LEAFLET NO.6

Pastures and Acid Soils

Lucerne leaves showing varying damage due to acidity

THE EFFECT OF SOIL ACIDITY ON PASTURES

Poor pasture production is a common and direct result of soil acidity. Also associated with soil acidity is:

- loss of productive species,
- weed and insect invasion,
- soil erosion,
- increased risk of dryland salinity,
- general vegetation decline,
- nutrient run-off into water storages,
- animal production decline,
- reduced microbial activity, and
- diminished farm income.

Soil acidity can cause one or in most cases a combination of the following problems.

LEGUME NODULATION FAILURE

The legume component of the pasture is vital, for it converts atmospheric nitrogen to a plant available form providing high quality forage for grazing animals. Conversion of atmospheric nitrogen to the plant available form depends on live bacteria (rhizobia) which colonise and form nodules on legume root systems.

These bacteria are specific to their host plant and have differing tolerances to soil acidity. All are restricted at low pH levels, with the most acid sensitive rhizobia being those that colonise acid sensitive plants.

Lime pelleting will assist in the short term. However, within 12 months nitrogen conversion will be severely reduced if acid soil conditions are not corrected. The resulting pasture will be unproductive, weed invasion will occur and animal production will decline.

ALUMINIUM AND MANGANESE TOXICITY

Soils with pH below 4.8 frequently present toxic levels of aluminium and manganese. Aluminium toxicity will immobilise phosphorus, damage plant roots, and restrict exploration for other nutrients and water. This effect is more marked on highly weathered soils (eg podzolic). Aluminium affected plants are usually stunted and clovers are pale, with small leaves. Very sensitive species - especially lucerne and to a lesser extent some varieties of phalaris - are unthrifty and very spindly in habit. In very acid soils they may die within two years of sowing.

Manganese toxicity is more common on the weakly weathered soils such as red, black clay loam and self mulching soils. Manganese toxicity is favoured by hot, dry conditions or warm, waterlogged soil.

Manganese toxicity is less common than aluminium toxicity. It causes yellowing of leaf margins and general stunting of susceptible plants. It is sporadic in occurrence depending on soil moisture and temperature.

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Lime application to reduce acidification in crops

NUTRIENT DEFICIENCIES

As soil pH declines below 4.8, the availability of some nutrients is severely reduced. Aluminium is known to immobilise phosphorus within the plant as well as the soil, resulting in symptoms that are similar to those of phosphorus deficiency. The uptake of calcium and magnesium is also restricted in acid soils with very high levels of soluble aluminium.

An important trace element, molybdenum, becomes very insoluble and thus not available for plant use in acid soils. Molybdenum is required in the legume nitrogen fixation process, but is also needed by grasses for protein synthesis.

Some microbial activity slows in soils with a pH below 4.6. Mineralisation of organic matter and release of other nutrients is adversely affected, until soil acidity is corrected with substantial amounts of lime.

PLANT DISEASE INCIDENCE

Limited research has shown that some disease producing organisms of pastures cause more damage in strongly acid soils.

Pasture seedlings are more likely to be affected in acid soils by damping off (a fungal disease). Established sub clover plants are more prone to root rot disease in acid soils.

