Dryland Legume Pasture Systems: Improving nitrogen fixation

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RESEARCH

Location
Minnipa Agricultural Centre, paddock S8
Rainfall
Av. Annual: 325 mm
Av. GSR: 241 mm
2018 Total: 269 mm
2018 GSR: 208 mm
Paddock History
2017: Scepter wheat
2016: Medic pasture
2015: Mace wheat
Soil Type
Red sandy loam
Soil Test
$pH_{(H20)}$ (0-10 cm) 8.4
Plot Size
5 m x 1.5 m x 4 reps

Key messages

- **This trial aims to investigate opportunities for symbiotic improvement.**
- **Inoculation will be critical to the establishment of new legume species, where they have not previously been grown. The extent to which inoculation can still improve medic nodulation is being investigated.**
- **There was no response to medic inoculation in the 2018 trial, even when the inoculation rate was doubled.**
- **Trigonella was better nodulated and produced greater root weights than the medics.**
- **These results cannot be fully interpreted until the N-fixation data becomes available.**
- **Medic breeding lines with improved N-fixation capacity are being developed as part of the Dryland Legume Pasture Systems project and will be tested in 2019.**

Why do the trial?

Legume pastures have been pivotal to sustainable agricultural development in southern Australia. They provide highly nutritious feed for livestock, act as a disease break for many cereal root pathogens, and improve soil fertility through nitrogen (N) fixation. Despite these benefits, pasture renovation rates remain low and there are opportunities to improve the pasture base on many low to medium rainfall mixed farms across southern Australia. There are also reports of poor protein levels in wheat following medic pastures and many reports of poor medic nodulation. Previous work has shown that substantial responses to inoculation are possible in the Victorian Mallee, which is possibly linked to the poor N fixation capacity of some populations of soil rhizobia. The extent to which inoculation can still improve medic nodulation on Eyre Peninsula requires clarification.

The Dryland Legume Pasture Systems (DLPS) project aims to develop recently discovered pasture legumes together with innovative management techniques that benefit animal and crop production and promote their adoption on mixed farms in the low and medium rainfall areas of WA, SA, Vic and southern NSW. One objective within this work program is to increase the amount of fixed N provided by the pasture.

This is a component of a new five year Rural Research and Development for Profit funded project supported by GRDC, MLA and AWI; and involving Murdoch University, CSIRO, SARDI, Department of Primary Industries and Regional Development; Charles Sturt University and grower groups.

How was it done?

The trial at Minnipa in paddock S8 was arranged in a fully randomized block design, with four replications. A similar trial has also been established at Lameroo, SA.

The experiment comprised three inoculation treatments (no rhizobia applied or, standard and high rates of inoculation) and four legumes. The legume species were Herald strand medic, representing an ‘old’ medic; PM250 strand medic, representing a ‘new’ medic; Z2447 medic, a medic with putative improvements in N-fixation capacity; and trigonella, a new legume that is also nodulated by medic rhizobia. The high rate of inoculation was applied as a double rate of recommended label rates of peat inoculant on seed and supplemented with inoculated glass micro-beads also inoculated at double rate and sown at 10 kg/ha with the seed.

Prior to sowing, plots were sampled at 0-10 cm to provide basic soil chemistry and a soil disease profile. The trial site was sprayed prior to sowing with 1.5 L/ha Weedmaster (glyphosate) + 80 ml/ha Nail and 300 ml/100 LI 700 to eradicate any naturalised medic plants already present.

The trial was sown on 27 June under relatively dry conditions, having received only 22 mm of rain in the three weeks prior to seeding.

Trial plots were measured to assess ground cover (using a Green Seeker) on 21 September 2018. As no plots had achieved 100% coverage, these readings were very low. On 24 September twenty plants per plot plus two canola plants, were removed and sent away for assessment of nodulation and determination of shoot and root dry weight. These samples will also be tested for N-fixation using the ^{15}N natural abundance method.

What happened?

In the 2018 season, the 'Improving N Fixation' trial was more negatively affected by the dry and windy weather than the 'Legume Adaptation' trial (EPFS Summary 2018), despite the two trials being in adjacent locations and sown on the same day (27 June). Plant emergence counts were completed on 9 August 2018. Some of the newly emerged seedlings had been buried by soil blown across the plots, with the trigonella particularly affected, resulting in a lower plant density (Table 1). Subsequent rainfall (89 mm in August) boosted the growth and vigor of all plants in the trial.

