SOIL EXTENSION ACTIVITIES – EVALUATING DIFFERENT RATES OF LIME AND INCORPORATION TECHNIQUES WHEN AMELIORATING ACID SOILS

KEY MESSAGES

- **Segmented pH soil testing in problem paddocks can help farmers get a clearer picture of what is happening within each soil layer**
- **Many factors influence soil behaviour, so it's important to understand your soil before making amelioration decisions**
- **Soil can have high levels of variability and this will play a role in choosing which amelioration options will suit best**
- **Once a soil constraint is identified, it is important to understand other soil characteristics before committing to deep incorporation of an ameliorant such as lime; some machines may go too deep and cause further issues, for example, by bringing up toxic sub-layers**
- **Where surface lime was applied, pH increased in the 0-5cm range only. The use of machinery incorporation resulted in a pH increase at depth, with a higher pH achieved as liming rate increased.**

OVERVIEW

Soil issues in the Riverine Plains region are often complex and can be variable across both vertical and horizontal profiles. For example, acidity may not be present at the surface (< 10 cm) and can be quite profound at depth (e.g 15-20 cm). Soil constraints such as acidity, when left unmanaged, can cause serious yield losses and reduce profitability in susceptible crop types. Typically, the most pH sensitive crop types are lentils, faba beans, chickpeas, and vetch. A highly acidic soil is usually considered to have a pH less than 4.8 (CaCl2), below which aluminium availability often increases dramatically, while soil with pH less than 5.2 will cause yield loss in sensitive species. It's recommended farmers should target pH above 5.5 in the root zone to avoid crop losses and maximise nitrogen fixation from pulse crops. The vertical stratification of pH means soil testing needs to be comprehensive in order to understand where problems lie, so that they can then be effectively addressed. You can only fix the problem if you truly understand the problem.

Traditional bulked soil testing at 0-10cm depth does not identify acidity issues below 10 cm, which means many farmers may be unaware of the sub-soil constraints in their paddocks. The issue for many growers is that comprehensive soil mapping, ground truthing of soils and amelioration is expensive, and this has traditionally been a disincentive for farmers to take the important first step to improving their soils.

AIM

This project is supporting land managers by promoting the benefits of increased frequency and comprehensiveness of soil testing to inform soil management decisions and take action to improve soil health.

PROJECT PROGRESS

In early 2022, Riverine Plains worked with farmer hosts that had identified paddocks with problem soils through EM surveys. These sites were soil tested, in 5cm increments to a depth of 20cm, to understand the key constraints contributing to the issues being seen above ground (for example poor emergence, poor nodulation of pulse crops, weeds that thrive at low pH, poor crop growth and yield).

As part of the project, which also involved discussion group meetings and workshops, a trial was established which focused on different machinery options to incorporate various lime rates at two sites. The trial aimed to better understand and compare the options for product incorporation and depth, seed bed preparation and overall plant establishment in soils with highly acidic soils. Each paddock was grid sampled by Precision Agriculture before deciding upon an area within the paddock to host the trial.

The first demonstration site, at Hopefield New South Wales, was sown to barley on 4 May 2023 and the pre-treatment soil test results (Table 1) show pH to be below 4.8 at all depth increments. Soil pH below 4.8 (CaCl2) results in aluminium becoming more soluble, which is a problem because solubilised aluminium is highly toxic to growing roots. This results in severe root stunting, limiting plant access to water and nutrients and causing reduced yield outcomes.

To examine the effect of pH and pH stratification, a demonstration trial was established that included five incorporation methods (lime mixing methods), including a control (no incorporation), speed tiller, deep offset discs, deep offset discs and speedtill, and a Horsch Tiger, combined with four liming rates of 0, 1, 2.5 and 5 tonnes/ha, applied in a matrix layout. Lime was applied and incorporated in March 2023, with post-treatment soil testing completed in August 2023. At this site, aluminium was particularly problematic between 5 and 30 cm.

Table 1 Pre-treatment soil test results Hopefield, June 2022

DEPTH (CM)	PH (CACL2)	SODIUM % OF CATIONS (ESP)	ALUMINIUM SATURATION (%)
0-10	4.3	<1.00	12
0-5	4.7	<1.00	3
5-10	4.0	<1.00	25
10-15	4.0	<1.00	37
15-20	4.1	<1.00	46
20-30	4.2	<1.00	45
30-40	4.6	<1.00	8

A second demonstration site, at Rand NSW, was sown to faba beans in May 2024, and pre-treatment soil test results are shown in Table 2. This site is a heavier clay compared to the sandier soils seen in the Hopefield site and has soil pH of <4.8 in the 0-15 cm depth, beyond which pH increases to above 5. Aluminium toxicity is present in the 5-10 cm layer but was not as severe as at the Hopefield site.

At this site, incorporation methods include a control (no incorporation), kelly chain plus offset discs, and compact disc harrows (Rubin 12" and 10"). Similar to the Hopefield site, lime application rates of 0, 1, 2.5 and 5 tonnes/ha, were applied in a matrix layout. The site also received of 0.8t/ha gypsum post incorporation.

Table 2 Pre-treatment soil test results Rand (average of plots), January 2024.

DEPTH (CM)	PH	SODIUM % OF CATIONS (ESP)	ALUMINIUM SATURATION (%)
0-5	4.8	4.3	2.0
5-10	4.5	4.8	7.1
10-15	4.8	6.5	1.9
15-20	5.4	8.2	0.5
20-30	5.8	10.1	0.4

Test results from the Rand site (Table 2) show that soil sodicity (ESP) starts to increase above 15 cm, while soil pH is not in the problematic range below this depth. Consequently at the Rand site, applying lime and gypsum to 15 cm is likely the best option to correct the low pH stress. This will avoid bringing sodic dispersive soils to the surface and ensure gypsum is fast-tracked to greater depths where sodicity is more prevalent.

Figure 2 The effect of 5t/ha lime incorporated using different techniques when sampled in August 2023

OBSERVATION AND COMMENTS

Soils are variable by nature and amelioration is costly. Consequently, it is worthwhile spending the extra time to gather more information to improve decision making when amending soil pH. The NSW DPI soil acidity and liming publication provides an excellent guide as to how best to estimate your lime inputs based on soil pH and soil ECEC (effective cation exchange capacity).

It is recommended that farmers complete segmented pH soil testing in 'problem' paddocks first, to get a clear picture of what is happening at each layer. In addition to soil pH, the ECEC test is necessary to help estimate the lime amount required for the target depth. Once the pH is identified, including severity and depth, it is important to understand other soil characteristics before incorporating lime, as some soils may have other non-pH related problems. For example, in sodic dispersive soils (estimated by ESP), which are found in many soils across the NSW Riverina, the sodicity problem increases with depth (Table 2). At the Rand site, the pH and ESP changeover occurs at 15 cm (below 15 cm it is acid and above 15 cm it is sodic), so mixing lime to 20 cm would in this case would bring sodic soil to the surface and be counterproductive. A simple dispersion test for each soil layer can be applied. This test, along with a pH test in 5 cm increments will help identify the recommended depth of cultivation that is best for lime incorporation.

Throughout this project we have engaged with experts from AgriSci, Precision Agriculture and NSW DPI to guide our decision making on machinery choice and product rate. Completing side-by-side strips in this trial has demonstrated which machinery works best with this soil type and can help landholders with similar conditions make more informed decisions.

NEXT STEPS

The pre-treatment and post-treatment tests at the Rand site will be taken from individual plots, and once these results are available it will be easier to compare. Detailed learnings from this site and across the entire project will be available next year, once final soil testing and analysis has been completed at the Rand site.

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