INOCULATING FABA BEANS IN SUBOPTIMAL SOIL CONDITIONS

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TAKE HOME MESSAGES

- Inoculating faba beans before sowing improved nodulation on acid soil.
- New acid tolerant rhizobia (strain SRDI-969) increased nodulation, but not grain yield which was limited by low rainfall.
- The evaluation of strain SRDI-969 is still underway but is showing promise as a future replacement for the current commercially available strain (strain WSM-1455).

BACKGROUND

Increasing expansion of the Australian pulse industry means more pulses are being grown on challenging soils, including those in the north central region of Victoria. As a result, pulses are being grown on paddocks where suitable rhizobia may not be present in the soil. It is essential that pulses are grown in proximity to rhizobia to allow nodules to form and for the plant roots to fix nitrogen. Previous research has shown that current commercially available rhizobia strains may perform sub-optimally below a pH_{CaCl2} of 6 (Ballard *et al.* 2019) and new strains of rhizobia are being identified to combat soil acidity.

Rhizobia strain WSM-1455 is the commercially available Group F strain (recommended for faba beans) and is usually delivered in a peat slurry form. Rhizobia strains SRDI-969 and SRDI-970 were recently identified as potentially acid tolerant strains and are also delivered in a peat slurry form.

AIM

To compare the effect of rhizobia strains and application rate on the nodulation of faba beans and the subsequent impact on crop biomass, grain yield and grain quality in suboptimal (acidic and high salinity) soil conditions.

PADDOCK DETAILS

Location:	Pyramid Hill
Crop year rainfall (Nov-Oct):	273mm
GSR (Apr-Nov):	158mm
Soil type:	Clay
Paddock history:	2018 – Barley
	No known faba bean, lentil or field pea history

Table 1. Soil test results to depths of 0-10cm and 10-40cm.

Soil depth (cm)	pH (CaCl2)	EC (ds/m)	ECe (ds/m)	Soil Nitrogen (kg/ha)	Bean inoculating rhizobia status
0-10	5.1	0.54	4.6	111	Nil detected
10-40	7.7	0.76	6.5	23	

TRIAL DETAILS

Crop type/s:	PBA Samira faba bean
Treatments:	Nil; rhizobia strain WSM-1455 (commercially available peat slurry); rhizobia strain WSM-1455 (double rate); rhizobia strain SRDI-969; and rhizobia strain SRDI-970
Target plant density:	25 plants/m^2
Seeding equipment:	Knife points, press wheels, 30cm row spacing
Sowing date:	14 May 2019
Replicates:	Four
Harvest date:	13 November 2019
Trial average yield:	1.2t/ha

TRIAL INPUTS

Fertiliser:	Granulock® Supreme Z + Flutriafol (200mL/100kg) @ 60kg/ha

Weeds, insects and disease were managed as per best practice

METHOD

A replicated field trial was established at Pyramid Hill using a complete randomised block trial design. Tests showed an absence of bean nodulating rhizobia in the soil (Table 1). Assessments throughout the season included crop biomass at flowering, nodule counts at flowering, grain yield, grain protein and 100 grain weight.

Nodulation assessments were made at flowering and involved excavating the soil and counting the nodules on the various locations of the plant root (crown or elsewhere on root). Grain protein was assessed using a near infra-red machine (NIR).

RESULTS AND INTERPRETATION

Nodulation and crop biomass at flowering

Nodulation measured at flowering showed significant benefits of applying rhizobia compared to the nil treatment (Table 2). Rhizobia strain SRDI-969 produced more nodules than the other strains. Nodules were located around the crown area of the root, confirming nodulation was prompt and likely resulted from the inoculants applied. Rhizobia strain SRDI-969 was the only inoculant that achieved close to adequate nodulation (average of 42.3 nodules per plant). Fifty to 100 nodules per plant are recommended for adequate nodulation and less than 20 is deemed poor nodulation (Ryder and Denton 2017). Doubling the rate of commercially available inoculant (WSM-1455) did not increase nodulation compared to the standard rate in this trial, even though it has been shown to be a beneficial strategy elsewhere (Ballard *et al.* 2019).

