# Acid tolerant Lucerne Rhizobia: nodulating better at low pH

## Background

Lucerne is a summer active perennial pasture legume, capable of responding to summer rainfall. Lucerne grows well at $pH_{Ca}$ of 5.5-8.5. 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 have been working on developing a rhizobium strain which is able to nodulate with lucerne at lower pH. A lucerne line was also developed with improved nodulation.

As part of this work, funded by the Future Farm Industries CRC, field trials were established in 2009 at various sites across Australia, including on Kangaroo Island. Trials were sown in Newdegate, WA, Barnawartha and Boorhaman in Vic, and Kersbrook, McLaren Flat, Mount Gambier and KI in SA. The purpose of these trials was to validate the results achieved in glasshouse trials.

Aluminium toxicity is another issue which arises in low pH soils. The toxic form of aluminium becomes more available at pH below 5, and this inhibits root growth. SARDI has sown a second site near Vivonne Bay to evaluate its new lucerne lines developed with improved root growth in high aluminium conditions.

Lucerne has many benefits as a pasture in high rainfall areas, including its ability to reduce recharge due to its deep taproot, therefore reducing likelihood of dryland salinity. It is capable of producing feed all year round, but especially during the summer-autumn feed gap, reducing the need for supplementary feeding.

## What was done

*Acid tolerant Lucerne rhizobia*

A field row trial was handsown on Greg Johnsson's farm near Kingscote, on sandy loam over clay, $pH_{Ca}$ 4.6. Entries in the trial included the current commercial inoculant, RRI 128, as well as 10 experimental strains, a limed commercial entry, and nil treatments, using SARDI Ten Lucerne and an improved nodulation line. Working with rhizobia means that we have to be careful to avoid cross-contamination between plots. Walking over the trial is kept to a minimum so as not to spread rhizobia around, and when sampling plots to check for nodulation we must sterilize equipment between each treatment.

*Drought tolerant trial*

Also sown at the Kingscote site is a drought tolerant trial investigating some alternative species such as native legume Cullen, and several accessions of Tedera (leguminous *Bituminaria*).

IMAGE 1
**Tedera (*Bituminaria bituminosa*)**

*Aluminium tolerant lucerne*

Several lines which have been promising in hydroponic glasshouse aluminium screens have been sown in a trial at Rick Morris's near Vivonne Bay. The site is sand over gravel at 10cm, with a $pH_{Ca}$ of 4.3 and high aluminium (18.44% of CEC or 0.85 meq/100g). A small trial was also included to look at the performance of recently developed *Lotus corniculatus* cultivars. Lotus is a perennial pasture legume tolerant of acid soils and waterlogging.

*Sulla*
The biennial legume Sulla was sown in test plots at both Kingscote and Vivonne Bay sites. Establishment was poor due to failure of the commercial inoculum to nodulate the sulla seedlings.

IMAGE 2
**Lucerne rows in the Kingscote nodulation trial. The front right treatment is a no rhizobium treatment and is showing symptoms of nitrogen deficiency. The plot immediately behind is experimental strain 686 and is a darker green colour showing successful nodulation and hence nitrogen fixation.**

## Initial Results

From the *Acid tolerant Lucerne rhizobia*
The first measurements were taken five weeks after sowing. Plant counts were done to assess establishment of each row of plants, and 20 plants from each plot were sampled and taken back to SARDI's labs at Waite for analysis of nodulation. Further nodulation counts will be done in 2010 as well as yield measurements and plant counts to monitor the effectiveness of the strains.

Initial data shows that the limed control performed best for nodule number and yield. This control had the commercial inoculum plus 5 t/ha lime at sowing, and has a pH of $5.9_{Ca}$ compared to 4.5 over the rest of the trial site.

Although these first results show that RRI 128, the current commercial inoculum, has had the highest nodulation in the year of sowing, it can be expected that the survival of this strain in the low pH soil will reduce over time. This is where the more tolerant strains will provide a real benefit, allowing Lucerne to re-nodulate each year for the life of the stand. Results will be collected over the next couple of years to evaluate this survival over time.

The results from the Kingscote trial, as well as from the other trials around Australia, have allowed researchers to cut the number of potential strains down by eliminating those with poor field performance. For example, strains 643 and 684 (shown in figure 2 to have only similar vigour to the uninoculated 'nil' treatment) have already been culled from the program.

Figure 1 shows that some of the new strain treatments have improved seedling vigour over the nil treatment and the current inoculum. The highest vigour score was achieved by the treatment with 5 t/ha lime, as could be expected

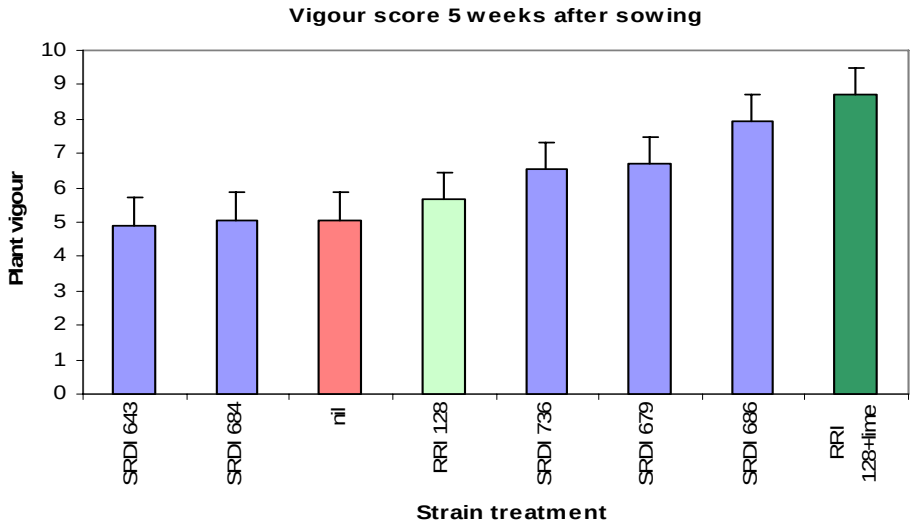


FIGURE 1
**Plant vigour scores of SARDI Ten, 5 weeks after sowing. The red 'nil' bar had no rhizobium inoculum applied, while the light green 'RRI 128' bar shows the current commercial inoculum. The treatment which had lime applied had the highest vigour, shown by the dark green bar. All other treatments are SARDI experimental strains. Error bars show the lsd for the data.**

SARDI uses results from field trials all over Australia to develop Lucerne varieties that are well adapted to Australia's conditions. Plants from farmers' paddocks where trials are conducted are often dug up and used for breeding if they display significant persistence, resistance to pests or diseases, or other beneficial qualities. Having trials on KI will mean that new varieties in future may have a component of their genetics proven to be successful under KI's conditions.

**Funding / Sponsors**
- CRC Future Farm Industries

**Take home messages**

The advantages of lucerne are
- Responds to summer rainfall
- Deep taproot system to use water and reduce dryland salinity
- Less nitrogen fertilisers due to nodulation with rhizobia.

**For further information contact**
- Alan Humphries, SARDI, Waite on 8303 9651 or email alan.humphries@sa.gov.au
- Erica Marshall, SARDI, Waite on 8303 9604 or email Erica.marshall@sa.gov.au