Soil Acidity in the Mallee

Fact sheet | July 2018

Acid soils are becoming increasingly common in the South Australian Mallee, especially in continuous cropping systems and particularly in the southern Mallee.

Acidic soils cause a range of issues including loss of productivity and landscape degradation. Soil acidification is a naturally occurring process, however modern intensive, high input farming practices have accelerated the rate and spread of soil acidity to the point where it is a major issue in many Australian agricultural areas.

Soils are considered to be acidic when the pH level is below 5.5 using the water test, and below 5.0 when using the calcium chloride (soils laboratory) test. Acidic topsoil can also lead to sub soil acidification over time if left untreated.

How soil acidification occurs

The biggest contributor to soil acidity is the inefficient use of nitrogen fertilisers, particularly where ammonium based synthetic fertilisers are used in cropping. Soil processes convert ammonium nitrate into nitrate and hydrogen ions. When nitrate use is low then the concentration of excess hydrogen ions increases within the soil resulting in lower soil pH.

Removal of plant material from harvesting crops or grazing pastures also contributes towards soil acidification. Plant material is generally alkaline in nature and helps to buffer soils that are acidic. Continually exporting crop matter reduces the opportunity to balance soil pH levels.

The impact of acid soils on crops

Acid soils are hostile to cropping and grazing systems for a number of reasons. Low soil pH increases the incidence of aluminum toxicity resulting in stunted root growth and reduced plant access to water and nutrients. A lack of water and nutrients results in reduced crop and pasture growth, crop yield and grain size, and is often most noticeable in seasons with a dry finish.

Crop performance is further compromised in acidic soils because nutrients are bound to the soil at low pH. Therefore the nutrient value of applied fertiliser is not fully available for plant uptake. This is evident in crops that underperform despite receiving a sufficient dose of fertiliser and adequate rainfall throughout the growing season.

Sandy soils are inherently more prone to acidification when compared to clay soil. Sandy soil structures are less able to buffer against becoming acidic, struggle to retain nutrients and have a lower water holding capacity, which aids in the leaching and drainage of beneficial nutrients.

Understanding the implications of acid soils

There are various implications for landholders with acid soils, ranging from production limitations through to loss of soil cover and the declining of soil biological health.

The presence of acidic soils can seriously limit crop options, preventing growers from being able to choose varieties to suit the crop rotation and to capitalise on market prices. Low yields, poor quality and a reduced grain size will restrict profitability and management strategies such as liming will also increase the cost of production.

The economic effects are similar for landholders growing pastures for livestock. Pasture options are restricted and growth of some beneficial pasture species will be inhibited. This will lead to costs in additional feed or a reduction in profitability by restricting herd sizes. The nutritional value of pastures is also reduced, increasing the need for supplementary feeding.

In both pasture and cropping enterprises, declining rates of vegetation will allow acid tolerant weed species to dominate. This will require additional herbicide applications and further reduce the volume and quality of productive crops and pastures that are available to stock.

Increasing acidity has a serious detrimental effect on soil health and biology including declining rates of beneficial microorganisms such as Rhizobia, which are critical in the process of nitrogen fixation in legumes. Earthworms and soil insects are unable to thrive in acidic soils, resulting in a decline in soil structure and organic matter decomposition.

Monitoring soil pH

It is important that landholders are aware of the conditions that can decrease soil pH. In highly productive systems, the biggest contributing factors are:

- the use of nitrogen fertilisers, especially on sandy soils and sandy rises
- the inclusion of legume crops in a crop rotation where nitrogen availability exceeds crop requirements
- the removal of biomass as hay, grain or pasture via grazing

Testing and monitoring soil pH levels provides a baseline understanding and recording this information allows landholders the opportunity to identify any changes over time. This can be done with in-field soil testing kits, or by sending samples away for laboratory testing.

When testing for soil pH, landholders should use the following approach:

- Soil test each soil type on the property separately
- For each soil type, test both the soil surface (0-15 cm) and sub surface layer (15-30cm)
- For each of the two layers, collect 20-30 samples, mix in a clean bucket for a representative sample and test
- Note the location of the soil sample (i.e. mark fence posts or record coordinates) so the same area can be retested in future for an accurate comparison

Treating soil acidity

Once acid soils have been identified, landholders should take relevant action to correct soil pH. Clay spreading is a consideration, especially for paddocks that have an alkaline sub soil clay content suitable for incorporation into sandy top soils. As well as being a useful treatment for acidic soils, incorporating clay into sandy soils can have a positive impact on the soil's ability to retain nutrients and hold water.

Location of clay from soil surface	Extraction technique	Approximate cost ($ per ha)
Less than 30cm	Spading	Dependent upon proximity to clay source
Within 30-65cms	Delving	$125-$175
More than 65cm	Spreading	$250-$350

Diagram 1: Incorporation method and indicative costs based on the distance of clay sources from the soil surface.

Using precision mapping to manage soil acidity

An emerging method of monitoring paddocks at risk of acidity is the use of soil pH and electrical conductivity (EC) mapping. In 2017, a project focused on the use of this technology in diagnosing acid soils on five properties in the southern Mallee in order to help landholders understand the extent of the problem and identify potential management options.

