BEST PRACTICE LIMING TO ADDRESS SUB-SOIL ACIDITY

KEY POINTS

- **Paddocks with a history of no-till management (cropping and pasture) may have highly stratified pH values in the top 20cm. This means accurate testing for soil acidity may require sampling at 5cm increments, rather than the traditional 10cm increments.**
- **Not all lime has the same Calcium Carbonate Equivalence (CCE) value and therefore they have different capacity to neutralise acidic soils, get yours tested.**

BACKGROUND

Acidity levels in topsoil and sub-surface layers are increasing across the southern region of Australia and are rapidly becoming a key constraint to productivity. Increasing soil acidity and the associated declining production is a gradual process. Applying lime to address increasing acidity is often the first input to be dropped when cash flow is limited due to its high cost. Additionally, the development of acidity can be masked where an acid throttle (a layer of low pH that restricts movement of nutrients and roots past it) exists in a stratified layer. This is often overlooked in lab analysis of 0-10cm mixed soil samples. Often growers do not recognise the gradual decline in fertility and do not apply lime until the problem is already established.

With the low solubility of lime and its relative immobility, top-dressed lime can take ten or more years to significantly increase subsoil pH below 10 cm. Soils that have not been adequately maintained with lime applications to counter the increasing rate of acidification, need a management solution to increase subsoil pH, as well as having a faster return on investment and increase in crop productivity.

The placement of the lime in the soil plays a significant role in the lime's ability to neutralise acidity when it exists at depth due to the need to establish contact for the acid base reaction to occur. The quality of the lime is another factor contributing to its effectiveness in neutralising soil acidity, specifically its neutralising value. Effective Neutralising Value or ENV describes a chemical property of the lime based on its Calcium Carbonate Equivalence (CCE) to neutralise acid and can vary greatly between lime sources. In addition, the lime's fineness also has a significant impact on its ability to neutralise acid where finer products have higher surface area and therefore greater contact with soil particles to improve its efficacy. A higher Effective Neutralising Value (ENV) lime is generally more expensive, so ensuring maximum value from higher ENV lime through effective placement in the soils is of great significance to farmers.

AIM

To demonstrate best practice liming strategies and a field demonstration of the impacts of lime quality.

OBJECTIVES

The objective of this project is to establish one replicated field trial to demonstrate best practice liming strategies and a field demonstration to show the impacts of lime quality per annum, over two years. It will demonstrate different incorporation methods, evaluate the impact of different lime types/sources, as well as extend findings including comparisons of the economic and agronomic returns using the Acid Soils SA calculator tools.

Extension efforts are focussed on raising grower awareness on the speed of acidification and stratification of soils in this region. This is while providing resources and tools available to assist management decisions such as the aforementioned calculators.

It is pertinent for growers to evaluate the most practical and economical methods for managing soil pH and paddock variability in soil types. This will form part of the demonstration whereby achieving the best overall benefit on variable soil types will be examined. 'Nil' treatments, where no lime is applied, are designed to showcase the cost of complacency toward addressing pH in the short and long term.

Is it hoped that by the end of the project in December 2023, growers and advisers in northeast Victoria will have improved understanding of the state of topsoil and subsoil acidity, the limitations to crop profitability it causes, and finally, an improved knowledge of the agronomic and economic benefits of different lime sources, lime quality and incorporation methods.

Table 1. Final treatments for the trial

TREATMENT#	DETAILS
1	Control – nil lime: nil incorporation
2	Nil lime, with incorporation
3	Lime to target pH 5.2, incorporated by sowing
4	High rate of lime (to pH 5.8), incorporated by sowing (0-10cm value)
5	High rate of lime (to pH 5.8), incorporation by shallow discs (0-10 value)
6	High rate of lime (to pH 5.8), deep incorporation to 10-15cm, follow up with speedtiller
7	High rate of lime (to pH 5.8), to deep incorporation to 10-15cm, follow up with speedtiller (rate calculated for 5.8 at depth) DELUX option

METHOD

After consultation with a steering committee, made up of growers and researchers, a number of treatments were agreed and are provided in Table 1 below.

