Success with lucerne in acidic soils

Location: 'Spring Valley', Mangoplah, NSW

Enterprises: Lamb, wool and grain

Owner: Bernard M[c]Rae

Key points

- Start planning at least two years before sowing lucerne into acidic soils.
- Check for the presence of acidic layers.
- Apply adequate rates of fine-grade lime at least 18 months before sowing to allow time for the lime to react and raise pH.
- Incorporation of lime into the acid soil layers speeds up the lime reaction, increasing pH to the depth the lime is mixed.
- Soil pH of subsurface layers will gradually increase if the 0-10cm layer pH_{Ca} is maintained above 5.5.

Introduction

A miss with the lime spreader at 'Spring Valley' on the Southern Slopes of NSW highlights the importance of effective lime application in establishing a productive lucerne stand in acidic soils. It created the perfect location for a soil pit field day: 'Success with Lucerne in Acidic Soils,' held in September with NSW Department of Primary Industries' soil research scientist Jason Condon and pasture development officer Helen Burns. They emphasised forward planning to identify and ameliorate acidic subsurface layers well before sowing lucerne.

Background

Rotationally grazed lucerne has intensified prime lamb production for Bernard M^{c}Rae at ‘Spring Valley’, a mixed farming operation midway between Wagga Wagga and Holbrook, NSW. High quality, year-round paddock feed is provided by a combination of dual-purpose cereals, brassicas, perennial grass-based pastures, with lucerne filling the summer/autumn feed gap.

With an average annual rainfall of just over 550mm, the creek flats of Spring Valley appear to be ideally suited to lucerne. However, like many soils of the area with a long farming history that included sub clover seed production soil pH_{Ca} (i.e. soil pH measured in calcium chloride) is less than 4.5 to a depth of 20 cm and exchangeable aluminium (Exch. Al) at about 30%. A well-planned liming program is essential to raise soil pH to optimise establishment and persistence of lucerne stands on these soils.

> Low soil pH affects root growth, establishment and persistence of lucerne; and the rhizobia strain needed for lucerne nodulation and N fixation is sensitive to $pH_{Ca} < 6$! As pH declines nutrients such as phosphorus (P) and molybdenum become unavailable for plant uptake, while other elements such as aluminium and manganese rise to levels toxic to plant growth.

Paddock preparation and lucerne establishment

A productive stand on such severely acidic soils begins with paddock preparation 2 to 3 years before sowing lucerne. A weed management program minimises weed competition during the critical seedling stage and lime application, well before sowing, allows time for lime to react and increase soil pH and decrease aluminium toxicity.

A cropping phase from 2016 to 2018 (i.e. oats, forage brassica and grazing wheat) reduced the weed population, and fine-grade lime applied at a rate of 2.5 t/ha was incorporated to an estimated depth of 18 cm using off-set discs in April 2019. An uneven and ‘fluffy’ seedbed is a disadvantage of discs, which Mr M^{c}Rae levelled using a combination of harrowing and passes with the combine to produce a firm, even seedbed.

Mr M^{c}Rae said that dry conditions delayed sowing of the hybrid lucerne, Titan 5, until early June.

“I’d planned to sow in autumn, but a mild winter was predicted, so held off until June when there was sowing moisture,” he said.

> **Titan 5** is a relatively new lucerne variety, bred in Australia from a cross of *Medicago sativa* (common lucerne varieties) with *Medicago falcata*. This variety was chosen for its winter dormancy, spreading growth habit and ground coverage, and persistence under grazing. Titan 5 is well suited to the challenges of the acidic, poorly drained soils on the flats of Spring Valley. With a dormancy rating of 5 (compared with 6 for Aurora) production slows from late autumn to late winter, minimising the risk of overgrazing.

The lucerne was sown at a seeding rate of 12 kg/ha, with 100 kg/ha of MAP fertiliser. Despite very dry conditions through spring and autumn, the lucerne established well. It was topdressed with 100 kg/ha of Single Superphosphate in July 2020.

