Match-making is the key for legumes

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ABOVE: Melilotus siculus *shows promise on salt-affected soils, but is having nodulation problems. The plot in foreground is not nodulated and growth is poor. (Photo: R Ballard)*

Developing new legumes and improving the performance of traditional legumes for better production and improved sustainability of farming systems requires a two-pronged approach – studying the plant itself and just as importantly, selecting the appropriate rhizobia (root nodule bacteria). The trick is the rhizobia must be compatible with the legume and adapted to the soils in which it is likely to be grown.

FFI CRC researchers, along with partners from the Centre for Rhizobium Studies (CRS) and the National Rhizobium Program (NRP) are making positive progress. But the task is challenging to say the least. Researchers are casting the net wide, investing in both native and exotic legumes and all agree that finding the right rhizobia is fundamental to success.

Completing the puzzle

South Australian Research and Development Institute (SARDI) rhizobiology expert and NRP participant, Ross Ballard, said achieving a complementary mix of plant and Rhizobium was a "key part of the legume research puzzle."

key points

- The search is on across Australia and beyond for new legumes which can adapt to challenging environments
- Success relies upon finding a complementary mix of plant species and rhizobia
- The discovery of new exotic perennials can also bring about the additional challenge of searching for suitable rhizobia.

Ross and his colleague Nigel Charman are working to identify better Rhizobium for two legumes of major interest to the FFI CRC – lucerne and *Melilotus siculus*.

In the quest to improve lucerne performance on acidic soils, researchers are looking for rhizobia with improved acidity tolerance. These rhizobia will be used with more acid-tolerant lucernes being developed in breeding programs in South Australia and New South Wales.

To date, 200 strains of rhizobia have been gathered from highly acidic soils across NSW for further study.

"We will be looking at their ability to survive and form nodules in very acidic conditions, initially in the greenhouse in hydroponic solutions," Ross said. "Hopefully from this work we can select a strain that will help lucerne establish more reliably and be more productive in the field.

"We already know we have some better strains and are confident of pushing the boundaries even further with the recently collected material."

At the same time Ross's group is building on earlier efforts of the CRS in Western Australia and has been selecting lucerne lines that form more nodules under acidity stress.

"With this research we hope to develop further, even more acid-tolerant lucerne breeding lines – lines that can be referred to as 'super nodulators'," Ross said.

The second legume of interest to the group is *Melilotus siculus* – a legume totally new to Australian agriculture. It is an annual species that has the advantage of being able to grow well in salty and waterlogged environments, where most other legumes fail.

A successful legume pasture can dramatically increase the profitability of farming in salt-affected areas and *Melilotus siculus* could be just what is needed. The problem is that the regenerating pastures of this promising plant are failing to nodulate. Enter the rhizobiologists again.

To face the challenge, a large collection of rhizobia are being screened.

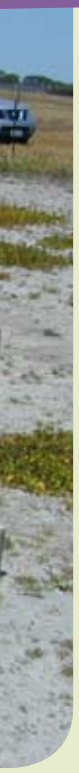
"We are especially interested in how the rhizobia for this plant over-summer in salty soils," Ross said. "We hope to find some that are up to the task, so they can promptly nodulate the new pasture shortly after the break of the season."

Ross is also hopeful these new rhizobia strains will improve the nodulation of burr medic, a species better known by farmers and sometimes grown on salt-affected soils.

This work is in collaboration with Andrew Craig and Amanda Bonython in SA, and Phillip Nichols in WA will be largely based on field studies at salt-affected locations. The researchers are also keen to see if the performance of their best rhizobia can be even further boosted if perennial plants such as chicory and puccinellia are grown in a mixture with the *Melilotus*.

The idea is that the perennial plants will provide the rhizobia with some protection during the harsh summer months. Field trials, using mixtures similar to those farmers might use, were important to determine the effect other plants may have on the rhizobia.

"We are really pushing the boundaries where these plants and rhizobia can be productive," Ross said. "In these situations, having the right rhizobia will be absolutely critical to the ongoing development of these new legume species."



Legumes from our own backyard

Research is also underway to uncover important native legume species.

As part of the *Using native perennial species in agriculture* project researchers have identified four particularly promising native species — *Cullen*, *Lotus*, *Swainsona* and *Glycine*. These species have demonstrated a tolerance for the medium rainfall areas of southern Australia (see *Focus on Perennials* Issue 2).

NRP participant Dr Matt Denton and his team at the Department of Primary Industries, Victoria have identified root nodule bacteria for a range of these legumes.

"Thousands of root nodule bacteria were isolated from 166 soils from WA, SA and Victoria," Dr Denton said. "Their effectiveness was measured on a range of host plants, including *Cullen australasicum* and *Lotus australis*."

To determine the compatibility between the plant and the rhizobia, plants were inoculated with individual rhizobia under controlled conditions in the absence of mineral nitrogen. Their shoot and root biomass were also assessed. Effective strains of *Lotus*, *Cullen*, *Swainsona* and *Glycine* were then isolated and used in field trials in WA, Victoria and SA. Dr Denton said the trials were performing exceptionally well so far.

"Identifying appropriate rhizobia and understanding their use in the context of an agricultural pasture system is likely to be one of the key factors in helping the successful establishment and persistence of native legume species.

"This project has an important role in assisting the development of new pasture species that are well-adapted to Australian conditions."

ABOVE: Professors John Howieson and Ben-Erik Van Wyk (University of Johannesburg) collecting herbaceous perennial legums in the arid Western Cape region of South Africa. (Photo: Ron Yates)

Searching further afield

Another exciting rhizobium challenge has emerged for CRS researchers at Perth's Murdoch University with the discovery of unidentified and yet unstudied rhizobia.

The discovery was made during an international hunt for legumes that drew CRS deputy director, NRP participant and passionate plant researcher, Professor John Howieson, deep into South Africa's remote western cape farming areas.

Uncovered amongst the virgin paddocks was an array of legumes with the potential to value-add to Australia's arid, acidic, low-rainfall farming land. And the hardy legumes were accompanied by a swag of previously undocumented rhizobia.

The foreign rhizobia create an unprecedented challenge for John and his fellow researchers. A challenge that promises to make for intriguing research but will add years of work to the domestication of these promising legumes.

The undiscovered status of the rhizobia means many factors must be assessed before the plant can be domesticated.

"It means the research will be an even longer process than with other newly developed plants but it is more likely that other exciting discoveries will be made in the process," Professor Howieson said. "Each plant's rhizobia must be assessed for its acid tolerance. Even if the plant can survive the arid conditions of WA wheatbelt soils, and the bug cannot, then perenniality or regeneration of the plant cannot occur.

"This was called second-year mortality when it happened in the 1960s with sub-clover."

Currently five CRS science students are exploring the properties of new rhizobia sourced from South Africa. New rhizobia so far discovered include those for the promising perennial legumes *Lotononis angolensis* and *Rhynchosia ferulifolia*.

"These Rhizobium species have not yet been given a scientific name but the naming process has started and provides the students in the CRS with a strong incentive to be involved," Professor Howieson said.

This type of research has been undertaken by the CRS for more than a decade and is quite time-consuming due to the international protocols that must be observed.

"It was only a few years ago that we finalised the scientific name for the rhizobium that nodulates *Biserrula*, even though we started working with those strains in 1993.

John's research is funded by the Australian Centre for International Agricultural Research (ACIAR) and Murdoch University.

LEFT: Lucerne roots are examined for signs of nodulation after growing for two weeks in low pH hydroponic solutions. (Photo: R Ballard)

More information

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