An intense soil sampling regime was completed in February 2022 across every replicate, to baseline and characterise the whole site, understand current pH levels, and ensure the proposed incorporation methods were appropriate. It was calculated that the rates of lime used would be:

Lime to target pH 5.2 – 1.2 tonnes/ha

High rate to 5.8 – 5.0 tonnes/ha

High rate to depth – 8.5 tonnes/ha

Figure 1 illustrates the trial plan whereby the replicated trial sites have a buffer in between the treatments. The buffer was sown to canola. At the end of the replicated trial, strip trails were established to assess the impacts of two types of lime quality, granular and fine and were both spread at 3t/ha and incorporated with sowing. The lime used from Galong was very fine with bulk density of 1.4, while the Mt Gambier lime was much coarser with a bulk density of 1.1.

DEMO 1 - MOUNT GAMBIER LIME 3T/HA - INCORPORATE WITH SOWING				
DEMO 2 - NIL LIME 3T/HA - INCORPORATE WITH SOWING				
DEMO 3 - GALONG LIME 3T/HA - INCORPORATE WITH SOWING				
1	Lime =5.0t/ha incorporate with TIGER		28	Lime =5.0t/ha incorporate by sowing
2	Lime =5.0t/ha incorporate by shallow discs		27	No lime, with Incorporation
3	Control - Nil Lime: Nil Incorporation		26	Lime = 1.2t/ha, Incorporate with sowing
4	Lime = 1.2t/ha, Incorporate with sowing		25	Lime =5.0t/ha incorporate by shallow discs
5	No lime, with Incorporation		24	Lime =8.5t/ha incorporate with TIGER
6	Lime =8.5t/ha incorporate with TIGER		23	Lime =5.0t/ha incorporate with TIGER
7	Lime =5.0t/ha incorporate by sowing		22	Control - Nil Lime: Nil Incorporation
8	Control - Nil Lime: Nil Incorporation		21	Lime =8.5t/ha incorporate with TIGER
9	Lime =5.0t/ha incorporate by sowing		20	Lime =5.0t/ha incorporate by shallow discs
10	Lime =5.0t/ha incorporate by shallow discs		19	Lime =5.0t/ha incorporate by sowing
11	No lime, with Incorporation		18	Lime = 1.2t/ha, Incorporate with sowing
12	Lime =5.0t/ha incorporate with TIGER		17	No lime, with Incorporation
13	Lime =8.5t/ha incorporate with TIGER		16	Control - Nil Lime: Nil Incorporation
14	Lime =1.2t/ha incorporate with TIGER		15	Lime =5.0t/ha incorporate with TIGER

13m 13m 13m 13m 13m 13m 13m 13m 13m 13m 13m 13m 13m 13m

221m

40m 30m 40m

N

Figure 1. Trial design for the liming demonstration

Lime was applied on 16 February 2022 with the incorporation completed on 17 February 2022. A Horche Tiger was used for the deep incorporation, with calibration to ensure that the depth of the lime was kept above 20cm. The speed tiller was run over both incorporated treatments to ensure a smooth surface for ease of sowing. Once the treatments were completed the host sowed and managed the trial site in line with management practices of the remainder of the paddock.

The site was sown to canola on 14 April 2022 with 70kg/ha of MAP. There was 250kg/ha of Urea applied and 100kg of GranAm® (ammonium sulphate fertliser) during the season.

