

Closing the Economic Yield Gap for Grain Legumes in Western Australia – assessing new acid tolerant rhizobia

Hosts: Mobrur - Excel Farms

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KEY MESSAGES:

- No negative impact of the use acid tolerant rhizobia on plant establishment.
- The use of acid tolerant rhizobia had a significant positive impact on faba bean biomass production - approximately 750 kg/ha increase as at mid-September.
- The use of acid tolerant rhizobia resulted in an increased nodulation at both assessment timings, however, was more apparent later in the growing season.

Background

Stirlings to Coast Farmers (SCF) consulted local growers and agronomists to determine the current pulse research requirements for our region. A plan was devised to expand the local agronomic knowledge of faba beans. Faba beans are the preferred pulse crop in the Frankland River/Tenterden region because they have the greatest waterlogging tolerance.

Many growers are replacing lupin hectares with faba beans because they are more profitable (where soil pH is above 5.2). A current limitation to growing faba beans is the detrimental impact of soil acidity on nodulation. Research shows that when commercial inoculants for faba beans are used, nodulation decreases rapidly below pH 6 to almost negligible at pH 4.

A rhizobium strain was developed by SARDI with increased tolerance to soil acidity and this strain is now commercially available. In 2023, SCF was fortunate enough to have access to this peat-based inoculant for the 2023 farm-scale legume trial. In discussion with Ron Yates (DPIRD), to best showcase the new strain, a demonstration site with a soil pH of approximately 4.8 was targeted and this was achieved in a paddock in Frankland River.

The trial compared a full rate of acid tolerant inoculant with a full and half rate of standard Group E/F inoculant.

Methodology

The farm-scale demonstration was sown on the 26 May 2023 into a paddock located in Frankland River, WA. The baseline pH of the topsoil was 4.8.

SCF worked with AAGI staff to design a simple but optimal layout for this farm-scale demonstration (Figure 1). Essentially the demonstration included two 'seeder-width' replicates of each of the following treatments:

- Faba beans sown at 120 kg/ha with acid tolerant inoculant (equiv. 1.25kg per 500kg seed)
- Faba beans sown at 120 kg/ha with full rate Group E/F inoculant (equiv. 1.25kg per 500kg seed)
- Faba beans sown at 120 kg/ha with half rate Group E/F inoculant (equiv. 0.625kg per 500kg seed)

The Grower (Excel Farms) was responsible for seeding, spraying and harvesting the crop. SCF was present at seeding to assist with inoculation and trial layout. SCF undertook all of the required field assessments. Unfortunately access to harvest data was not possible.

Prior to sowing, baseline soil samples were collected, and samples taken for Predicta rNod analysis (SARDI). In-season plant establishment counts, biomass and nodulation assessments were collected/measured from each plot.

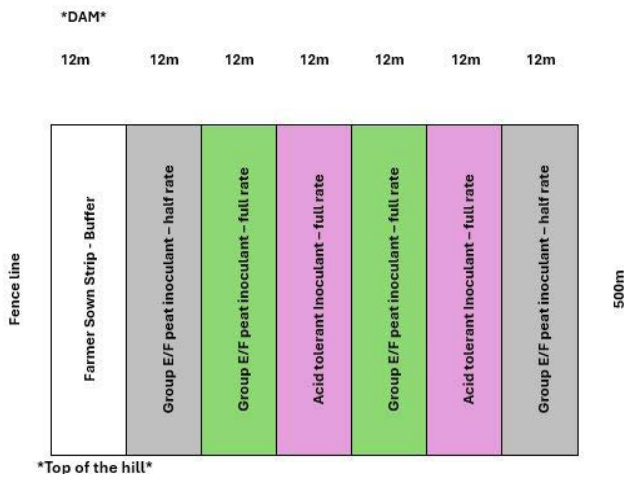


Figure 1. Demonstration Design – all treatments sown to faba beans at 120 kg/ha.

Results

Paddock history

The paddock had a long history of continuous crop production, with the previous seasons being in wheat in 2022 and canola in 2021. The paddock did not have a history of legume production, as a result the background rhizobium levels were predicted to be low.

Site characterisation

The trial site soil type was typified by loamy gravel over clay, with areas of sand and a greater surface gravel percentage on the rises, which fell away within the first third of the trial site, evenly across all treatment plots. The average growing season (April to October) rainfall for the site is 413mm (SILO).

Predicta rNod Testing

Predicta rNod testing was conducted prior to seeding to determine the background level of free-living rhizobia within the paddock. The results of the testing showed extremely low levels of existing rhizobia. This is unsurprising given the continuous cereal/canola rotation that had been in place on the trial site. This low level of background rhizobia allowed us to accurately measure the impact of the applied inoculant without risk of free-living rhizobia populating the roots.

Crop Establishment

Crop establishment counts were conducted on the 20 June 2023. The counts were conducted at approximately second node stage. The counts showed a slight trend towards a higher number of plants per m² in the plots treated with the acid tolerant rhizobia (Figure 2).

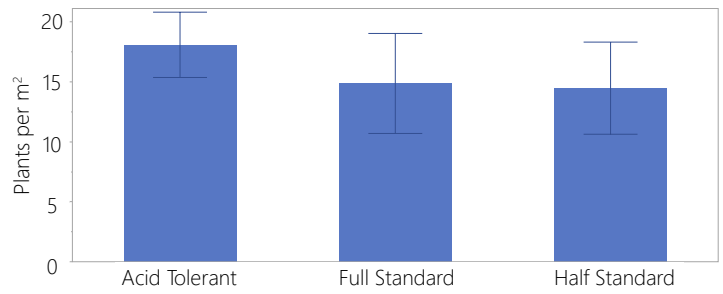


Figure 2. Average Crop Establishment for each Treatment, 2023.

