Wise Use of N-Fertiliser on Hill Country

How Does N Fertiliser Affect Soil pH?

Frequently Asked Questions

Why is soil pH important?

Soil pH is a measure of soil acidity. As soils become more acid, this has a negative effect on the growth of grasses and clover. Once soil pH drops below 5.8 the availability of organic nitrogen to grasses, and molybdenum to clovers, is reduced. As pH drops below 5.5 the amount of toxic aluminium and manganese in the soil increases and roots do not grow into the soil. This means that plants suffer more when rainfall is low.

What causes soil acidification?

Acidification is defined as an increase in the concentration of hydrogen ions (measured by pH) in the soil. These hydrogen ions make the soil more acid.

There are two processes that are essential to productive pastoral agriculture that contribute to acidification, and are therefore **unavoidable causes.**

1. Photosynthesis, where plants grow by fixing carbon from the atmosphere.

From this process, organic acids containing hydrogen ions accumulate in plants. When the plant takes up a cation (e.g. K, Ca, Mg) from the soil, they release a hydrogen ion to the soil and it becomes more acid. The opposite process occurs when a plant takes up an anion (e.g. phosphate, sulphate, nitrate). Hydroxyl (OH^-) or bicarbonate (HCO_3^-) ions are excreted by the plant to replace the absorbed anion and the soil pH is raised.

Acidification of soil from acid additions during photosynthesis in moderately to highly productive NZ pastures (10-15 t DM/ha/yr), is likely to require 100-150 kg lime/ha/yr to neutralise the acidity and maintain soil pH.

There are two factors that modify this effect:

a. *Increasing the legume content of the pasture will increase acidification.*
Legumes that rely completely on N fixation as their source of N absorb neutral (neither positively or negatively charged) nitrogen gas (N_2) instead of the anion nitrate and hence do not excrete hydroxyl or bicarbonate ions to counter acidification. The more legume in the sward the more acidification. Grasses take up more cations than anions and so excrete more acid

into the soil, and as legume N stimulates grass growth, this will also increase the amount of soil acidity

b. *Greater transfer of excreta into stock camps as occurs during sheep grazing in steep hill country will increase acidification*

This is because the plant material that contains a quantity of alkalinity equivalent to the quantity of acidity that has been imparted to the soil is released in excreta. If excreta is distributed unevenly in stock camps, these areas will see an increased soil pH while the rest of the pasture is acidified.

2. Nitrogen fixation

Most of the N fixed by legumes is consumed by grazing stock and excreted as urea. The urea is quickly converted to ammonia in the soil followed by nitrification to produce nitrate and hydrogen ions. If the nitrate anion is taken up by the plants then no net acidification occurs (see above). However if the nitrate ion is leached, it will remove a cation (usually Ca) with it and the hydrogen ion remains in the top soil to increase acidification.

Therefore on a sheep and beef farm where 5-25 kg N/ha/yr may be leached as nitrate, this will require about 20-100 kg lime/ha/yr to neutralise the acidification.

What effect does N Fertiliser have on acidification?

The application of N fertilisers does acidify the soil, the extent of which depends on the type of N fertiliser. While there is no question that most N fertilisers (except calcium ammonium nitrate and any nitrate fertiliser) will acidify the soil (as the ammonium ions are converted by soil bacteria to nitrate in the soil leaving H+ ions in the topsoil), typically this is a lesser acidifying effect than the processes discussed above. Sulphate of ammonia is the most acidifying because a large number of hydrogen ions are released as it is converted to nitrates in the soil, while urea is the least acidifying.

Guideline Rules of Thumb:

Ammonium sulphate: Requires 5 kg lime/kg N to neutralise the acidity. This equates to 112 kg/ha lime per 100kgha ammonium sulphate applied.

Diammonium phosphate (DAP): Requires 3.5 kg lime/kg N to neutralise the acidity. This equates to 64 kg/ha lime per 100 kg/ha DAP applied.

Urea: Requires 1.8 kg lime/kg N to neutralise the acidity. This equates to 82kg/ha lime per 100 kg/ha urea applied

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