The project used a Veris 'on-the-go' machine towed behind a vehicle to collect soil samples from 10cm depth at 29m intervals – providing 11 - 12 readings per hectare. Soil samples were collected and tested to ground truth the data gathered by the Veris machine.

The machine also recorded the EC of the soil to provide an idea of sub soil texture. Readings were taken at 0-30cm and 0-60cm depths in order to provide an idea of changes in soil type, salinity levels and rock substrate.

The information was converted into pH and EC maps for the areas surveyed, providing a detailed visual record of acidic soils and soil type, as well as pH variation within a paddock.

The trial resulted in the following observations:

- There was a large variation in pH across all five paddocks surveyed, ranging from 4.2 to 8.3pH
- The biggest range in pH in a single paddock was 4.2 to 7.9pH
- Sandy and non-irrigated country tended to have a pH lower than 6, whereas heavier soils and irrigated areas were all considerably higher
- Areas that had been clay spread had showed an improved pH, particularly on deep sandy soils and sand dunes

The trial allowed growers to see the extent, severity and variability of soil acidity in a representative paddock and to understand the influence of soil texture on soil pH.

The maps also provided a prompt for landholders to plan and undertake relevant management strategies, including clay spreading or liming. Those with variable rate capabilities could also use pH maps to target lime applications based on paddock zones, thereby saving on lime purchase and application costs.

Image 1: Soil sampling was conducted using a Veris 'on-the'go' machine.

The method used to extract clay from the sub surface depends upon depth of the clay from the surface. Where it is more than 65cm from the surface, it is necessary to mine and spread the clay from another paddock.

Developing a strategy to access, apply and incorporate clay depends upon the specific requirements of a farm, including the resources available to the landholder. Clay should be tested to determine its pH and ability to disperse. If the clay is suitable then landholders will also need to consider the spreading rate and incorporation method. It may be useful for landholders to develop a plan in conjunction with their agronomist, and ongoing monitoring of the site should be undertaken to assess the value of the exercise.

Additional products may also be incorporated with the clay. While not an alkalizing agent, gypsum helps to break up the clay and is also a useful source of sulfur for canola growers. Evidence suggests that adding lime to clay that is not already alkaline increases the lifespan of the alkalizing process so the process can be repeated less frequently.

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The surface application of lime is another strategy to manage acid soils, particularly in the soil surface layer. It is a very cost effective measure to treat surface acidity and readily available from a wide range of suppliers. Liming is not a particularly effective method for managing acidity in the sub surface layers due to low solubility and the long length of time that lime takes to permeate to the subsoil.

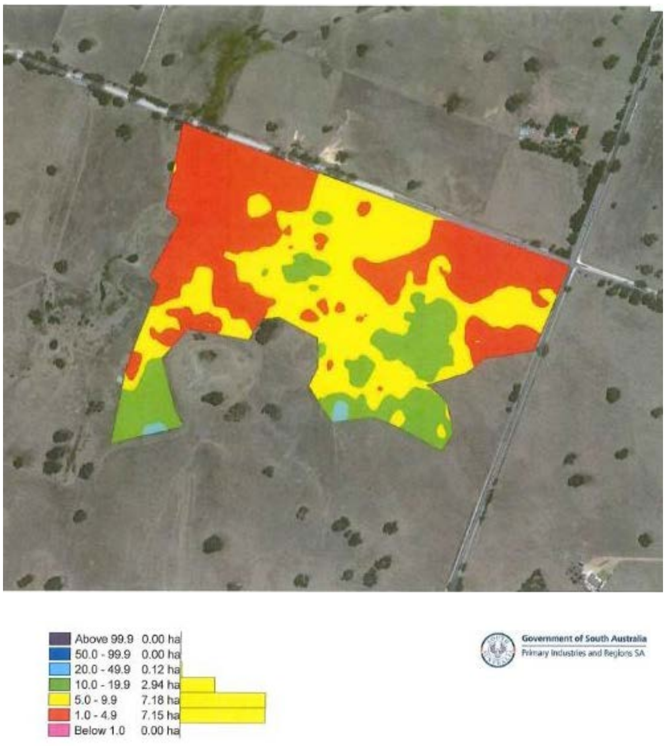

Image 2: A map showing the electrical conductivity that was produced from soil testing on a property in Aden Valley. The areas in red reflect highly acidic soils.

In no-till systems, the absorption of lime is slow and landholders are advised to use higher rates of lime or apply lime earlier in the season than usual. It may be necessary to incorporate lime with a one-off cultivation to treat sub surface acidity.

While lime comes in several different forms, the important factors to consider when buying it are particle size and neutralising value. Sources with a smaller particle size are more favorable as this increases the rate at which the lime particles can neutralise acid in the soil.

Identifying the most effective source of lime is best done with the assistance of a liming calculator which considers particle size, neutralising value and cost (including freight) to find the most cost effective option. Landholders should source a product information sheet from local suppliers and use an online calculator (such as http://soilquality.org.au/calculators/lime_comparison) to determine the costs.

Image 3: Regular soil testing is critical to monitor changes in pH.

For more information

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