Figure 1. An area of stunted, yellow plants became obvious in September 2019 due to a miss by the lime spreader in 2019. *(Photo: F McRae)*

Soil acidity explains areas of poor establishment and growth

Although the lucerne emerged evenly, Mr M^c^Rae said that an area of about 2 ha started to show up in early September 2019, where plants were dying and those left were stunted and had mottled yellow leaves, typical of manganese toxicity (Fig. 1).

“We worked out that this ‘poor’ area was where the spreader ran out of lime and was missed on the next spreader run,” he said.

“That lime miss is a reminder of the importance of liming lucerne on acidic soils and although we topdressed lime over that area in April (2020) it’s not going to catch up.”

Plants dug up from the adjacent ‘good’ area in August 2020, where 2.5 t/ha of lime had been incorporated, had nodulated and had more extensive root systems, while plants from the poor area had no nodules and root growth was restricted to the surface 5 cm soil layer (Fig. 2). A field assessment with a Manutec® soil pH kit and Spurr soil probe (dig stick) indicated that lime incorporation had increased pH in the good area to a depth of about 10 cm.

Identifying the problem

Soil sampling in 5 cm increments to a depth of 20 cm is important to understand the depth and severity of acidity in the top 0-20 cm. Monitoring pH change over time tells us if the liming program is working and if lime rates need to be adjusted – either decreased or increased.

Results of laboratory soil tests of samples collected mid-August 2020 confirm the field observations and show that lime had increased soil pH to a depth of 10-12 cm (Fig. 3). Samples collected at 2.5 cm intervals to a depth of 15 cm from the good (incorporated) lime area indicate that

18 months after incorporation lime had increased soil pH to pH_{Ca} 6.9 in the 0-2.5 cm layer and caused an increase in soil pH to a depth of 10-12 cm, decreasing Exch. Al % to that depth.

By comparison, in the poor area, the lime topdressed in April 2020 has had no effect on pH or Exch. Al % below 2.5 cm.

This topdressed lime increased pH_{Ca} in the surface 0-2.5 cm layer only (to just 6.6), which suggests that a large proportion of the topdressed lime remains undissolved on the soil surface. This undissolved lime will be very slow to react and increase pH. Unreacted lime is an opportunity cost to Mr M^{c}Rae.

Figure 2. A check with a Spurr soil probe (dig sitck) and soil pH field kit shows the pH profile of the soil from the good (left) and poor (right) areas. Examination of plants from the respective areas highlights the benefit of lime incorporation on plant vigour, root development and nodulation. The purple to green colour change in the left core indicates that incorporated lime has increased soil pH to a depth of about 10 cm in the good area, while the core from the poor area (right) shows that the topdressed lime remains on the soil surface and acidity (yellow) remains unchanged below.

