Improving the tolerance of lucerne to soil acidity

Background

Lucerne is a valuable forage plant in many farming systems because of its ability to provide high quality out of season summer feed for hay conservation or grazing livestock. Its even growth pattern provides a good contrast to annual pasture legumes and Mediterranean grasses, which provide most of their growth in late winter and spring, and this improves the flexibility and risk management of whole farm feed budgeting.

Lucerne grows well at pH_{Ca} of 5.0 - 8.5. Its ability to grow at lower pH levels is limited, in part due to the reduced survival of its symbiotic rhizobia (root nodule forming, nitrogen-fixing bacteria). Researchers at SARDI in collaboration with the Future Farm Industries CRC have been working on developing a rhizobium strain which is able to nodulate with lucerne at lower pH.

Our results are showing that the current commercial strain of rhizobia can have poor survival and performance in soils with a pH_{Ca} of less than 4.8. We started looking for new strains of rhizobia by isolating them from lucerne plants growing in very acidic soils in southern NSW. In total, over 250 rhizobia strains have been evaluated under controlled conditions in the glasshouse. The best strains were then entered into 15 field trials in SA, Vic and NSW.

As part of this work, field trials were established in 2009 at various sites across Australia, including on Kangaroo Island. Trials in South Australia were sown at Barnawartha, and Kersbrook, McLaren Flat, Mount Gambier and Kangaroo Island and Boorhaman in Vic. The purpose of these trials was to validate the field performance of rhizobia strains that had improved performance in acidic conditions in glasshouse trials.

Results in Kingscote

(Greg Johnsson's property near Cygnet River KI)

At the Kingscote trial the level of nodulation among entries in the second year of the trial was 87-89%, which is quite high for an acidic sandy soil with pH_{Ca}4.6. The high sowing rate (15 kg/ha) may have attributed to this.

The commercial strain (RRI128) performed well in this trial, with 89% nodulation and 9 nodules per plant. However, two of the experimental strains provided substantial increases in shoot dry weight compared with the commercial strain (SRDI736 and SRDI291). These strains may be forming a more effective symbiosis with the host lucerne plant (refer to Table 1).

Persistence amongst all entries was very high, with only a few plants in each treatment not surviving into the second year.

We expect that wild animals moved rhizobia between treatments, as there was 29% nodulation in the un-inoculated treatment which measured at close to 0% in the first spring. Unfortunately this will limit the ability of the trial to supply future results.

How does this compare to the national trials?

The national field trials are now providing us with some very good results, showing us the limitations of the new strains and the relative improvement in some of our experimental strains (Figure 1). One of the strains that performed well at Kingscote, Strain SRDI736, has the highest ranking across all sites and is being considered as a potential commercial replacement for the current strain, RRI128.

TABLE 1:
Nodulation of SARDI ten lucerne variety on acidic sandy soil (pH_{Ca}4.6) in August 2010 (11 months after sowing) at Cygnet River, Kingscote SA.

Strain	Percentage of nodulation	Number of nodules per plant	Root weight of plant (g)	Shoot weight of plant (g)
No rhizobia	29	2.4	306	258
RRI128	89	9.1	411	411
RRI128 + lime	89	6.4	565	497
SRDI291	87	13.0	658	617
SRDI736	89	9.6	596	619
SRDI672	87	6.6	426	365
Poorest strain	70	4.4	360	296
5% lsd	21	3.9	195	199
F prob	0.001	0.001	(ns) 0.076	0.001

The autumn assessment of 2010 trials provided the first evidence of differentiation between the performance of the strains at field sites with soil pH_{Ca} between 4.2 and 4.7 (Figure 1).

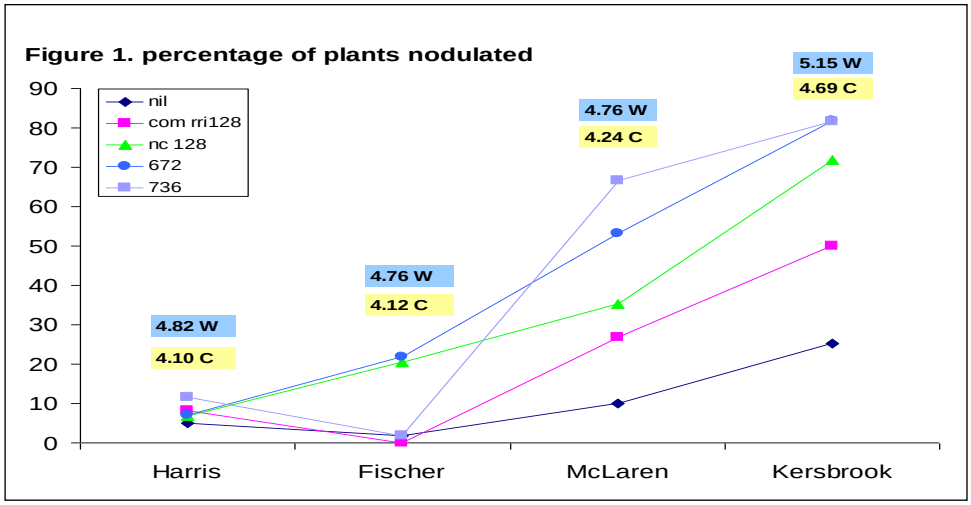
SRDI672 and SRDI736 nodulated 53-67% of plants at McLaren Vale, (pH_{Ca}4.24) in comparison to the two commercial entries that nodulated between 28 and 35%.

At Kersbrook, (pH_{Ca} 4.7) the experimental strains nodulated 80% of plants in comparison to 50-70% from the commercial entries (the commercial entries differ in their preparation). There were also increases in the number of nodules on the plants (data not shown).

Can I grow lucerne on Kangaroo Island?

Lucerne is a very good option to extend the growing season of pastures for parts of Kangaroo Island that have reasonable drainage and do not have aluminium toxicity. Results from this study and local experience suggests that lucerne can grown on acidic sandy soils with pHCa >4.5 with good success.

On heavier textured soil types (such as clay or loam soils) aluminium toxicity can be an issue, but unfortunately a single rule can not be applied across all soils so if in doubt consult with a person with expertise in soils or start by sowing a small area.
A broad recommendation for lucerne is that it is safe to sow above pH_{Ca}4.8, where aluminium is below 5mg/kg or 10% of the Cation Exchange Capacity (CEC).



Take home messages

- The research aims to find rhizobia that will support lucerne growth on acidic soils
- Good levels of nodulation found on acidic sand at Kingscote, despite soil acidity, pHCa 4.6
- Lucerne is highly recommended for KI soils that do not receive lengthy periods of water logging or have high levels of aluminum
- Purchase freshly coated seed as background levels of lucerne rhizobia are low.

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