Comparison of chickpea inoculant methods and the interaction with seed applied fungicide – Cunderdin 2021

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Key Messages

- Peat-based inoculant methods (slurry or granules) had more root nodules than those that were not peat-based
- Peat-based inoculant methods also had higher biomass until flowering
- Nodulation and biomass differences did not lead to yield differences, likely due to low Spring temperatures

Background

Chickpeas are a well suited break crop option for the Dalwallinu region. Good root nodulation from symbiosis of rhizobia and plant roots is required to get the most out of growing chickpeas. This improves crop growth and provides nitrogen benefits to following cereal crops. It is recommended that all chickpeas are inoculated prior to sowing to ensure good nodulation. Whilst reliance on background soil rhizobia from previous crops may be suitable for other legumes, such as lupins, this is not the case with chickpeas. Paddocks generally do not have enough of a history of chickpeas or adequate soil pH to ensure survival of rhizobia over the recommended 4-year break between chickpea crops.

Traditionally, grain legumes have been inoculated using a peat slurry product. Rhizobia are sensitive to both temperature and desiccation; therefore, peat needs to be stored in the fridge until it is ready to be used, and once inoculated seed should be sown within 6-24 hours to prevent drying out. Seed inoculated with peat slurry is best suited to sowing into moist conditions, as the rhizobia has no protection from drying out when sown into dry soil and rhizobia death can occur in high numbers quite quickly.

Recently, peat based granules such as Tagteam® have become available to inoculate pulses. These are a ‘wet granule’, which are used in a similar method to clay based granules, however they retain the high rhizobia number of peat slurry products and the need to be refrigerated prior to inoculation of seed. Clay based granules, such as ALOSCA®, can help overcome sowing in to dry/drying soil as the clay is better able to protect rhizobia from both drying out and heat. The clay may also provide more protection from potentially acidic conditions, such as exposure to fungicidal seed dressing or fertiliser. These granules require no special treatment (such as refrigeration) and can be mixed with seed into the cart, so they are easy to use, however they usually require higher application rates due to a lower number of rhizobia per gram of inoculant.

With some pulses, in situations where sowing conditions are not ideal, i.e. pH lower than 5.5 or marginal soil moisture, the recommended rate of peat slurry is doubled or a single rate of peat slurry is combined with ALOSCA® granules as an insurance policy. In these situations, it is known that some rhizobia death is likely to occur due to the imperfect soil conditions. Using either the double peat or combination of peat slurry and clay granules can ensure that there is still adequate surviving rhizobia numbers even after some death has occurred.

In addition to inoculation with rhizobia, it is recommended that all chickpea crops are treated with seed applied fungicide to manage seed borne Ascochyta risk, however it is also known that fungicide based seed dressings can impact on survival of rhizobia due to their acidic nature. It is recommended to sow as soon as possible after inoculation to minimise the time that rhiobia are exposed to the fungicide on seed. Another method that growers commonly use to avoid fungicide impacting on rhizobia survivial is to place clay based granules with fertiliser at seeding, therefore achieving separation of the fungicide and rhizobia.

Aim

We plan to demonstrate a range both peat and granular inoculant options for chickpeas, placement of these products with seed vs. with fertiliser, and the interactions of these products with seed applied fungicide.

Table 1: Trial Details

Location	Shorter Road, Cunderdin
Soil type	Brown-grey loam
Sowing date	4 May 2021
Sowing rate	CBA Captain, 103kg/ha
Fertiliser	Superphosphate 100kg/ha, (9.1P, 10.5S, 20.0Ca)
Herbicides, Insecticides & Fungicides	At seeding: 860 kg/ha terbuthylazine (875g/kg) + 100g/ha isoxaflutole (750g/L) + 0.83kg/ha propyzamide (900g/kg) + 400mL/ha chlorpyrifos (400g/L) & bifenthrin (20g/L) 8/6: 875mL/ha tebuconazole (400g/L) & azoxystrobin (20g/L) + 500mL/ha clethodim (360g/L) + 180g/ha butroxydim (250g/kg) + 1L/ha MSO (704g/L) 4/8: 300mL/ha alpha cypermethrin (100g/L) + 180g/ha butroxydim (250g/kg) + 1% MSO (704g/L)
Harvest Date	18 Nov 2021