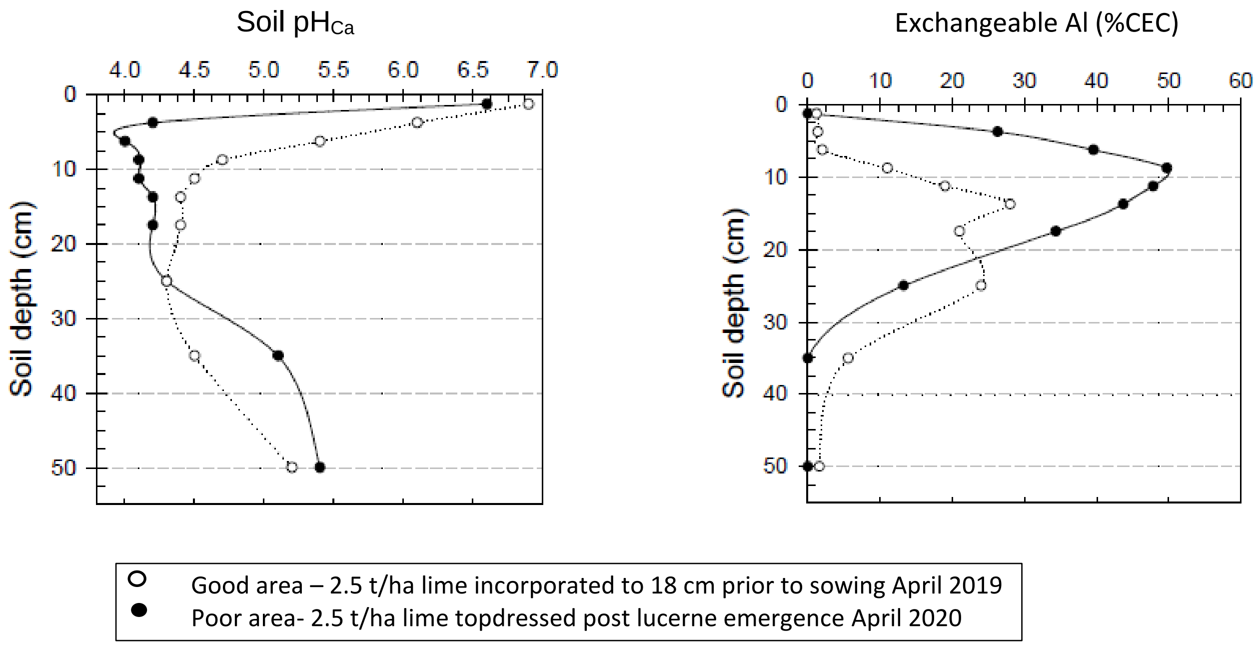

Figure 3. Laboratory test results for soil pH_{Ca} and exchangeable aluminium percent from samples collected from the good area (2.5 t/ha lime incorporated prior to sowing) compared with the poor area (2.5 t/ha lime topdressed in April 2020).

Subsurface acidity and poor drainage will limit stand life

Incorporation of 2.5 t/ha of lime has given Mr M^{c}Rae a vigorous lucerne stand in a soil that would otherwise be unsuitable for lucerne production. Soil pH_{Ca} of the 0-10 cm layer has been increased and Al% reduced to a level that has enabled lucerne to establish satisfactorily. However, the severely acidic layers below 10 cm, with associated high Exch. Al%, poor internal drainage and risk of manganese toxicity has restricted rooting depth and will ultimately limit the life of the stand (Fig. 4).

Mr M^{c}Rae said that although lime has increased pH of the surface soil, he expects that the lucerne stand will start to thin over the next three to four years, when he will probably drill either chicory or grazing wheat into the lucerne before spraying it out and going back into a cropping phase and then resowing to lucerne.

Mr M^{c}Rae said that if he had his time over again, he would increase the rate of lime he incorporated in 2019.

“Using off-set discs to incorporate the lime into the soil was the right decision, but I should have used a higher rate of lime to increase pH further down the profile,” he said.

Figure 4. A soil pit straddling the good and poor areas provided a clear view of the impact on rooting depth caused by unfavourable soil conditions in the subsurface layers (manganese nodules and poor drainage). There was limited root development below 12 cm in the good area (left) and below 5 cm in the poor area (right).

Managing soil acidity requires a long-term approach. The most effective and fastest method to increase pH in the subsurface layers is effective incorporation of adequate rates of fine-grade lime.

At a long-term research site near Wagga, on a soil type like that at Spring Valley, soil pH in the 10-20 cm layer was gradually increased when pH_{Ca} of the 0-10 cm layer was maintained above 5.5. This was achieved by:

- incorporating an initial 'capital' lime rate of 3.7 t/ha to a depth of 10 cm; and
- following up with regular 'maintenance' lime applications of between 1.6 and 1.7 t/ha every 6 years (Conyers and Li 2006).

Spring Valley is part of long-term soil monitoring program

Monitoring change in soil pH in the two areas of the Spring Valley lucerne paddock over the next few years will help resolve the current debate around topdressing versus incorporating lime and help guide producers' management decisions.

These geo-located sites are among about 60 in commercial paddocks of the Central and Southern Slopes of NSW that are part of a soil monitoring project initiated by Holbrook Landcare Network, Grassland Society of NSW and NSW DPI under the Australian Government National Landcare Program.

Paddocks have been selected that represent different mixed farming management systems across soil types that are typical of the regions.

Comprehensive soil data collected in 2019 and 2020 will be monitored over time to check the impact of the different management systems on key soil properties, i.e. pH, organic carbon, cation exchange capacity, phosphorus and exchangeable aluminium percent.

For more information contact Nick McGrath, Holbrook Landcare Network on 02 6036 3181

Further reading

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