23. Acid Soils in the Upper South East: It's Time to Lime!

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KEY MESSAGES

- Acidity was found to be more widespread in the USE than expected, with 15 of the 18 paddocks examined containing zones of soil with pH below 5.5
- Sandy loam and clay soils used for cropping were acidic
- Clay spread shallow sandy soils used for cropping were acidic
- Clay spread deep sandy soils used for grazing were acidic
- The target soil pHCa range is between 5.5 and 6.5; lime needs to be applied now to combat current and future acidification.

Background

The damaging effects and substantial cost of acidity have come back on the radar in recent years thanks to a number of GRDC and National Landcare projects that have been delivered throughout Southern Australia. Liming soils was regular management practice across the South East in the 1980s, but it has dropped off of the soil amendment program of many farmers over the last few decades. Producers in the upper south east were interested to explore the presence of acidity across their farms, particularly in paddocks with sandy soils that had been clay-spread or delved. The presence of acidity in the subsoil was also of particular interest.

The objective of the project was to work with landholders in the region to increase their capacity and knowledge to productively and sustainably manage their soil by developing a snapshot of the extent of acidity on their properties.

Activities

An initial workshop was held with 10 participating landholders in August 2017 where an overview of soil acidity was presented, including the process of acidification, causes, impacts and amelioration techniques.

Each participant was then visited on-farm to conduct field pH testing across one or two paddocks on their property. In each case the landholder accompanied the sampling team to learn how to take pH readings and to obtain a better understanding of their soil type variability. Soil cores were collected across each paddock using a hydraulic soil coring rig and a field pH kit was used to determine the pH of the soil down the core, at approximately 10 cm spacing's, starting at 5 cm below the soil surface. Composite soil samples were collected at representative sites and submitted for laboratory pH analysis in both water (pHw) and calcium chloride (pHCa) solutions. In total, approximately 600 ha of land was assessed in this way.

A final workshop in December 2017 provided each landholder with a report on the extent and degree of acidity across their paddock/s. Tools for managing soil acidity were presented, including the 'Maintenance Lime Rate' calculator and 'Lime Cheque'.

Approximately 45% of the topsoil (0 to 10 cm) sample points were below the target pHCa of 5.5 (adjusted from field pH), whereas only 3.5% of the sample points were above the pH range considered optimal for plant growth (5.5 to 6.5 pHCa).

Approximately 12% of the subsoil sample points were below the target pHCa of 5.5 (adjusted from field pH), reflective of paddock use. Below the root zone (>20 cm) the soil was more commonly alkaline, mostly due to the presence of clay.

Paddocks assessed throughout the project have been segregated into the following groups:

1. ***Sandy loam and clay soils used for cropping = acidic***

   High intensity cropping on shallow sandy clay loams and clay soils were found to be acidic throughout the top 10 cm (Fig. 1). These acidic topsoils usually overlie alkaline light to medium clay and often exhibit a strongly acidic horizon boundary between the lighter topsoil and heavier clay subsoil. This could be attributed to the clay properties, whereby compaction of the clay acts as a physical barrier that roots are unable to penetrate, but they are able to uptake nutrients from the surface layer. This depletes the clay surface of essential elements resulting in acidification, specifically at the horizon boundary – nutrients are locked in the deeper clay where the roots are unable to penetrate, keeping the horizon alkaline. ***These paddocks require immediate liming.***

2. ***Sandy soils that were clay spread or delved >10 years ago and used for regular cropping = moderately to strongly acidic***

   Paddocks with shallow sandy soils that have been cropped often had a strongly acidic zone in the 10 cm to 20 cm layer, primarily in the lower lying 'heavier' ground found on the flats and swales (Fig. 1). This acidity is also most likely due to the long-term removal of nutrients by plants (root zone) which increases the amount of H+ in the soil. Additionally, nitrate leaching may also be exacerbated on these soils types, resulting in a shift in the pH to become more acidic.

