agriculture
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agriculture
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PROVINCE OF KWAZULU-NATAL

PASTURES IN KWAZULU-NATAL

Pasture Fertilisation

LIME REQUIREMENTS

N Miles

INTRODUCTION

Acid soil conditions present a major constraint to crop and pasture production in the high rainfall areas of South Africa. Soil acidity is associated with poor establishment, weak growth and poor persistence of pastures.

Acid soils, in general, have favourable physical properties. However, the low pH of these soils is associated with plant nutritional problems, the most common being excess aluminium, together with insufficiencies of phosphorus and possibly calcium, magnesium and molybdenum.

THE NATURE OF SOIL ACIDITY

Research carried out over the past 15 years has proved that soluble aluminium (Al) is the component of soil acidity most harmful to plant growth. Aluminium is highly toxic to most plants. The root damage caused by excessive quantities of Al leads to poor plant recovery of water and nutrients.

For a given level of exchangeable soil Al, increasing levels of other cations, in particular calcium (Ca) and magnesium (Mg), reduce the harmful effects of Al. For this reason, percent acid saturation rather than Al *per se* has proved a more reliable criterion for determining whether Al toxicity is a problem or not. Percent acid saturation is calculated by dividing the exchangeable Al (and hydrogen (H) ions, since they are included in Al measurements) by the sum total of exchangeable cations.

$$\text{Acid sat } \% = \frac{Al + H}{Al + H + Ca + Mg + K} \times \frac{100}{1}$$

In this formula ion concentrations are expressed in equivalents [$cmol_c/l$]. In soil test reports Al + H is referred to as exchangeable acidity.

LIME EFFECTS ON SOIL PROPERTIES

Lime applications to acid soils increase soil pH and exchangeable Ca and Mg levels and decrease exchangeable acidity levels. The marked increase in total cations with liming is due

to lime increasing the soil's capacity to retain nutrients (increase in effective cation exchange capacity). This is an important beneficial effect of liming.

TOLERANCES OF PASTURE SPECIES TO SOIL ACIDITY

Pasture species differ widely in their ability to tolerate soil acidity. Tropical grasses and legumes evolved in an acid soil environment and perform well under such conditions. In contrast, temperate species are relatively intolerant of soil acidity. The harmful effects of acid soil conditions on nodulation and nitrogen fixation of temperate legumes render these species particularly susceptible to soil acidity. The relative sensitivity, to soil acidity, of the more commonly propagated pasture species in Natal are presented in Table 1.

Some comment on the critical acid saturation values presented in Table 1 is necessary. Recent research in Natal has pointed to the advantages, from an animal performance point of view, of including red and white clover in Italian ryegrass swards. Where this is practised, the nitrogen (N) fixing attributes of the legume are generally overlooked and fertiliser N is supplied at rates commensurate with the requirements of an irrigated pure Italian ryegrass sward. Under these conditions a soil acidity threshold of 10 % is considered adequate for the clovers. However, in perennial clover or clover/grass pastures, long term persistence of the clover and satisfactory N fixation require the elimination of essentially all exchangeable acidity at establishment. For this reason an acidity threshold of 0% is recommended under these conditions.

Table 1. Critical acid saturation values (acid saturation level above which yields are reduced) and sensitivity of pasture species to soil acidity.

Species	Critical Acid Saturation (CAS) value (%)	Sensitivity
Lucerne White and red clovers +	0	Highly sensitive
White and red clovers # Perennial ryegrass	10	Sensitive
Tall fescue Cocksfoot Italian ryegrass	25	Moderately tolerant
Kikuyu** Oats Coastcross II Smuts finger grass Star grass	40	Tolerant
*Eragrostis curvula*** Tropical legumes	50	Highly tolerant

+ permanent clover pasture

pasture to continue for one season only (*e.g*. clover/Italian ryegrass pastures)

** see comments in text regarding the acid tolerances of kikuyu and *E.curvula*.

Research has indicated that both kikuyu and *Eragrostis curvula* perform well at acid saturations appreciably higher than the critical values listed in Table 1 for these species. However, with increasing soil acidity levels, the calcium and magnesium contents of these grasses decline sharply and may be well below animal requirements. Attempts to rectify mineral imbalance by the use of animal licks are not always successful. Kikuyu, in particular, under very acid conditions, tends to have an unfavourable calcium: phosphorus ratio together with excessively high levels of potassium which may result in animal disorders. The critical acidity levels reported in Table 1 for kikuyu and *E. curvula* are not strictly, therefore, the levels above which substantial yield reductions are likely to occur: they are, however, guidelines intended to promote the production of more nutritionally balanced forage.

CALCULATION OF LIME REQUIREMENTS

A lime recommendation for a particular species on a particular soil is based on three criteria:

- the soil acidity tolerance of the species concerned,
- the exchangeable acidity level in the soil, and
- the efficiency of the liming reaction.

These three factors are taken into account in the computerised fertiliser recommendations from the Natal Region laboratory at Cedara.

HOW AND WHEN TO APPLY LIME

- **Lime should be incorporated into the soil some time before pasture establishment. A fine lime will react in 6 to 8 weeks in moist soil; coarse lime takes longer.**

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- Thorough mixing with the soil is essential in order to secure maximum benefits from lime additions. Spreading should be as uniform as possible, and once spread, the soil should be lightly disced or harrowed before ploughing. Ploughing without such prior mixing results in zones of treated and untreated soil.

- Under perennial pastures, re-acidification of soil may take place, particularly when large amounts of nitrogen fertiliser are applied. Where this is the case **topdressing with lime is necessary**, unless a decision is taken to re-establish the pasture. Since lime is relatively immobile in soils, topdressed lime is not as effective as incorporated lime. The need for adequate liming at establishment is thus emphasized. It should be noted, however, that topdressing with lime is an accepted practice in pastoral farming in overseas countries. The churning action of animal hooves together with active earthworm populations have been found to promote the incorporation and the reaction of lime in grazed pastures. Since surface-applied lime takes considerably longer to react than does incorporated lime, it is advisable, to anticipate acidity build-up and apply lime as a preventative measure. Careful monitoring of acidity levels in perennial pastures through regular (preferably annual) soil sampling is thus recommended.

DOLOMITIC OR CALCITIC LIME

In intensive, heavily fertilised pastures, herbage magnesium levels are frequently below animal requirements and veterinary officers report an increasing incidence of magnesium insufficiency related problems in animals on pastures. Although several magnesium fertilisers are commercially available, application of dolomitic lime is the most cost-effective means of correcting magnesium deficiencies. Where soil magnesium levels are less than 80 mg/l, it is recommended that dolomitic, rather than calcitic, lime be applied.

USE OF GYPSUM

Recent successes in combating subsoil acidity in maize soils through the application of gypsum have led to considerable interest in this product for use on pastures. At the time of writing, research findings on the use of gypsum on pastures are not yet available. The following points should, however, be borne in mind.

- Although gypsum counteracts acidity by mitigating the toxic effects of Al, it has little or no effect on soil pH *per se*. This is of particular significance in legume-based pastures, since the bacteria responsible for symbiotic nitrogen fixation operate effectively only within specific pH ranges.

- Topdressing of pastures with gypsum is likely to promote downward movement of magnesium from the topsoil. This would result in decreased magnesium levels in herbage and a consequent increase in the likelihood of magnesium related problems in grazing animals.