The differences measured in nodulation did not translate into a significant increase in crop biomass, with growth likely limited by low GSR (158 mm and a lack of stored moisture.). Even so, most crop biomass (2.4t/ha) was produced by the treatments that produced the most nodules (SRDI-969 and double rate of rhizobia strain WSM-1455).

Table 2. Nodule number and crop biomass at flowering. Letters indicate significant difference.

Treatment	Nodule number (per plant)	Crop biomass (t/ha)
SRDI-969	42.3[a]	2.4
WSM-1455 x 2	19.2[b]	2.4
WSM-1455	17.6[b]	1.9
SRDI-970	11.2[bc]	2.2
Nil	6.7[c]	1.9
Sig. diff.	**<0.001**	**0.17**
LSD (P=0.05)	**10.9**	**NS**
CV%	**36.5**	**17.4**

Grain yield and grain quality

Grain yield, grain protein and grain weight values were highest where WSM-1455 was applied at double rate. Conversely, values were lowest for the nil treatment (Table 3).

Lack of statistical significance in the yield data was likely the result of low rainfall over the growing season and spatial variation across the trial site associated with the acidic soil (pH_{CaCl2} 5.1 in 0-10cm) as well as moderately high salinity levels (ECe of 4.6 in 0-10cm and 6.5 in 10-40cm).

Table 3. Yield and grain quality data.

Treatment	Grain yield (t/ha)	Grain protein (%)	100 Grain weight (g)
SRDI-969	1.18	13.5	556
WSM-1455 x 2	1.31	13.7	562
WSM-1455	1.25	13.5	553
SRDI-970	1.20	13.3	548
Nil	1.05	13.1	544
Sig. diff.	**0.201**	**0.348**	**0.82**
LSD (P=0.05)	**NS**	**NS**	**NS**
CV%	**12.3**	**3.5**	**3.5**

COMMERCIAL PRACTICE

Inoculation will be of benefit when a pulse that uses the same strain (Group F) has never been grown, was not recently grown or where soil conditions such as acidity have reduced persistence of the rhizobia. While inoculation improved nodulation, the level of nodulation failed to reach adequate levels (Table 2) and it is likely the plants fixed less nitrogen. This trial has highlighted that even with good inoculation practice, soil conditions can still inhibit nodulation of plant roots.

Soil acidity is a crucial factor inhibiting the nodulation of faba beans. The pH in this trial is regarded as only moderately acidic, but paddocks with a pH_{CaCl2} of less than 5 are not uncommon in north central Victoria. There is the option to apply inoculant to seed every year to improve nodulation, but a longerterm approach should be to consider liming acidic paddocks and increasing the overall pH_{CaCl2} to above 5.5. Furthermore, salinity also appears to be a limiting factor in this environment with salinity levels higher than the salt tolerance of faba beans (Hazelton and Murphy 2007). Further research is required to determine the suitability and performance of rhizobia strains in these conditions.

Sowing conditions can also affect nodulation. If sowing into a challenging soil, avoid dry sowing to reduce further stress on the rhizobia. When dry sowing cannot be avoided, consider increasing the rate of inoculum – this should be a fairly straightforward decision since seed should be treated less than 24 hours before sowing.

The trial did not look at the longevity of the rhizobia in soil. Previous research has found the strains WSM-1455, SRDI-969 and SRDI-970 are unlikely to survive to the next season where soil pH_{CaCl2} is less than 5 (Ballard *et al.* 2019).

Strain SRDI-969 looks to be a promising replacement for WSM-1455, based on results at multiple other locations, but at the time of writing it is still under evaluation and a release date has not been set. In the meantime, growers should consider increasing the standard rate of inoculum in paddocks where soil conditions may be limiting bean nodulation.

REFERENCES

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