Soil Acidity in the Limestone Coast

Limestone Coast Landscape Board

What is Soil Acidity?

Soil acidity is any point below neutral on the pH scale. Danger levels occur when pH gets to pH 5.0 in calcium chloride and below. Many soils in the Limestone Coast are prone to soil acidity.

Sub-surface acidity is considered to be the sleeping giant of soil health issues in the region. It generally occurs in the A2 Horizon of the soil and below (approximately 10- 40cm) the surface of the soil. It has the potential to adversely affect agriculture in many areas of the Limestone Coast. Sub-surface acidity has the same basic causes and treatments as surface soil acidity, but is more difficult to detect and more expensive to treat.

The protracted time observed for applications of lime to reach the sub-surface soil layers means that proactive detection and treatment for sub-surface acidity is much cheaper than waiting until yield losses become apparent.

What causes Soil Acidification?

Surface soil acidification is a natural phenomenon and also an inevitable consequence of productive farming systems.

Under native vegetation, the rate of soil acidification is very slow. Many soils in the South East were slightly acidic to neutral prior to land development (Lewis et al., 1987).

Once sown to non native agricultural species, light textured soils can acidify quickly (a decrease in soil pH of one unit in 30 years).

Plant material is alkaline, when you remove plant material, like pasture, crops and hay plant material is alkaline, when you remove plant material, like pasture, crops and hay you also remove alkalinity from the soil. Here is a guide to the Average Annual Acidification rate from productive farming:

Cropping Pasture System	Average Annual Acidification rate (kgs lime/ha/year)
Continuous grain cropping	180 – 320 (232)
Crop – pasture rotations	40 – 230 (99)
Low production grazing	20 – 60 (35)
High production grazing	60 – 145 (112)

You can see if you have not had a regular liming program in place that your already acidic soil could become even more acidic in a relatively short space of time.

In addition, things like nitrification (oxidation of nitrogen) can also increase the acidity of your soil. The high use of nitrogen (N) in agricultural systems, whether by growing leguminous crops or pastures or by adding acidifying nitrogen fertilisers, can accelerate soil acidification. If not all the nitrogen is used by the crop or pasture, nitrification may occur.

Causes of sub-surface acidification are the same as for topsoil acidification. As the sub-surface is less likely to be sampled for analysis, acidification in this area may not be noticed until yield losses become noticeable. In addition, as acidification is a gradual process, and the effects on the plant are those of drought or nutrient deficiency, sub- surface acidification may go unnoticed for some time as the land manager attempts to fix nutrient deficiencies with fertiliser. Pasture systems such as those in the high rainfall (>600 mm) zone are particularly susceptible to this (Scott, Ridley et al. 2000).

The trend in recent years in cropping areas towards minimum tillage has raised some questions about the development of acidic sub-surface layers in soils with very little disturbance. Practices such as deep placement of N fertilisers have the potential to increase acidification below the surface without affecting upper layers of soil. In addition, the retaining of organic matter on the surface with reduced tillage contributes a neutralising effect on the surface but not lower down. This effect is also seen in pastures, which also do not usually have disturbed soil.

Why is it a problem?

Soil acidity is a severe soil degradation problem which can greatly reduce the production potential of farming systems in the Limestone Coast. Soil acidity literally eats into farm productivity and the long term sustainability of the soil resource by affecting many aspects of soil and plant health.

Soil pH levels do not usually directly affect plants until levels are extreme, and these effects are often difficult to reverse. If severe acidity is allowed to develop, irreversible damage to the soil can and will occur. Sub-surface acidity is much more costly to fix than surface acidity and a lot more costly than a regular liming program on your farm. The time taken for applications of lime to reach the sub- surface soil layers means that proactive detection and treatment for sub-surface acidity is much cheaper than waiting until yield losses become apparent.

As soils acidify, there are fewer choices of crops and pastures that will grow productively.

Most of the detrimental effects of acidity are due to the impacts of soil pH on the availability of plant nutrients. As soil health declines, the activity of nitrogen fixing bacteria declines and nutrient imbalances emerge:

- In acid soils, aluminium becomes increasingly available leading to toxic conditions. Some plants such as phalaris, barley and lucerne, are especially susceptible to aluminium toxicity and overall production can be severely reduced. In addition, aluminium and magnesium ions released into the soil at low pH can have toxic effects on bacteria.
- Phosphorus is also strongly influenced by soil pH level. As your soil pH moves towards the lower end of the pH scale (higher acidity level), it becomes increasingly tied-up in the soil and less available for plant uptake, which increases your fertiliser bills.