Table 2: Trial treatments

Treatment	Inoculant method	Seed dressing
1	Nil rhizobia	None
2	Nil rhizobia	P-Pickel T
3	Peat slurry	None
4	Peat slurry	P-Pickel T
5	Double rate peat slurry	None
6	Double rate peat slurry	P-Pickel T
7	Peat slurry + ALOSCA® with seed	None
8	Peat slurry + ALOSCA® with seed	P-Pickel T
9	Peat slurry on seed + ALOSCA® with fertiliser	None
10	Peat slurry on seed + ALOSCA® with fertiliser	P-Pickel T
11	ALOSCA® with seed	None
12	ALOSCA® with seed	P-Pickel T
13	ALOSCA® with fertiliser	None
14	ALOSCA® with fertiliser	P-Pickel T
15	Tagteam® with seed	None
16	Tagteam® with seed	P-Pickel T

Seed dressing: 200mL/100kg seed of P-Pickel T (360 g/L thiram + 200g/L thiabendazole)

Table 3: Soil Composition

Depth (cm)	pH ($CaCl_2$)	Col P (mg/kg)	Col K (mg/kg)	S (mg/kg)	N (NO_3) (mg/kg)	N (NH_4) (mg/kg)	EC (ds/m)	OC (%)
0-10	5.6	55	191	7.5	25	4	0.120	1.24
10-20	5.2	20	90	5.0	10	2	0.054	0.74
20-30	5.8	7	87	4.2	6	1	0.097	0.51

Table 4: Rainfall (mm) from BOM Cunderdin Airfield station (10286)

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Apr-Oct	Annual
2021	1	29	80	19	56	32	102	45	29	39	0	0	322	432
Average	23	18	20	23	31	37	51	42	26	19	15	8	229	313

Results

This trial was sown into dry, hard soil. As such, seeding depth was difficult to control, with actual seed depth between 2-5cm. It received 27mm of rainfall in the two days after seeding. Despite not consistently achieving the target seeding depth of 5cm, plant establishment was acceptable, with an overall plant density of 38 plants/m^2, slightly below the target of 45 plants/m^2. Neither seed dressing nor inoculant treatment had any impact on plant density. Sowing occurred within 24 hours of inoculation and post-sowing rainfall provided excellent conditions for root nodulation to occur.

