An in-depth look at ameliorating soil acidity

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Key points

- Acidic subsoils are common in the Riverine Plains region.
- Previous trials have shown deep placement of amendments can improve wheat and canola production.
- Replicated field trials have been established near Rutherglen, Victoria to test innovative methods to address subsoil acidity in the Riverine Plains region.
- A large-scale on-farm site near Rutherglen is planned for 2018.

Introduction

Subsoil acidity (deeper than 10cm below the soil surface) is a major constraint to crop production in the high-rainfall (500–800mm) cropping zone. While acidic surface soil (0–10cm) can be effectively addressed by incorporating surface-applied lime, ameliorating the subsoil has not been practical.

A current project funded by the Grains Research and Development Corporation (GRDC) aims to identify and evaluate a range of innovative products, which may be used to overcome the effects of subsoil acidity. A series of trials is being conducted in New South Wales and Victoria, two of which are long-term trials established in Rutherglen and Cootamundra.

Aim

To quantify the yield limitation caused by subsoil acidity and evaluate innovative soil amendments to address subsoil acidity.

Rutherglen site

Method

A three-year field trial was established in Rutherglen, Victoria during March 2017.

The initial soil profile of the selected site exhibited severe subsoil acidity (Table 1). Preliminary estimates of exchangeable aluminium (Al) indicate potentially growth-limiting concentrations in the surface soil (0–30cm), with the greatest concentrations present in the 10–20cm soil layer.

TABLE 1 Initial pH and exchangeable aluminium percentage for Rutherglen field trial, prior to treatments, January 2017.

Soil depth (cm)	Soil pH ($CaCl_2$)	Al%
0–10	4.55	12
10–20	4.22	30
20–30	4.32	10
30–40	5.05	3

Fourteen treatments were applied in a randomised complete block design, with three replicates and plot dimensions of 5 x 20m: a nil control, surface (0–10cm) incorporated lime (to a target pH 5.5) and a range of deep (10–30cm) placed ameliorants including: deep ripping only, lime, dolomite, magnesium silicate (at two rates), reactive rock phosphate (at two rates), phosphorus (P) applied as a liquid, phosphorus with lime, and lucerne pellets (at two rates).

The surface soil (0–10cm) in all plots receiving deep amendments was adjusted to pH 5.0 by incorporating lime. All deep ameliorants were applied at rates sufficient to achieve a pH of 5.0 ($CaCl_2$) from 10–30cm as determined by laboratory incubation studies carried out at Charles Sturt University, Wagga Wagga, NSW.

Soil chemical properties and moisture content will be monitored during the 2017–19 seasons. The site was sown to canola in 2017, wheat in 2018 and possibly barley will be grown in 2019. Plant establishment, dry matter (DM) during the season and grain yield at the end of the season will be measured each year.

Cootamundra site

Method

A similar trial was established at Cootamundra, NSW during 2016. The treatments were applied in March, and included: deep-placed (10–30cm) ameliorants of lime, lucerne pellets, lime with lucerne pellets, with a control of no amendment, deep ripping only, and surface (0–10cm) liming.

Four crops were grown on treated plots: barley, wheat, canola and field peas. These crops will be rotated within the field each year on a four-year rotation.

Plots were sampled for moisture content, soil chemical properties and crop attributes, such as establishment, DM production and final grain yield.

The trial was implemented as a randomised block design with three replications. Plots are 5 x 20m in size.

Results

The initial soil samples taken at the Cootamundra site showed that subsoil acidity had caused high levels of exchangeable aluminium in the 10–20cm layer of the profile (Figure 1).

Deep ripping (to a depth of 30cm) reduced the physical strength of the soil, as measured by a penetrometer (Figure 2) in one replicate of the wheat plots. Penetrometers measure the force required to move a cone shaped probe through the soil. This was conducted across the plot on a transect perpendicular to the rip line to a depth of 50cm.

It seems the effect of deep ripping with lucerne pellets was beyond the ripping depth (30cm). Further research is required to ascertain the reasons for this but it is possible some of the breakdown products of the organic material are soluble and therefore, mobile.

At harvest, there were significant differences in wheat yield between treatments ($P < 0.05$), with the deep lucerne pellet treatment delivering the highest yield (Figure 3). This is probably due to extra nutrients released into the soil from lucerne pellets.

Soil test results during late August 2016 showed the two lucerne pellet treatments increased the amount of mineral nitrogen (N) available to crops by about 70–100kg N/ha, compared with all other treatments.

However, no yield advantage was observed in the lucerne pellet treatments for canola and barley. The combination of high nitrogen levels and ideal spring

