Spalding lime trial – early results

Andrew Harding[1], Brian Hughes[1], Nigel Fleming[1], Bonnie Armour[1], Dr Nigel Wilhelm[1], Hugh Drum[1], Dr Sean Mason[2], Ruby Hume[3]

[1]PIRSA-SARDI; [2]APAL; [3]University of Adelaide

Key findings

- Lime significantly improved soil pH 19 months after application.
- Lime is more effective if it is incorporated rather than broadcast on the surface.
- It is important to sample soils at 0 – 5 and 5 – 10 cm as sampling 0 – 10 can mask results at 5 – 10 cm.
- Maintain soil pH above pH 5.5. If the pH falls below that level, aluminium levels start to increase and can become toxic, some nutrients like molybdenum also become less available and *Rhizobia* populations (important for nodulation of legumes) sharply decline.
- As the soil pH starts to fall below pH 5.5 ($CaCl_2$) biomass production can decline. When soil pH falls to pH 4.3 ($CaCl_2$) this can result in a 50% biomass loss of vetch.

Why do the trial?

Soil acidity is an increasing and significant issue. It is estimated that more than 2.4 million hectares are currently prone to soil acidity in SA, and that this is likely to increase to about 4 million hectares by 2050. Increasing soil acidity is a natural process but is accelerated with the use of high amount of ammonium-based nitrogen fertilisers, with higher yielding crops and more intensive cropping systems. Yields of crops and pastures start to fall when the soil pH falls below a pH 5.5 ($CaCl_2$).

How was it done?

In May 2020, as part of a GRDC project 'New knowledge and practices to address top-soil and sub-surface acidity under minimum tillage cropping systems of SA' a lime trial (one of 11 sites in SA) was established at Spalding to compare and evaluate lime sources, to assess broadcasting versus incorporation and investigate the effectiveness of compost and lime.

The lime sources included Clare Quarry and Angaston Penlime®. Lime was either applied to the surface or incorporated with a rotary hoe at a normal rate of 3 – 4 t/ha and a higher rate of 6 – 8 t/ha. The compost (cow manure) was sourced from Princess Royal Station feed lot and applied at 5 t/ha. The lime and compost were applied by hand on May 11, 2020.

A control and tillage treatment was included as a benchmark while a sulphur treatment (elemental sulphur broadcast onto the surface at 1 t/ha and incorporated) was added to determine the effects of increased acidification. The treatments were replicated four times and plots were sown with a small plot seeder. The site was identified as having a low soil pH from soil pH mapping. The soil is a light sandy clay loam over a medium clay (red-brown earth). The surface (0 – 10 cm) pH was 4.4 ($CaCl_2$) and the extractable aluminium (0 – 10 cm) was 4.7 mg/kg.

The trial was sown to Spartacus CL barley in 2020. During the year, incorporated lime with or without compost the crop appeared more vigorous. However, by harvest there were no differences in grain yield between treatments. The trial was badly frosted in October 2020.

In 2021, the trial site was sown by the landowner with Timok vetch at 50 kg/ha and with 60 kg/ha DAP on May 22. The seed was inoculated.

Greenseeker NDVI, biomass cuts and plant tissue sampling of the vetch was undertaken on August 24, 2021. Extensive soil sampling for soil pH and nutrients was carried out on all plots at depths of 0 – 5, 5 – 10 and 0 – 10 cm on December 6. Soil samples (0 – 1 cm) were also tested for *Rhizobia* populations.

Results and discussion

Biomass

Visual differences were present in the vetch in August 2021. The sulphur, control and tillage treatment were generally light green to yellow and approximately half the height of the lime treatments (Figure 1). Greenseeker NDVI and biomass cuts showed that the lime incorporated treatments had nearly twice the amount of dry matter (t/ha) compared to the control.