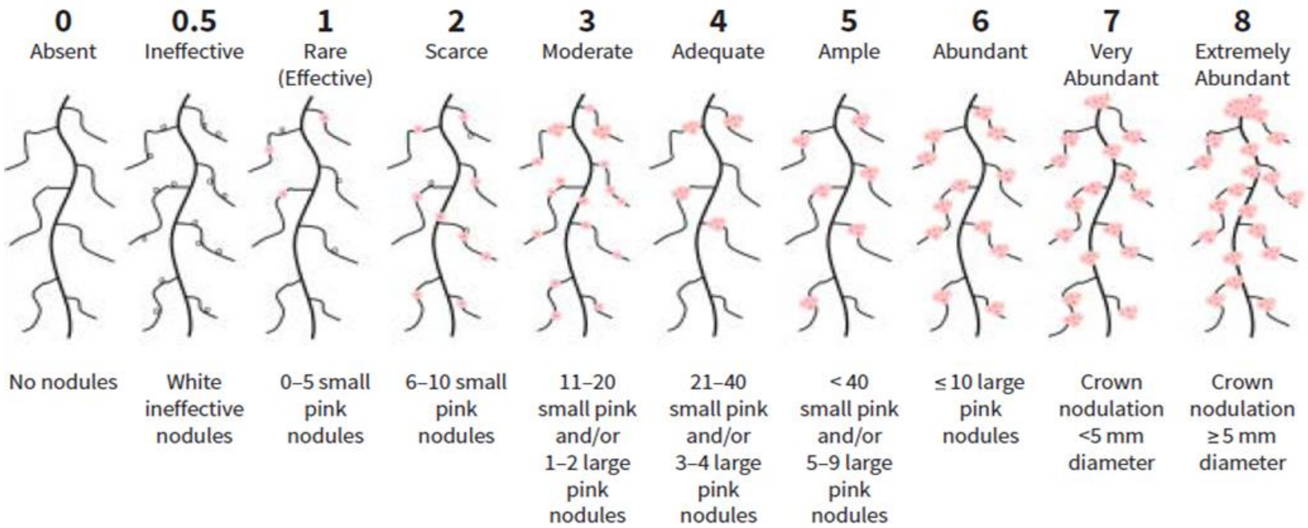

Figure One: Nodulation rating scale used to assess samples from this trial. Taken from Howieson, et al. (2016)

Figure Two: Roots collected from Cunderdin in 2021 that were rated at 0, 3, and 8 from left to right.

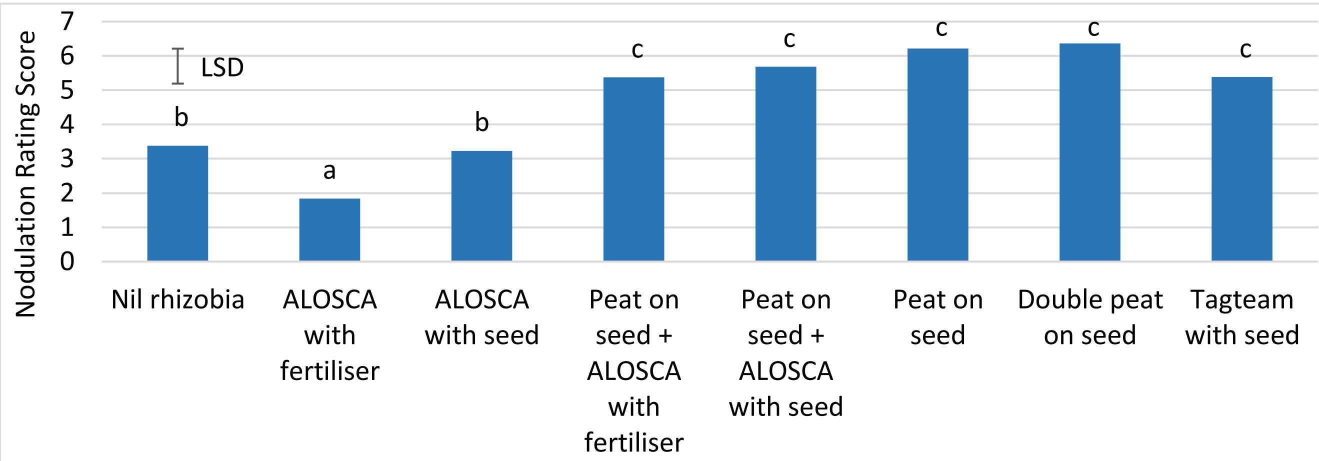

Figure Three: Average nodulation rating for each rhizobia treatment from samples taken 14 weeks after sowing at full flower (16 August, *p <0.001)*. Treatments that share a common letter are not significantly different.

At 14WAS there was a significant difference in the nodulation rating score when treatments were separated by the rhizobia they were inoculated with (Figure Three). The nil rhizobia treatment in this trial did have some effective nodules present on plant roots, despite the paddock having no history of growing chickpeas and cleaning machinery with ethanol between seeding each treatment. The ALOSCA® with fertiliser treatment had nodulated poorly with an average rating of 2, well below the adequate rating of 4. This is possibly due to the distance the roots needed to grow before they encountered the inoculant, with the fertiliser placed several centimetres below the seed. With all inoculant treatments, it is recommended that they be placed as close to the seed as possible. When ALOSCA® was placed with the seed, it was comparable with the nil treatment and had moderate nodulation.