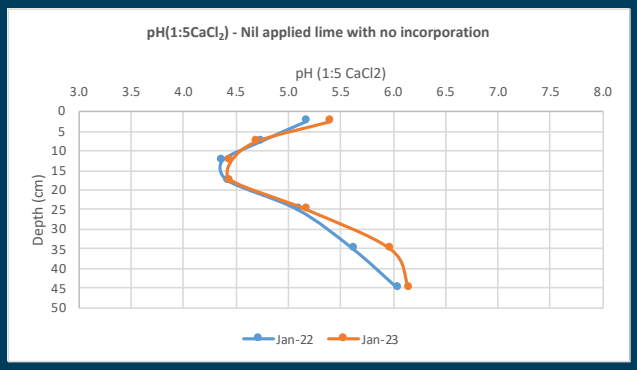
Green seeker measurements were taken on 21 July and on 2 August to assess differences in growth between plots. Photos were also taken during the season as a record of plot growth.

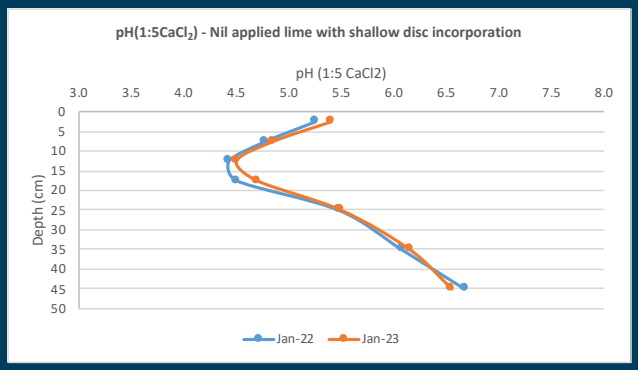
Harvest was not carried out by a plot header for the trial site due to inundation of the site by water, which prevented collection of yield data. Despite significant waterlogging, the host farmer harvested the site with the remainder of the paddock.

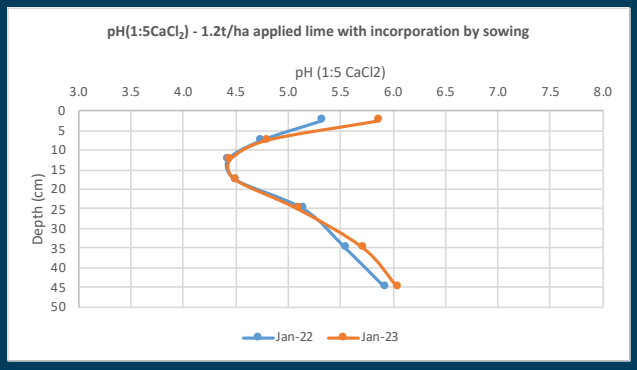
RESULTS

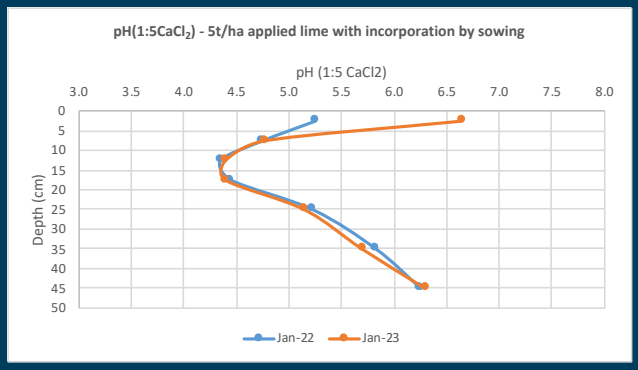
Soil test results for the January 2023 sampling (Year 1) have not yet been statistically analysed. However, early data suggests high rates of lime with incorporation is an effective tool to improve lime placement and ameliorate subsurface acidity. pH results are presented in Figure 2 below. Aluminium and CEC were also measured but are not displayed in Figure 2.