Fertiliser	Acidification (kg lime per kg of N fertiliser)		
	Minimum (0% leached)	Maximum (100% leached)	Average (50% leached)
Urea	0	3.6	1.8
Ammonium nitrate	0	3.6	1.8
Ammonium sulphate	3.6	7.2	5.4
DAP (18:20)	1.8	7.2	5.4
MAP (10:22)	3.6	7.2	5.4

Table 1. Lime required to counteract acidity caused by common N fertilisers in soils.

- Biological activity of many bacteria is reduced at low pH, including beneficial bacteria such as *Rhizobium* species that supply nodulated leguminous plants with nitrogen, and other free- living nitrifying bacteria (Brady and Weil 2002). Tolerance of Rhizobium species to acidity varies – for example, Bryan (1923a; 1923b) found that bacteria of soybeans were killed at a soil pHca of 3.5-3.9, bacteria of red clover at pHca 4.5-4.7 and those of lucerne at pHca 5.0.
- Fungi are less affected by pH and so may dominate the biological activity in acid soils.

Some indicators that acidity may be a problem for you are:

- A soil test indicating your soil is of low pH
- Uneven growth of plant species
- Poor nodulation of legumes
- An increase in acid tolerant weeds e.g. sorrel
- Poor establishment of species such as lucerne, phalaris, medics, barley and canola
- The formation of organic mates in the surface layer
- Stunted root growth
- Declining water use efficiency.

When is it a serious problem

A pHca of 5.5 or less at the surface is a strong indicator of an even lower pH (stronger acidity) level below the surface.

In the Limestone Coast it is important to test your paddock away from limestone roads, as often the portion of your paddock closest to the road will test at a higher pH (weaker level of acidity) than the rest of the paddock due to residual lime blowing from the road into the paddock.

References

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Disclaimer

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Understanding pH

Soil is made up of various components which determine its properties. These include mineral particles (sand, silt and clay), organic matter (living and dead), air and water.

The water component is where pH is measured; this is where dissolved chemicals cause the soil to be acidic or alkaline.

Soil acidity and alkalinity are measured in units of pH. The pH scale is from 0 (most acid) to 14 (most alkaline) and a pH of 7 is neutral. pH is measured using a logarithmic scale, which means that for a pH decrease of one, the acidity increases by a factor of 10. For example:

pH 4 is 10 x more acidic than pH 5 and 100 X more acidic than pH 6.

Most soils have pH values between 4.5 and 9.5. Soils with a pH value of 6.5 to 7.5 are referred to as neutral, while those with a pH less than 6.5 are acidic, and greater than 7.5 are alkaline.

Soil pH affects the amount of nutrients that are soluble in soil water, and therefore, the amount of nutrient available to plants. Some nutrients are more available under acid conditions while others are available under alkaline conditions. However, most mineral nutrients are readily available to plants when soil pH is near neutral.

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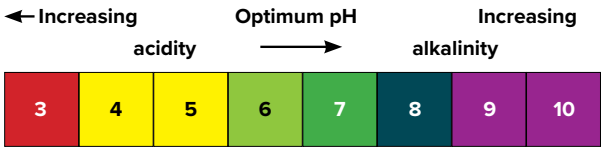

Undertaking your own test for pH

You can easily test your soil pH, and an approximate value of soil pH can be made with a relatively inexpensive field test kit (available at hardware stores), and if done regularly it provides a good guide to soil pH.

Soil samples for pH testing should be collected from a depth of 10cm. The core extracted to this depth should be of a uniform width. A cylindrical soil corer is ideal for this purpose. When assessing a paddock, soil cores should be taken within single soil types and within single management systems. Don't mix together cores from visibly different soil types, and avoid mixing together soils that have been managed differently. Ten to thirty cores that are taken across a paddock should be thoroughly mixed together (bulked) in a bucket. To take the pH follow the instructions provided in your field kit.

More information

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