Nodulation score

Nodulation was assessed twice during the growing season for each treatment. The early nodulation score was taken to measure if there was any difference in early infection resulting from the acid tolerant rhizobia strains. A second nodulation assessment was taken later in the season to measure the impact of each inoculant treatment on the plant's nodulation.

Nodulation Assessment 1

The first nodulation score was taken on the 20 June 2023. Figure 3 shows a slight difference in nodulation score between the full rate of the standard and acid tolerant inoculant, however, this was not significant (Figure 4). There was a full nodulation score difference between the half rate of standard inoculant (score 3.1) and the full rate of the acid tolerant inoculant (score 4.1).



Figure 3. Image of the faba bean roots from the acid tolerant inoculant treatment (left) and the full rate standard E/F Inoculant (right), 8 August 2023.

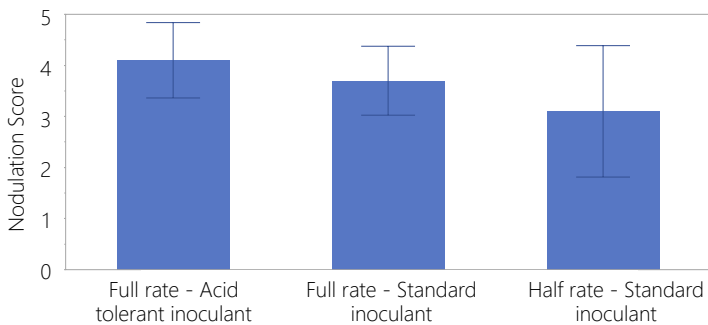


Figure 4. Average nodulation score (Ron Yates, DPIRD Scoring Method) for each treatment on the 20 June 2023.

Nodulation Assessment 2

The second nodulation assessment was completed on the 20 August 2023. At this timing the difference in nodulation could be clearly observed, with the acid tolerant inoculant resulting in an average nodulation score of 5.3 compared to 3.8 for the full rate of standard inoculant and 3.4 for the half rate (Figure 5). It should be noted that the paddock to this stage had suffered prolonged periods of water logging, and as a result the nodulation score across the whole site was lower than what would likely to be expected under ideal growing conditions.

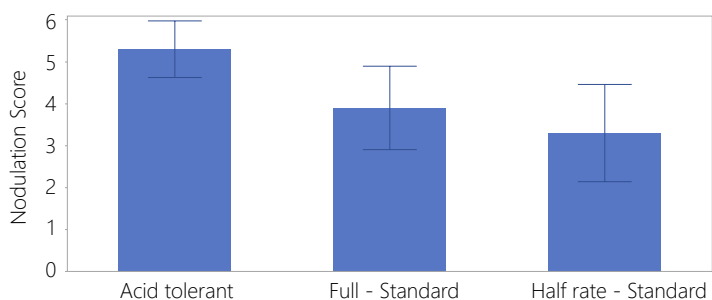


Figure 5. Average nodulation score (Ron Yates, DPIRD Scoring Method) for each treatment on the 20 August 2023.

Legume Biomass

Biomass cuts were taken on the 22 September 2023, during the early flowering period. There was a significant increase in legume biomass within the acid tolerant plots (Figure 6). This increase was driven by a combination of greater establishment and better in-season, and evenness of, plant growth. Both the full rate and the half rate of the standard inoculant resulted in a similar level of biomass production.

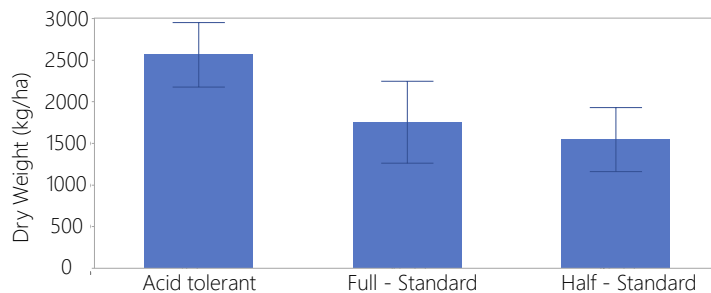


Figure 6. Average plant biomass for each treatment (cuts taken 22 September 2023).

Conclusions

The trial effectively demonstrated the benefit of the acid tolerant strain of rhizobia on acidic soil types. The faba beans that were grown using the acid tolerant inoculant had slightly better establishment, higher nodulation scores (particularly later in the growing season) and had higher biomass production. It was unfortunate that SCF was not allowed back to the property to access the yield data (due to change of management), however, we are confident the yield results would have been somewhat representative of the higher biomass that was present in the acid tolerant inoculant treatments. Overall, the trial gives local growers the confidence that the new acid tolerant inoculant (now commercially available) can improve crop growth and nodulation on acidic soils (pH 4.8) which will, hopefully, lead to greater uptake of legumes into local crop rotations.

Acknowledgements

Grateful acknowledgement is made to GRDC for investment in the project and to GGA for leading the project on behalf of WA grower groups.



Mark Seymour (DPIRD) showing Frankland River members the actively growing faba bean nodules at the trial site, September 2023.