There was no response to inoculation (Figure 1), even where the inoculation rate on seed was doubled and additional inoculant was provided on glass beads. In total, this provided more than forty times the industry standard of 1000 rhizobia per seed.

Table 1 Legume, inoculation rate, number of rhizobia added and plant density in the N-fixation trial at Minnipa in 2018

Legume	Inoculation rate	Rhizobia (no./seed)	Plant density (plants/m²)
Trigonella balansae	No rhizobia	0	37
Trigonella medium	Standard	11,000	49
Trigonella high	High*	22,000	47
Z2447 nil	No rhizobia	0	66
Z2447 medium	Standard	15,500	83
Z2447 high	High	33,500	75
PM250 nil	Nil	0	90
PM250 medium	Standard	12,200	103
PM250 high	High	29,000	79
Herald nil	Nil	0	75
Herald medium	Standard	16,750	80
Herald high	High	33,500	116

**High inoculation rate treatments also supplemented with glass beads inoculated with rhizobia.*

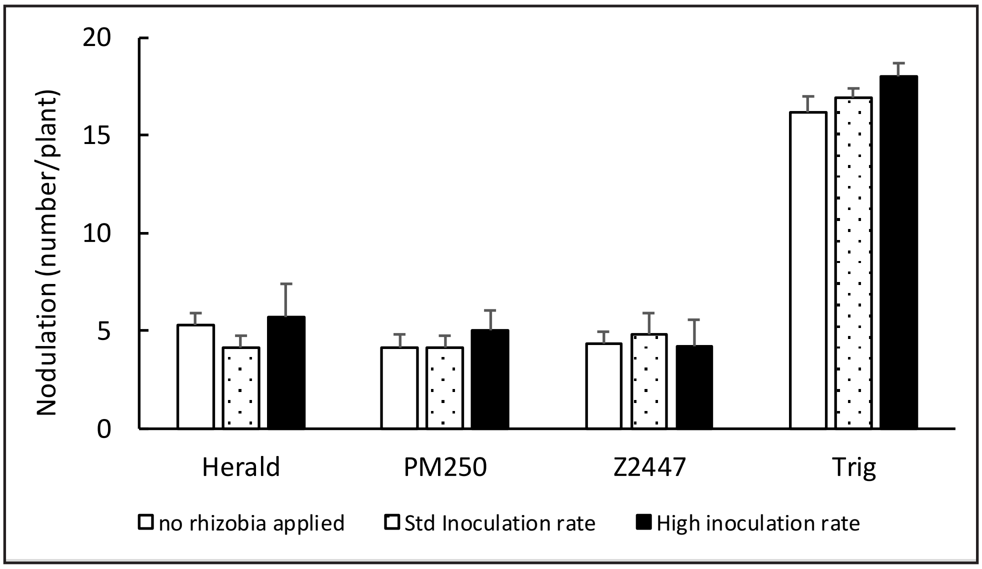

Figure 1 Effect of inoculation treatment on the number of nodules per plant at Minnipa. Bars above columns indicate standard error of the mean. LSD for comparison of all means is 2.6.

For nodulation, the three medics: Herald, PM250 and Z2447 were similar, having 4-5 nodules per plant. The trigonella had a greater number of nodules (≥16 per plant) when compared to the medics. This higher level of nodulation occurred even when reliant on the background rhizobia, i.e. in the nil rhizobia treatment.

The trigonella had 40% greater root weight than the three medic species. Shoot dry weight did not differ between the four legumes.

The results for percent N-fixation are not yet available.

What does this mean?

Plant samples are still being processed to determine N-fixation percentage. This measure is important for interpreting the differences observed in nodulation between the medics and trigonella. It is possible that fewer nodules are needed by the medics because they are more efficient at fixing N than trigonella. Alternatively, the low numbers of nodules on the medics might be limiting the amount of N they are able to fix. The N-fixation data will allow the calculation of fixed N/ha.

The medic line Z2447, previously selected for improved N fixation potential, performed below expectation. It was included in this trial due to seed availability. Other medic lines with improved N-fixation capacity have been developed and will be tested in 2019.

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