All treatments that were peat based, whether they were applied as a slurry or granule, at single or double the recommended rate, or in combination with ALOSCA® granules, had significantly more nodules than treatments that did not have a peat-based product on them. Ratings for these plots were either ample or abundant nodulation. Plant biomass at 8WAS (data not shown) followed the same trend, with all treatments that had a peat-based product having more biomass than the ALOSCA® only treatments or nil plots. As the season carried on, the obvious visual differences in biomass became less apparent. By 14WAS only the double peat treatment stood out as having more plant matter than non-peat-based treatments and by harvest time there was no difference in biomass between any of the treatments.

Despite the increase in biomass early in the season, there was no extra benefit to nodulation when the double rate of peat slurry was used, nor was there an added benefit when peat slurry was combined with ALOSCA® granules. Whilst this trial was sown into dry soil, 10mm of rain fell within a few hours of seeding and another 17mm the following day. The soil pH was also within the acceptable range for chickpeas. Hence, the peat-based products, which would likely have suffered more rhizobial death if left sitting in dry soil or lower pH, were able to nodulate better and had more early plant growth than the ALOSCA® based treatments. As mentioned above, ALOSCA granules can perform very well when sowing in to dry or drying conditions and we may have seen different results if this trial was sown into dry soil.

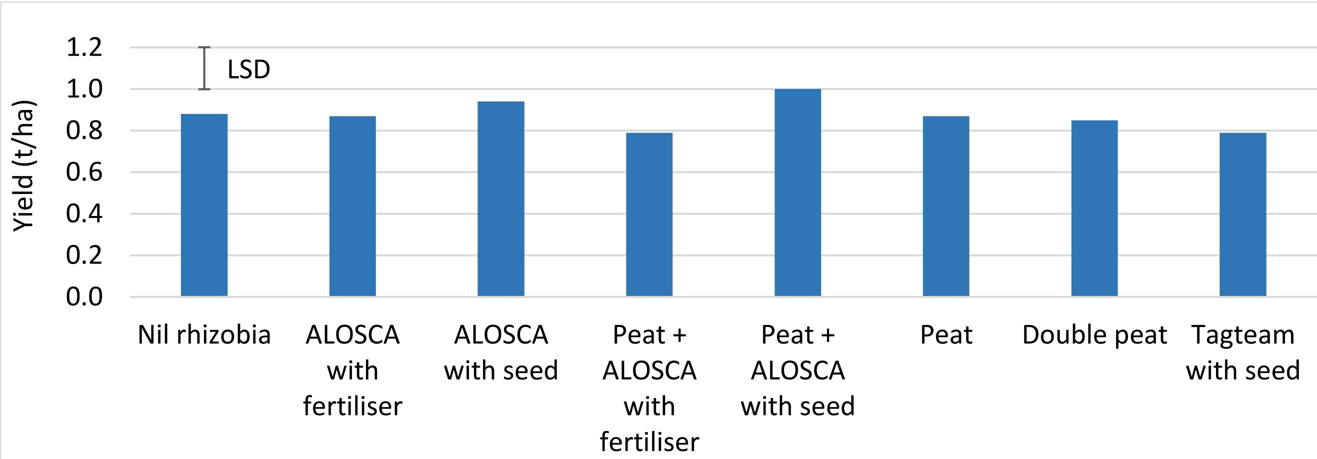

Figure Four: Seed yield at Cunderdin in 2021. Rhizobia *p = not significant*. Treatments that share a common letter are not significantly different.