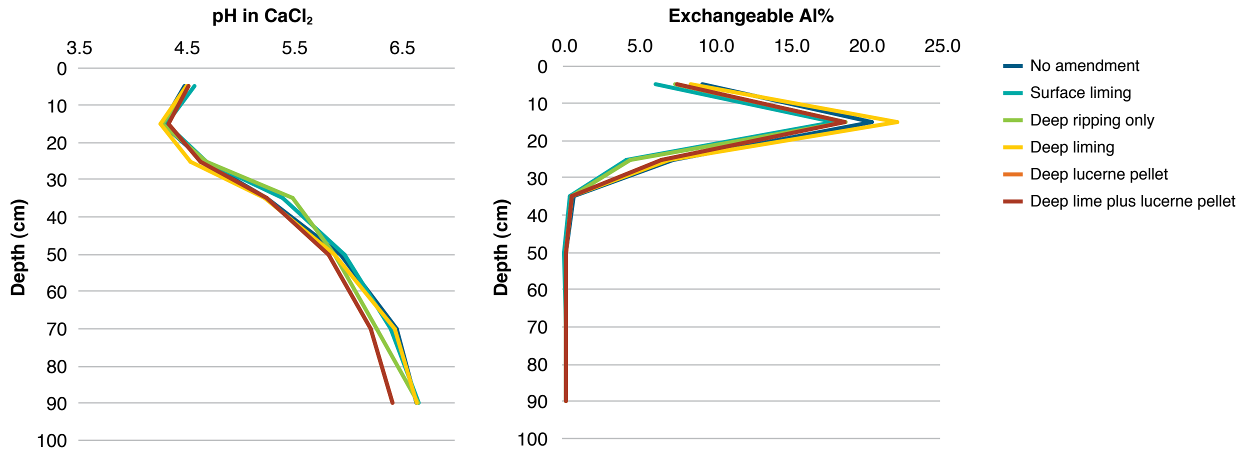

FIGURE 1 Initial soil pH and exchangeable aluminium (% of effective cation exchange capacity — ECEC) within the soil profile at Cootamundra, NSW for a range of treatments during 2016

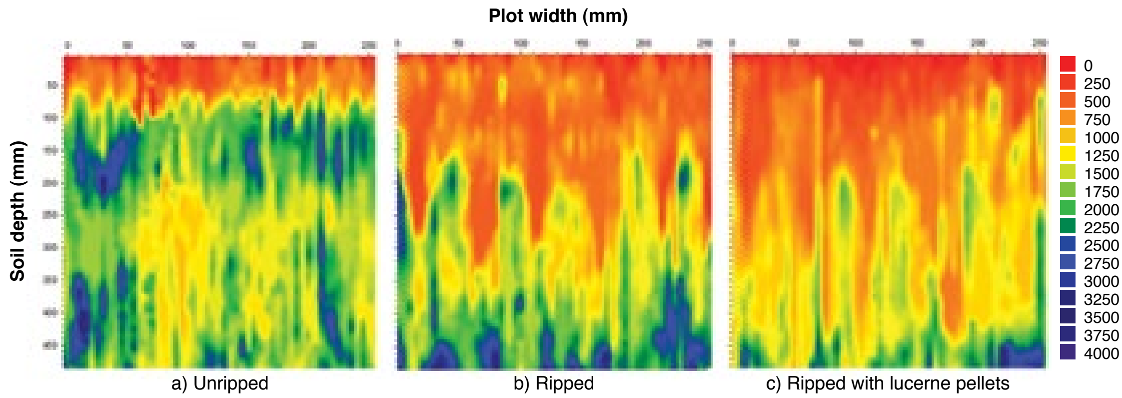

FIGURE 2 Penetrometer readings (kPa) taken September 2016 from one replicate of wheat plots a) unripped; b) deep ripped to 30cm and c) deep ripped + lucerne pellets.

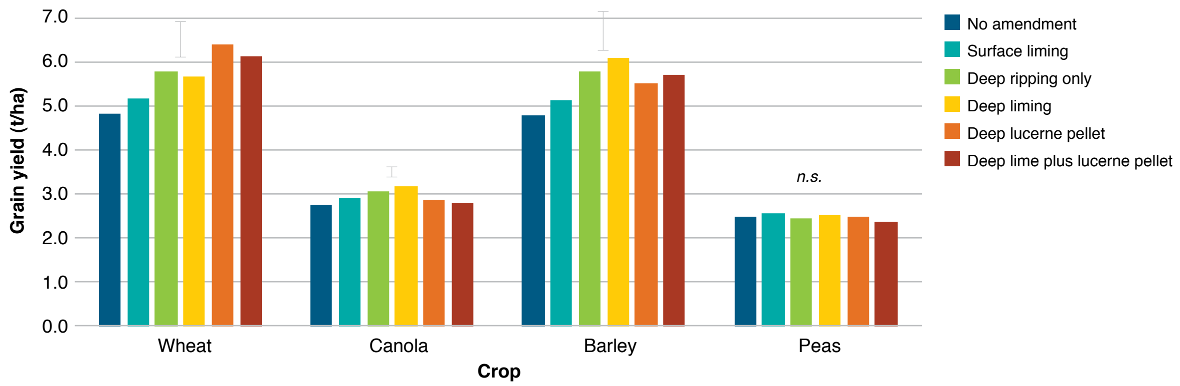

FIGURE 3 Treatment effect on grain yield at Cootamundra, NSW during 2016

Least significant difference ($P<0.05$) bars are shown for each crop type

growing conditions resulted in severe lodging after flowering. There were also no treatment effects on field pea grain yield.

Observations and comments

Subsoil amendment treatments applied at Cootamundra resulted in large visual benefits to growth in terms of DM production. The resulting increase in biomass relative to the control caused excessive lodging in canola and barley as the crop matured.

As a number of field trials are being established in different regions, including the Riverine Plains, to test the potential for ripping and deep placement of amendments to overcome the effects of subsoil acidity, more information will become available in the coming years on effective options for managing subsoil acidity in cropping systems.

A second trial will be established in the Rutherglen region during 2018, which will be managed by Riverine Plains Inc, using farm-scale large plots to further validate these results.

Sponsors

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