Research Projects

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Acidification of Cropping Soils in South Australia – Causes and Effects

Why acidification can be a problem

Plants and soil microorganisms have soil pH ranges that they prefer - as soils become more acidic, yields can decline, nitrogen fixation by legumes becomes inefficient, cropping options are reduced. *Already soil acidification is starting to affect land values in some states. The rural banks and land valuers are well aware of the problem.*

Below pH 5.5 acidification can start to have serious effects on soil nitrogen and carbon turnover, and can decrease molybdenum and phosphorus availability. Below about pH 5, acids produced by fertilisers and plants can increasingly *decompose the soil minerals* themselves leading to increased leaching of nutrients and salts, and to toxicity (aluminium and manganese). Acidification affects the root environment and stunts root growth leading to decreased efficiency of water use and reduced grain yields.

The soil pH decrease that results from most acidification is often slow and not easily noticed by land managers because of:

- infrequency of soil testing
- natural seasonal variations
- the decades that pass before a critical low pH might be reached, and
- lack of knowledge of what the undeveloped pH of the soil was.

How do we know there's a problem?

There is much experience from interstate and overseas to show that acidification happens with most cropping systems now in use. The main causes of soil acidification in agriculture have been known for a long time.

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Recent research in South Australia showed clearly that acidification occurred to some extent at all cropping sites investigated. In some instances the topsoil pH decreased by as much as 2 units in about 25 years. Common acidification rates on South Australian cropping sites are equivalent to the need to apply annually about 100 kg $CaCO_3$ (lime), a tonne every 10 years, but high nitrogen use may result in rates 5 or more times greater, a tonne every 2 or 3 years.

Some indicators of acidification problems

- Less tolerant plants (lucerne, medics, canola, barley, peas, beans) do not perform as well as tolerant plants (oats, most wheat, lupins, sub clover).
- Molybdenum deficiency.
- Nodulation problems in legumes.
- Soil pH_{Ca} test about pH 5 or less.
- Subsoil pH also low.

Causes of soil acidification

The main causes result from the effects of intensification of agriculture and increased cropping frequency - greater use of legumes, greater export of products such as hay and grain, increased use of acidifying nitrogen fertilisers. The acidification rates measured recently in the South Australian cropping zone were related to these causes, and to bicarbonate removal in alkaline-sodic soils.

Of greatest concern is the acidifying effects resulting from use nitrogen fertilisers and elemental sulfur. These fertilisers can increase annual acidification rates many times. 100 kg of N as MAP can result in a 5 fold increase in acidification rate in the year of application.

Why soils behave differently with acidification

Soils acidify at different rates for a number of reasons:

- the acidity produced by farming systems differ
- soils have different "pH buffering capacity", that is they have different ability to absorb the effects of the acids. Generally, the more organic matter and clay a soil has, the harder it is to change its pH, and the more lime it takes to increase its pH.

Strategies for land managers

- Be aware of the problem.
- Be aware of your crop requirements for soil pH.
- Monitor your soil pH - it is a cheap soil test and part of most basic soil testing services (pH changes slowly; testing every 4 or 5 years is usually sufficient).
- Don't let acidification advance to the point where your subsoils also acidify, they are difficult and expensive to fix and result in inefficient water and nutrient use.
- Introduce a liming program in a timely way; in the long run you will save money and prevent damage to your soils. The longer a necessary liming program is delayed, the more the soil can be damaged.
- Seek advice on remediation.

Some points about using lime

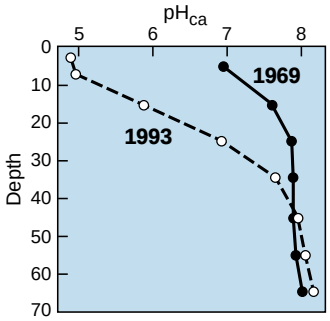
Surface applied lime can take several years to be effective (hence the need for timely application) and is best applied with cultivation or some form of incorporation.

Be careful to ensure that your plant manganese and zinc nutrition (and possibly copper and iron) is adequate since the availability of these elements decreases as soil pH increases with liming. This could be expected in acidic, sandy soils.

Don't overlime. Overliming is the excessive use of lime. It is better to use smaller amounts more often (for example amounts up to 2 t/ha every few years) until a target soil pH is achieved.

Find out about the products that are available in your area. Cartage and spreading costs need to be considered. Use an effective product that is good value for money, with a high neutralising value.

Sodic red-brown earth from Tarlee



Acidity produced by fertilisers (average)

	kg of calcium carbonate (lime) per kg of N or S supplied
Urea	**1.8**
Ammonium nitrate	**1.8**
DAP	**3.6**
Ammonium sulfate	**5.4**
MAP	**5.4**
Elemental sulfur	**3.0**

Photos: D Coventry

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