   In many instances, the lower lying 'heavier ground' had been delved and the sand dunes have been clay spread. While the sand dunes still have relatively low productive capacity and have remained mostly neutral, the heavier flats have become strongly acidic in the top 20 cm. The clay modification on these sands may have initially adjusted the pH into the optimum range for plant growth (suspected lime content in the clay), but it appears that it is no longer effective and the profile has become acidic.

   Interestingly, at one site the delve lines were evident as isolated strips of taller crop growth in the wheat and soil sampling on and off the delve line revealed stark differences in the soil pH. This suggests that the action of delving is not sufficient to uniformly change the soil type and ameliorate acidity across the whole paddock over the long term.

   A uniform broadcast application of lime is immediately required to neutralise the soil at these sites. Alternatively, a second application of clay/delving is also worth considering, along with sufficient deep incorporation, to replenish the nutrient bank and enhance the soil's acidity buffering capacity.

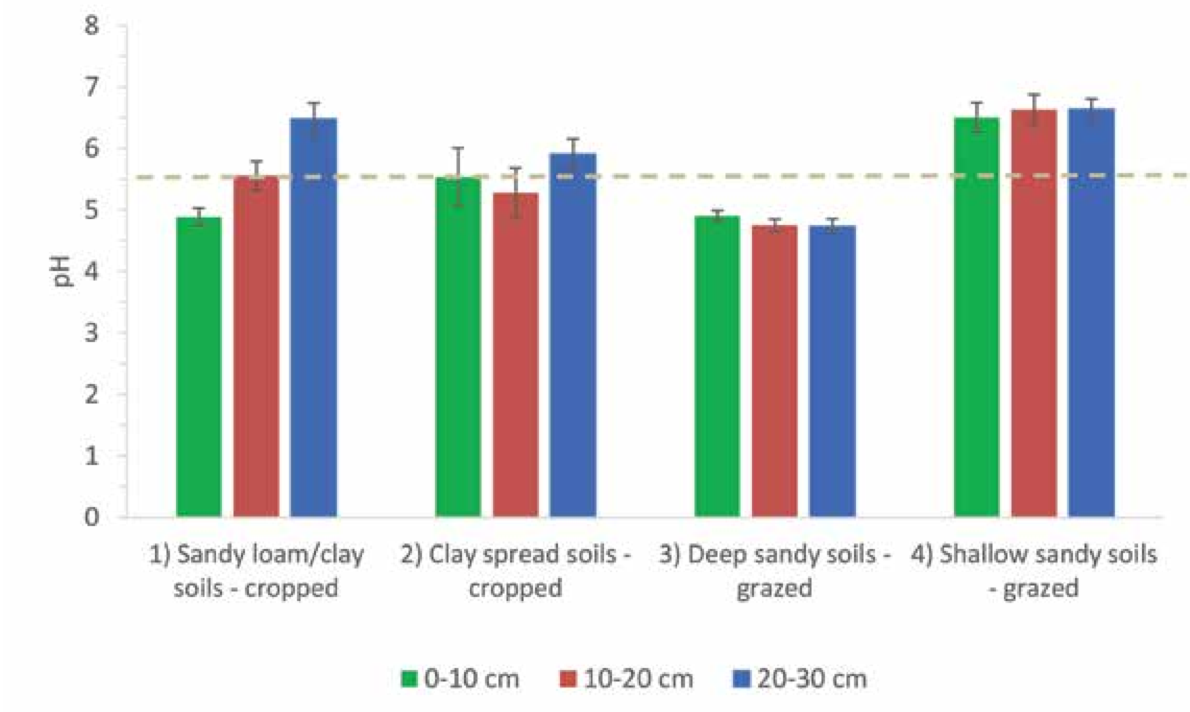

Figure 1: Average soil pH of the four major soil types studied in the project (the error bars on the columns indicate the degree of variation around the average). The dashed horizontal line highlights the minimum optimum target of 5.5 (pHCa), showing the cropped soils to be acidic in the surface and subsoil and the deep sandy soils to be acidic throughout. Shallow sandy soils used for low intensity grazing are generally neutral to alkaline in the top 30 cm.