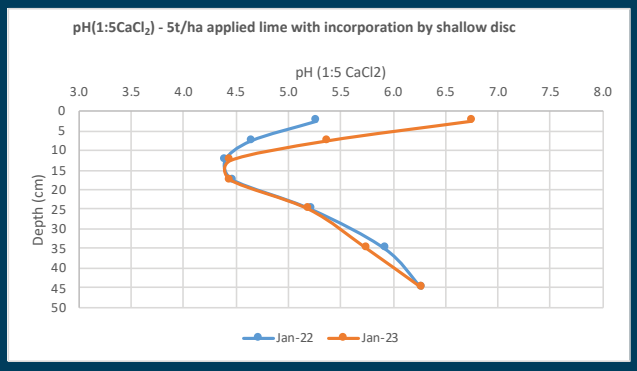
pH

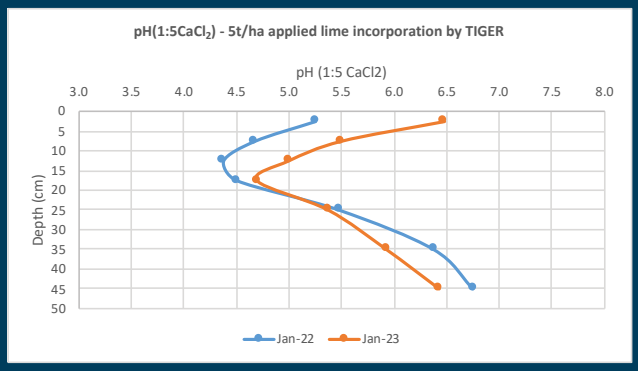












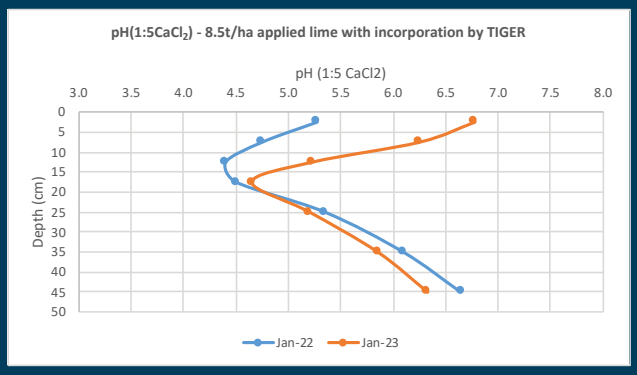


Figure 2 Impact of lime treatments and incorporation methods on pH at depth over a 12-month period

Slugs caused significant damage to the whole paddock in 2022, despite the site being baited twice. It appeared anecdotally that plots that had incorporation and lime treatments were less affected by slug damage, and where lime wasn't incorporated, damage was higher. This however this was not able to be quantified. Figure 3 shows the poor and patchy emergence of one of the plots following slug attack.

The region experienced a large rainfall event in January, with the site having around 150mm.

There was a total of 1150mm for the year and 538mm GSR (growing season rainfall, May – Oct). October had a large rainfall event after the image displayed in Figure 3. This caused the canola to 'lie down' in patches or had been 'washed out'.

Harvest was not able to be carried out by a plot header for the trial site, which disappointingly, resulted in no trial yield data. Despite the crop being black and on the ground the host farmer harvested the site with the remainder of the paddock.

Figure 3. a) waterlogging effects b) slug effect. Photo taken 12 July 2022.