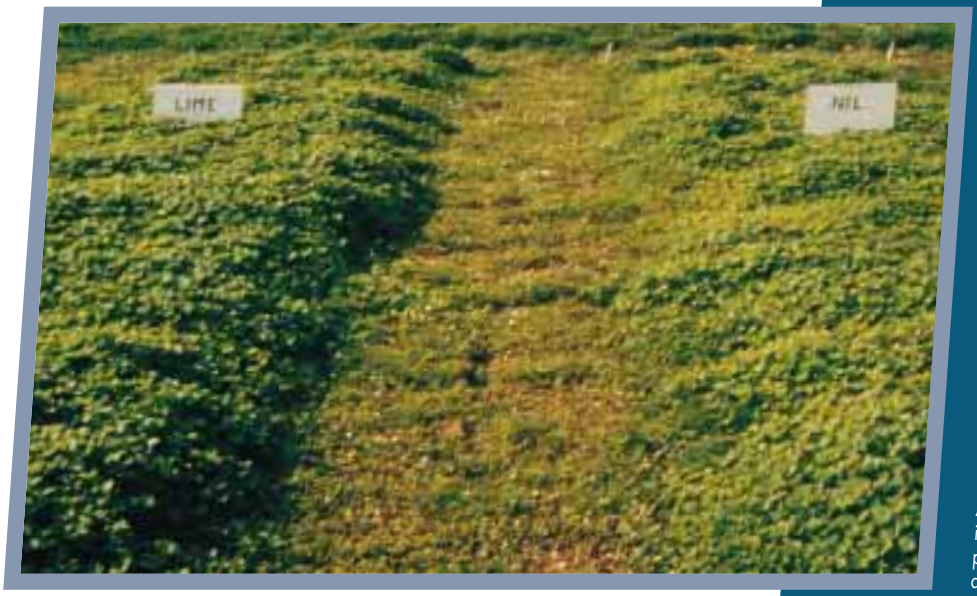
MANAGEMENT TO OVERCOME SOIL ACIDITY

Soil acidity is an increasing problem in the higher rainfall areas of NSW. It presents major problems for management under current low profitability conditions.

Strategies for acid soil management in pasture zones need careful assessment in terms of the short term cost/benefit as well as longer term viability. If one, or a combination of the following strategies is not used, it is likely that further acidification of pasture soils will occur. This will result in a loss of productive species and an accompanying drop in animal production and in farm viability.

■ **Use of acid tolerant species.** Table 1 gives the aluminium tolerance of a range of pasture plants and reflects their poor production in acid soils. It is important to note that growing acid tolerant plants will enable production to continue, but will not correct acidity. At best it is a short to medium term strategy to maintain farm income, while taking action to correct and reverse acidification.

■ **Choice of pasture types.** The use of deep rooted perennial grasses will improve recycling of nitrogen and thereby reduce further acidification. Annual species will not provide this benefit as effectively but in the short term may be useful in assisting with physical incorporation of lime at the time of seedbed preparation and sowing.



Applying lime improves pastures and animal production.

■ **Fodder Conservation.** Regular cutting of legume rich pastures, especially lucerne, increases acidification. Soil pH should be regularly checked and lime applied to counter any decline.

■ **Grazing Management.** One objective of a grazing management system should be to maintain a desirable grass:legume balance of about 70:30. This will assist in maintaining a healthy grass component, adequate ground cover, resist the invasion of weedy species and maintain animal production. In turn, this objective will resist continued pH decline.

■ **Soil analysis and lime use.** Regular soil sampling, to improve fertiliser efficiencies and monitor acidification, is an important factor to guard against long term degradation.Lime is the only means of correcting acidification but the economics of this strategy are very dependent on commodity prices. Soil test results will assist in making better use of lime, in monitoring pH damage and selecting appropriate fertiliser products.

PASTURE SPECIES AND GROWTH IN ACID SOILS

Table 1 lists some pasture plants relative to their sensitivity to exchangeable aluminium - measured as a percentage of ECEC. It is a guide only as pasture species at various locations are known to slowly adapt to pH and other fertility factors. For example, some old phalaris paddocks may continue to produce well with exchangeable soil aluminium levels up to 15 per cent. However, freshly purchased seed of Australian phalaris is unlikely to produce plants with the same degree of tolerance to aluminium.

TABLE 1.

Aluminium sensitivity of some pasture plants and suggested exchangeable aluminium upper limits (ECEC Al.ex %)

■ Highly sensitive 5%	Barrel, strand and burr medic, lucerne, strawberry, balansa, berseem and Persian clover, buffel grasses, Thynopyrum tall wheat grass.
■ Sensitive 10%	Red grass (Wagga), wallaby grass (Danthonia linkii), phalaris, red clover, snail, murex medics, Caucasian and Kenya white clovers.
■ Tolerant 15%	Tall fescue, Pioneer Rhodes grass, rye grasses, Haifa white clover and subterranean clover.
■ Highly tolerant 20%	Yellow and slender serradella, Cocksfoot, Consol lovegrass, paspalum, kikuyu, Microlaena stipoides, Danthonia racemosa, Themeda spp. Maku lotus, common couch.

Table 2 provides a guide to critical manganese levels affecting some pasture plants.

TABLE 2.

Tolerance to manganese (Mn), and critical levels* of manganese for pasture plants.

Tolerance to manganese	Plant	Critical level* of manganese (mg/kg)
Highly sensitive	lucerne, barrel and burr medics	200–400
Sensitive	white and strawberry clovers	400–700
Tolerant	sub clover	700–1000
Highly Tolerant	most pasture grasses	>1000

* The critical levels of manganese in this table are the levels (in the youngest fully developed leaf) that are sufficient to cause a 10% decline in growth.

Source: NSW Agriculture Agfact AC.19 *Soil Acidity and Liming*.

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This pamphlet is one of a series on Acid Soil Management, prepared for the New South Wales Acid Soil Action Program by Mick Duncan, Acid Soils Specialist, Armidale, July 1999

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