Soil test results

There has been a significant change in soil pH over the last 19 months (Figure 2). Soil pH in the 0 – 10 cm layer was at or above a target level of pH 5.5 ($CaCl_2$) for all lime treatments however, sampling the 0 – 5 and 5 – 10 cm layers separately showed that broadcasting lime only slightly increased pH in the 5 – 10 cm layer. Broadcasting lime has resulted in the 0 – 5 cm layer having a pH 1.8 units higher than the 5 – 10 cm layer. This shows the importance of sampling 0 – 5 and 5 – 10 cm layers separately.

The increase in soil pH due to liming has decreased toxic levels of soil aluminium and manganese. The increase in soil pH has also resulted in higher exchangeable calcium and lower exchangeable cations of magnesium, potassium, sodium and hydrogen. Adding sulphur decreased soil pH and increased toxic levels of extractable aluminium and manganese compared to the control. Adding compost had no effect on soil pH.

Figure 1. L-R: Penrice lime (6 t/ha) incorporated; control; Clare Quarry (8.4 t/ha) + compost incorporated; sulphur incorporated; Clare Quarry (4.2 t/ha) incorporated.

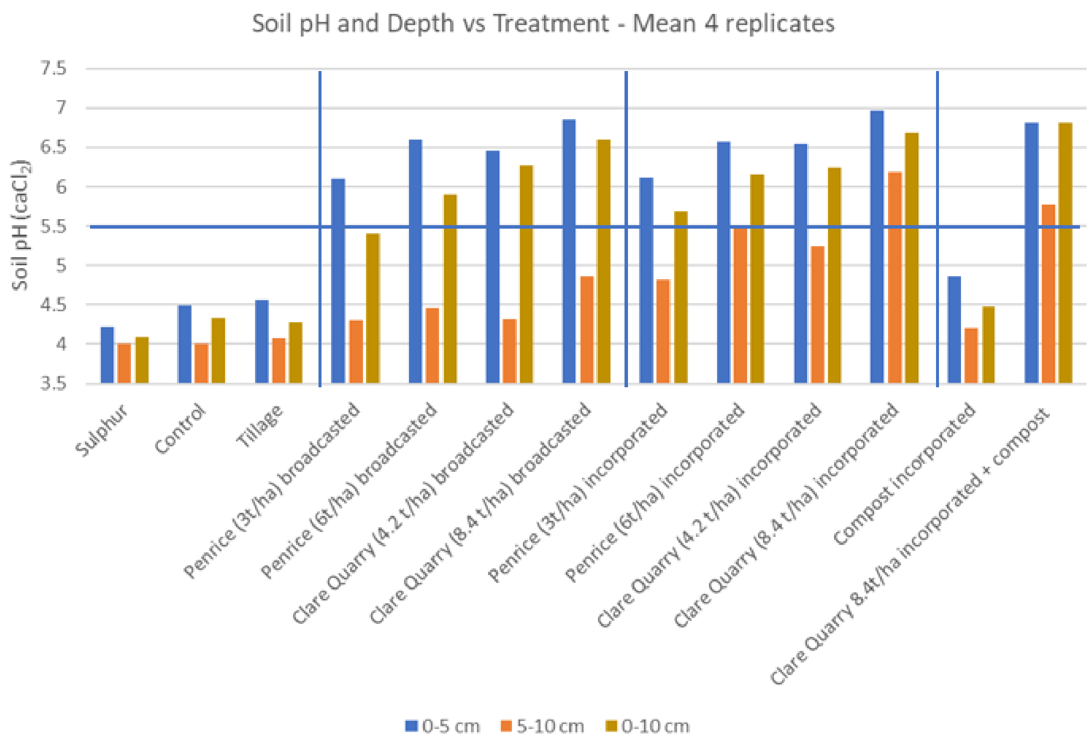

Figure 2. Effect of sampling depth and lime strategies on soil pH at Spalding 19 months after application. The horizontal blue bar is the target soil pH to avoid acidity issues.

Tissue test results

Tissue tests taken in August 2021 showed that the control and tillage treatments had high levels of aluminium and manganese with marginal levels of calcium, nitrogen, copper, boron and very low levels for molybdenum.