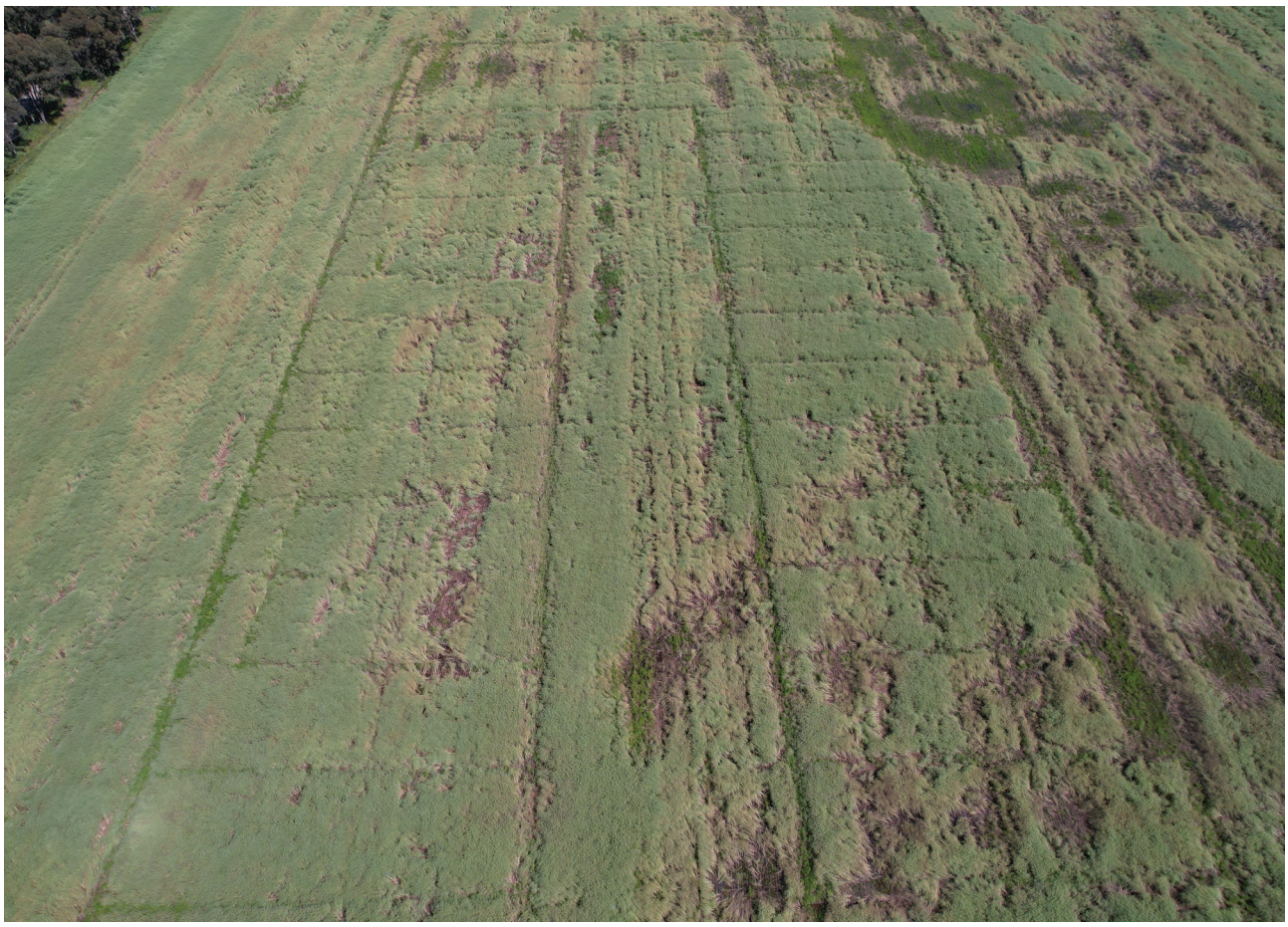


Figure 4 Drone image taken 17 October 2022. Canola had finished flowering and was either lodged, rotted or had not established.

DISCUSSION

Riverine Plains hosted a paddock walk shortly after soil amelioration had been completed. A dig stick and visual observation were used to confirm that the incorporated lime had moved to the required depths.

The areas eaten by slugs were re-sown in an attempt to improve crop cover and trial uniformity, mimicking local grower practice for patchy establishment/ slug damage. Re-sown sections were able to compensate for the poor establishment later in the season.

Due to the site experiencing extensive waterlogging there were concerns waterlogging effects would confound trial results such that significant effects from amelioration treatments may not be able to be inferred from yield and soil test results. Preliminary analysis of the soil test results in 2023, fortunately indicate treatment effects are present despite waterlogging of the site.

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