NZLPA
NEW ZEALAND LIMESTONE PRODUCERS ASSOCIATION

RESEARCH SUMMARY APRIL 2024

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Benefits of Liming

Soil acidity (pH <7) is a global concern due to its impact on agricultural productivity. While natural soil acidification processes are inevitable due to weathering and plant-soil interactions, human activities accelerate this process – especially in New Zealand where the extensive use of legumes and acidic fertilisers contributes to high soil acidification rates.

To counteract this, corrective measures must match the rate of acidification caused by natural and human factors. Aglime application is a common solution, but it needs to be frequent and adequate.

Aglime not only reduces soil acidity but also improves soil structure, nutrient availability, earthworm and microbial activity, and pasture quality, ultimately enhancing productivity. Additionally, lime serves as a vital source of calcium, crucial for legumes in New Zealand's pastoral systems.

THE SCIENCE

Soil acidity happens naturally over time due to things like weathering, plant processes, and nitrogen fixation. But use of certain fertilisers, can also speed up the process.

Limestone contains calcium carbonate, which when dissolved in the soil releases calcium ions (Ca2+) that helps balance its pH and make it better for plants. As a general rule, applying one ton of lime per hectare can raise soil pH by 0.1 units.

Liming Material	**CCE/ Neutralising Value (%)**
Pure Calcium Carbonate ($CaCO_3$)	100
AgLime Calcium Carbonate ($CaCO_3$)	65-95
Calcium Hydroxide/Hydrated Lake/Slaked Lime ($Ca(OH)_2$)	120 – 135
Calcium Oxide / Burnt Lime / Quicklime (CaO)	150 – 179
Dolomite (<50% Mg) / Calcium Magnesium Carbonate ($CaMg(CO_3)_2$)	95 – 109
Gypsum ($CaSO_4$)	none

Various liming materials and their CCE/neutralising vale (%) (Havlin et al., 2014; McLaren % Cameron, 1996; Prasad & Power, 1997).

The full report of which this summary is based on can be found at:
https://aqa.org.nz/wp-content/uploads/2022/03/Benefits-of-Liming-1.pdf

THE RESEARCH

While liming adjusts pH and provides calcium, its significance in ensuring soil fertility and plant health cannot be overstated. Understanding the complex interplay between soil acidity, calcium availability, and plant nutrition is essential for sustainable agriculture in New Zealand. The considerable studies undertaken over the years in regards to this can be accessed by reading the full report available on ***https://aqa.org.nz/wp-content/uploads/2022/03/Benefits-of-Liming-1.pdf***.

For ease of use the New Zealand Limestone Producers Association have simplified the research into the following key points:

Soil Acidity:

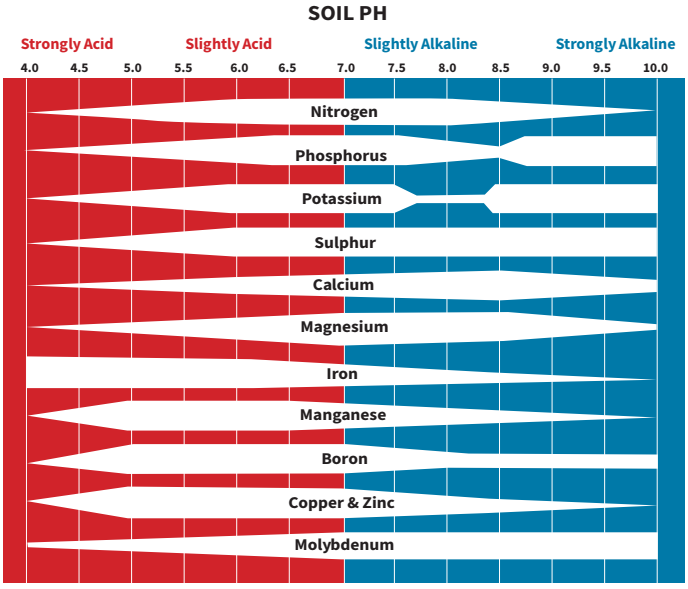
- Applying Aglime to acidic soil increases pasture yield – ranging from 16% to as much as 68%.
- Soil acidity can harm legumes by inhibiting their ability to fix nitrogen. Aglime helps overcome this by creating better conditions for legumes, esp. white clover to thrive.
- Liming arable crops is critical, with some studies showing significant yield increases for crops like barley, cereals, and winter oilseed rape after lime.
- Limed pastures are more appealing to livestock and more evenly grazed.
- Livestock grazing on limed pastures have shown better weight gains and wool production, thanks to the improved quality and quantity of the pasture.
- Aglime can lead to significant improvements in soil structure by helping soil particles stick together forming a more stable aggregate. It also increases the amount of organic matter returned to the soil, improving aggregate formation and stability. These improvements can be seen in as little as 6-12 months post application.
- Better soil structure can lead to increased water retention, better root growth, and higher yields.
- Some studies found that Aglime application improved soil moisture and increased crop production by up to 42%.
- Aglime helps counteract soil toxicity – esp. high levels of aluminium and manganese. If left unchecked toxic conditions will go deeper into the soil and will decline productivity even further.