Yields in this trial were quite low (Figure Four), with a site average of 0.9t/ha. Despite the differences in biomass earlier in the season and peat-based treatments achieving greater root nodulation, all treatments yielded the same. The site received good spring rainfall from August until October (Table 4), however throughout this period temperatures were quite low. Chickpeas need daily average temperatures above 15°C to reliably set and fill pods. From the time flowering began in early August until mid-October, temperatures were below this threshold nearly 80% of the time (Figure Five). This severely hampered the ability of the crop to put on grain yield despite good biomass accumulation of around 6t/h.

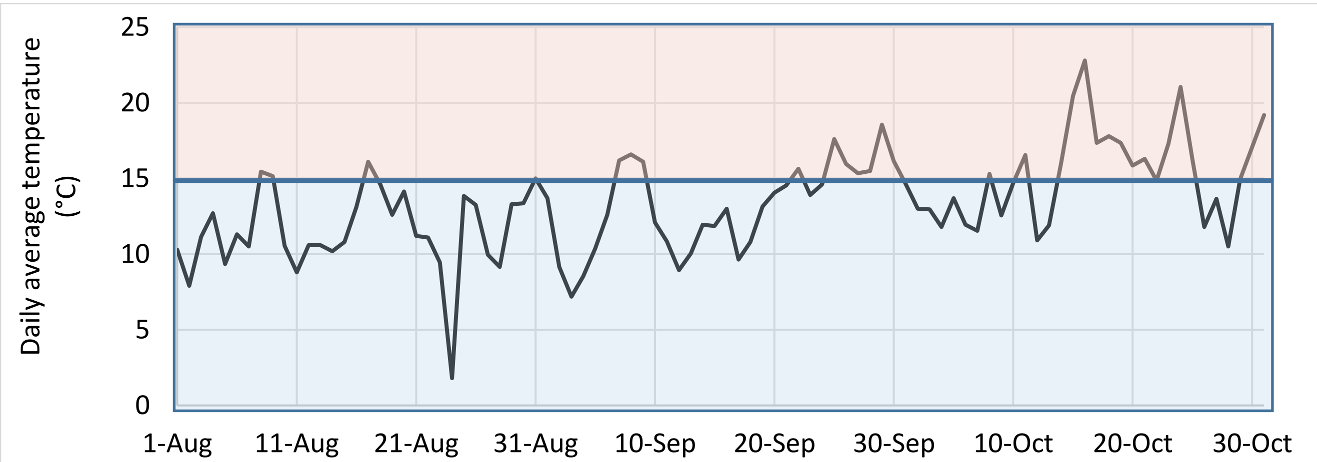

Figure Five: Average daily temperatures (°C) at Cunderdin in Spring 2021. Temperatures above 15°C are high enough for chickpeas to retain flowers and set pods.

Comments
Seed dressing did not have any impact on plant density or nodulation success in this trial. This is reassuring, given fungicidal seed dressing is recommended on all chickpea crops as a first line of defence against Ascochyta blight and other fungal diseases, such as pythium. Plots that were inoculated with a peat-based product had significantly more nodulation than those that did not have a peat-based product. Yields across the trial were lower than expected and all rhizobia and seed dressing treatments yielded the same despite differences in nodulation and biomass throughout the year, likely due to cool Spring temperatures.

While chickpeas can grow without adequate nodulation, they will fix less atmospheric nitrogen. This can cause yield loss in the year the pulse is grown, as well as deplete soil N reserves and minimise the N benefits to the following cereal crop. Many factors can impact on rhizobia survival and ability to form nodules. These can include storage conditions prior to seed application, such as not refreigerating peat inoculant, interaction with seed applied fungicide or fertiliser, low soil pH or moisture and crop stress soon after sowing such as waterlogging. It is important to handle and apply inoculants as per the manufacturers instructions to maximise crop nodulation and nitrogen fixation.

Using the scale in Figure One, it is easy for growers to assess nodualtion in their own pulse crops. The scale can be used for all pulses. Samples can be collected following the instructions in the GRDC video Legume Nodulation: sample preparation https://www.youtube.com/watch?v=0VL7ClY-K9w.

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References
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