Molybdenum is important for nitrogen fixation and internal utilisation of nitrate. Symptoms of insufficient molybdenum in legumes include a general stunting and yellowing, as a result of insufficient nitrogen supply and green and small root nodules (Norton, 2015).

Adding lime particularly when incorporated, increased plant uptake of calcium, molybdenum and nitrogen.

Rhizobia

Rhizobia (root nodule bacteria) are responsible for nodulation and nitrogen fixation in legumes. When soil pH was below pH 5.3 ($CaCl_2$) *Rhizobia* levels in the soil were almost zero (Figure 3). As pH increased, so did *Rhizobia* levels. With improved *Rhizobia* populations and molybdenum status, the number and size of plant nodules increased which in turn, increased nitrogen nutrition.

Soil pH and biomass

The trial results showed that when the soil pH starts to fall there can be an increasing biomass loss. When the soil pH falls to 4.3 ($CaCl_2$) this can result in a 50% biomass loss of vetch (Figure 4).

Liming is important to improve and maintain soil pH. The trial has shown that lime is more effective when incorporated to at least 10 cm rather than leaving it on the surface after broadcasting. It is anticipated that this trial will continue for another two years.

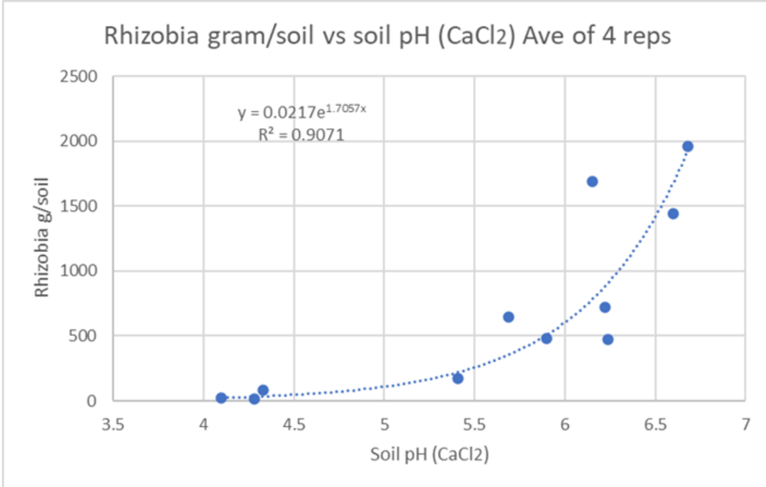

Figure 3. Soil pH ($CaCl_2$) and estimated E/F Rhizobia (per gram soil) (Compost treatments not included).

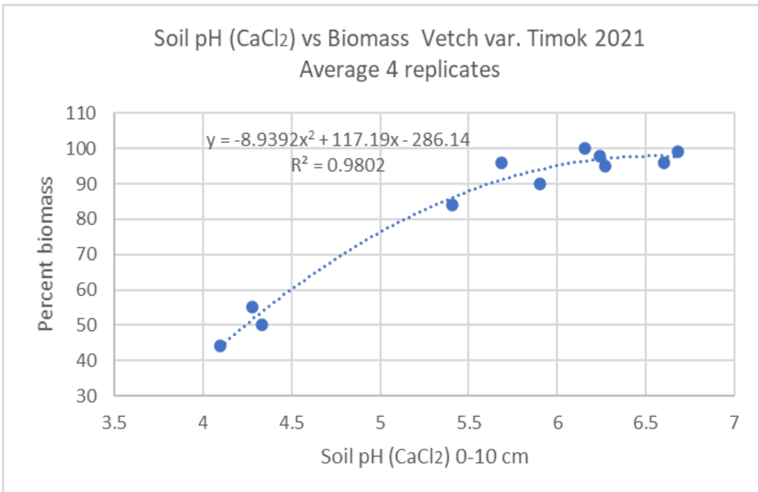

Figure 4. Soil pH (CaCl2) and percent biomass (Compost treatments not included).

References

Norton R. (2015) Molybdenum and its role in crops and pastures. *SANTFA The Cutting Edge Winter 2015.*

Acknowledgments

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