Calcium Availability:

- Some argue that it's not acidity itself but calcium deficiency that harms plants. Soil acidity indirectly affects plant health by leaching away calcium, essential for various plant functions. Calcium influences carbohydrate accumulation, water uptake, and root growth, crucial for legumes and their nitrogen-fixing abilities.
- Historical practices like applying gypsum in ancient Rome and experiments with calcium treatments in the USA underscore calcium's role in boosting plant performance. Calcium-rich Aglime enhances legume productivity and nodulation, crucial for soil fertility and crop yield.
- In New Zealand, soils are generally considered calcium-sufficient based on their natural calcium content. However, this overlooks variations in soil cation exchange capacity, which affects calcium availability. Soil acidity remains a concern, especially with ongoing acidifying processes and predominant focus on nitrogen, phosphorus, and potassium fertilisers.

Plant Nutrition:

- Aglime increases soil pH and improves nutrient availability by:
  1. increasing nitrogen availability to boost plant growth and overall yield.
  2. releasing more phosphorus for plant use to improve root growth, fruiting, and tillering, enhancing overall yield.
  3. increasing microbial activity in the soil, helping release sulphur from organic matter, which plants need for growth.
  4. helping achieve a pH of around 6 to 7.5 ensures a consistent level of potassium for plants, which is crucial for their health.
  5. providing plants with more calcium – aiding in various physiological processes like water uptake and nutrient absorption.
  6. helping increase the availability of magnesium, another essential nutrient for plants.
  7. helping maintain a pH of around 6.3 to 6.5 through liming is crucial for optimal availability of the micronutrients Iron, Manganese, Boron, Copper, Zinc, & Molybdenum – essential for various plant functions.
- Studies have shown that liming leads to more earthworms by making the soil less acidic and providing calcium, which earthworms need. The calcium helps neutralize the materials they ingest, which are then excreted as casts, enriching the soil with organic matter and nutrients.
- Liming promotes microbial activity by increasing soil biomass, respiration rate, and enzyme activity. This helps with nitrogen and sulphur mineralisation and improves soil aggregate stability.
- Liming also reduces nitrous oxide emissions by promoting the growth of denitrifying bacteria, which convert nitrous oxide into harmless nitrogen gas. Overall, liming enhances soil microbial activity, benefiting soil health and productivity.
- Liming increases the availability of both beneficial existing soil nutrients and nutrients introduced during fertiliser application. The net benefit of a higher pH is an increase in fertiliser efficiency.



Relationship between soil pH and the relative availability of individual nutrients. Bar breadth represents the relative availability of the nutrient concerned at the corresponding pH. The pH for overall optimum nutrient availability is shown by the vertical green line at approximately pH 6.3 (Sime, 201).