3. ***Deep sandy soils that have been clay spread and used for grazing = acidic***

In low intensity grazing paddocks where deep sand (>50 cm) has been clay spread, the neutralising effects of the clay have worn off and the profile is acidic throughout the top 30 cm (Fig. 1). The studied soils were acidic in both the deep sands of the dunes and in the swales. It is likely that the rate of clay applied and the depth to which it was initially incorporated was not sufficient to mitigate acidity; low pH is a natural feature of these deep sands across the SE, which is exacerbated with crop and pasture removal. The presence of Sorrell in areas of poor pasture productivity was a good indicator of the presence of acid soil.

Acidity in this scenario may be best managed by clay spreading at a higher rate and by incorporating it as deep as possible to improve the buffering potential and productive capacity of these deep sandy soils. ***Immediate lime applications are alternatively recommended.***

4. ***Shallow sandy soils that were clay spread or delved >10 years ago and used for sporadic cropping and/or grazing = mostly neutral to alkaline***

Shallow sandy soils, where clay is generally found within 30 cm of the surface, that have been clay spread and or/ delved and used predominantly for grazing with sporadic cropping, were found to be mostly neutral to alkaline (Fig. 1). Once again, the 'heavier ground' in the paddocks expressed isolated areas of mild to moderate surface acidity. Soil pH needs to be monitored in these paddocks if cropping, hay removal and N inputs are to become more intensive in the future, paying particular attention to the heavier ground which has the potential for higher crop production and product removal.

Where low intensity grazing (permanent pasture) had been the main land use on shallow sands that had been clay spread/delved, the profile was generally neutral to alkaline. The alkalinity of the clay used for spreading has likely assisted buffering against acidification.

The soil ***pH at these sites needs to be closely monitored*** if more intensive crop or product removal is planned as they have the potential for rapid acidification.

Paddocks with high degrees of topographical and soil type variation, such as these, demonstrated the importance of sampling by soil type, rather than collecting a composite sample from across a whole paddock. It is strongly recommended that farmers/agronomists explore their paddocks and dig some holes in different soil types and depths to identify the presence and severity of pH using an indicator kit before designing their sampling transect/plan for collecting samples for lab analysis. Alternatively, paddocks such as these would benefit from precision soil pH mapping, enabling the development of highly accurate variable rate lime applications that are suited to soil type.

Conclusions

Results from this project have shown acidity to be prevalent on sandy soils in the USE, particularly those used for regular cropping; they also showed the neutralising effects of clay spreading and delving to be relatively short lived. Lime is an essential soil amendment required in these systems.

It is crucial that soil pH is kept above 5 and prevention is much better than cure, hence the recommendation to keep the soil pH above 5.5 in cropped soils. When the surface soil pH falls below 5, any lime applied will be used in the surface layer and the subsoil will continue to acidify. If soil acidity is not ameliorated by sufficient application of liming products, the consequences include:

- loss of production and financial returns, particularly for acid-sensitive plants
- progressive acidification of subsurface and subsoil layers, which are much more costly to ameliorate
- reduced uptake of soil water that can lead to rising water tables and increased soil salinity
- increased leaching of iron, aluminium and some other nutrients from the soil, potentially contaminating surface and ground water.

Lime treats soil acidity by neutralising the acid reaction in soils and is the only cost effective way to manage acidic soil; it is most effectively applied to prevent acidification in the first instance. Farmers should discuss soil pH and lime requirements with their agronomist. Alternatively, multiple decision support tools are available at https://agex.org.au/project/soil-acidity/ to aid the identification of acid prone farming systems and also ***to determine the rates of lime required to overcome acidity:***

- Maintenance Lime Rate Calculator – estimate the replacement lime required to counteract the annual acidification of the surface soil layer.
- Lime Cheque – estimate lime application rates for acidic soils and compare the costs of lime from different suppliers.
- Acid Cost - estimate the losses in production for a farm business caused by acid soils.

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