is not currently being submitted for any other degree or qualification.

I certify that any help received in preparing this thesis, and all sources used, have been acknowledged in this thesis.

Data files have been supplied as appendixes on a compact disc at the end of this thesis.
This thesis differs from the original submitted as corrections have been made.

DEDICATION

This thesis is dedicated to two mates, Tim Dalby and Paddy O'Sullivan, who were there at the start at USP and who were there at UNE. Bula vinaka Tim and Paddy.

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ABSTRACT

Soil acidification is a serious, world wide, land-degradation problem that can be accelerated by pasture management. In Australia, the true extent of soil acidification and distribution of acid soils is not fully known. Agriculturally-induced soil acidification is widespread in southern New South Wales (NSW), Australia, and active research has been undertaken in that area. Soil acidification is not well understood on the NSW Northern Tablelands and more research was needed to understand better soil acidification in NSW. The extent and severity of acid soils under pasture, and pasture management impacts on soil acidification in the Northern Tablelands region were assessed in this project.

To estimate the extent of acid soils across the region, a regional-scale soil pH map was produced. Approximately 72% of the mapped soils were acidic with a soil pH of a 1:5 soil:0.01 M $CaCl_2$ suspension (pH_{Ca}) of 5.5 or less and, of these, 27% were strongly acid. Soils tended to be more acidic to the southeast of the region. Only 6% of soils were in the optimal range for plant growth (5.1-6.0 pH_{Ca}).

The impact of pasture management on soil acidification was investigated in a paired-sites study. Soil samples from forty-one sites, comprising a grazed, fertilized, improved pasture (paddock) and adjacent native pasture (reserve) were tested for a range of chemical properties. Soil acidification, measured by pH_{Ca}, as a result of pasture management was not significant and suggested that accelerated soil acidification due to pasture and grazing management is not a problem in the soils of the Northern Tablelands. The more robust measurement was soil pH_{Ca}; soil pH_W was affected by a salt effect caused by fertilizer application to the paddock. Soils in the paddocks had higher concentrations of available phosphorus, available sulfur, total N and nitrate-N compared with those of the reserve areas. Nitrate leaching, a major acidifying process, was not evident but this might have been the result of drought and a single sampling time was insufficient to assess this.

A repeated-measures analysis determined the influence of rainfall and temperature on soil pH, electrical conductivity, nitrate-N and ammonium-N over the seasons of a year. Drought affected this study with a lower rainfall than the long-term average in spring and summer, and higher than average falls during autumn. Nitrate concentrations increased with an increase in rainfall in three of five paddocks studied and uptake of nitrate by pasture plants was

apparent in the warmer months. Some nitrate movement down the profile was detected following rain at a time when pasture plants were dormant.

Controlled incubation experiments investigated nitrification of Northern Tablelands' pasture soils. Soil samples from adjacent reserve and paddock areas were amended with ammonium sulfate at different moisture levels, incubated at different temperatures and tested for nitrate-N and ammonium-N. Incubation conditions imposed moisture levels to simulate dry (15 kPa), moist (130 kPa) and wet (1 500 kPa) conditions and cold (7°C), warm (13°C), hot (19°C) and very hot (25°C) temperatures. Nitrification was limited by low moisture, a cold temperature, and management. A pronounced management effect showed increased nitrification in soils from the paddock. Nitrification of soil from a fertilized, pastured paddock occurred under all temperatures and moisture levels but proceeded at a faster rate with warmer temperatures. Nitrification was negligible in most reserve soils even under optimum, hot and wet, incubation conditions.

On the NSW Northern Tablelands, nitrification is influenced by management and seasonal factors, but even though nitrate is readily produced under sown, fertilized pastures, this does not accelerate soil acidification. Higher nitrification in the paddock probably results from increased microbial activity with higher fertility in this area from fertilizer amendments and pasture management using legumes. Indirect evidence of pasture uptake was found and if nitrate leaching was a frequent occurrence under wet conditions, a fall in soil pH_{Ca} would have been evident. The sequence of nitrogen cycling differs between the Northern Tablelands and southern NSW. On the Northern Tablelands, rainfall during spring and summer coincides with the growth of pasture plants, which take up nitrate before it can be leached. In southern NSW, autumn and winter rainfall can leach accumulated nitrate before it can be utilized by pasture plants in winter and spring.

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