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Assessing the impact of dry sowing on the nodulation and N_2 fixation in chickpea – Year 2

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Key messages

- Chickpeas inoculated with peat-based or bentonite clay granule inoculant and sown, either dry or into moisture, provided similar growth and production in a subsequent wheat crop.
- No significant differences in final grain yield of wheat was observed between inoculant types or sowing times.
- Some differences were observed in plant growth where the previous chickpea crop had been inoculated compared to uninoculated; however, inoculant type had no effect on wheat growth.
- Wheat grain quality was better when grown after an inoculated chickpea crop compared to an uninoculated crop and would contribute to a higher quality grade.

Aims

To investigate the residual effects of dry sowing and inoculation type on chickpeas to the growth of a subsequent wheat crop.

Background

A trial was established at the Merredin Dryland Research Institute in 2019 to determine if dry sowing chickpeas would have any effect on the nodulation, nitrogen fixation and production of the crop compared to sowing into moisture after the season break. The trial also investigated the performance of peat and bentonite clay granule inoculant to determine if either was more effective under either of these sowing conditions.

There was lack of observable results between inoculated plots either sown dry or into moisture and this may have been a product of seasonal conditions and the heavy soil type of the trial site. Dry sowing did not significantly impact on the nodulation and N_2 fixation of chickpeas nor did inoculation with peat versus bentonite clay granule products. However, sowing with a wheat crop in the subsequent year may provide an opportunity for the crop to utilize any residual effects of the chickpea inoculation treatments from the previous season.

To determine if there may be any residual effects from either the time of sowing or inoculant product used to the following crop, the original plots were over sown with wheat.

Method

Wheat (*Triticum aestivum*) was sown over trial plots from the chickpea dry sowing nodulation trial on 2 June 2020. The trial was sown into a moist seedbed in a heavy red clay soil type. No fertiliser (compound or nitrogen) was used at sowing or applied during the growing season to allow for residual treatment effects from the previous year to be as visible as possible.

Plant establishment was measured at GS21, anthesis cuts were taken to determine biomass at GS65, and harvest cuts were taken at GS92 to determine the harvest index of each plot. Plots were harvested using a trial plot harvester on 5 November 2020 with grain weighed for yield and later analysed using a near-infra red (NIR) grain analyser for moisture, protein and test weight (also referred to as hectolitre weight), 1000 seed weight counted, and screenings measured. When the crop had reached GS24 (4 tillers), plant samples were taken and sent to CSBP laboratories for total N content analysis.

All data collected from the trial was analysed using ANOVA on the programme Genstat 19th edition.

Results

Crop emergence was measured at GS12 (2 leaves fully emerged) by counting two 0.25m quadrats (two seeding rows) per plot. The number of plants at emergence was similar between the plots except with the Alosca wet sown treatment which has higher plant number ($p<0.050$) than the Alosca dry sown and the uninoculated wet sown treatment (Figure 1). The grand mean plant number at emergence was 140.5 plants/m^2 which is slightly under the optimum plant density (150-160 plants/m^2) for the area's annual rainfall, giving an approximate germination rate of 93% which, given the heavy soil type of the trial site, is satisfactory. The Alosca wet sown plots was the only treatment to achieve the optimum plant density.

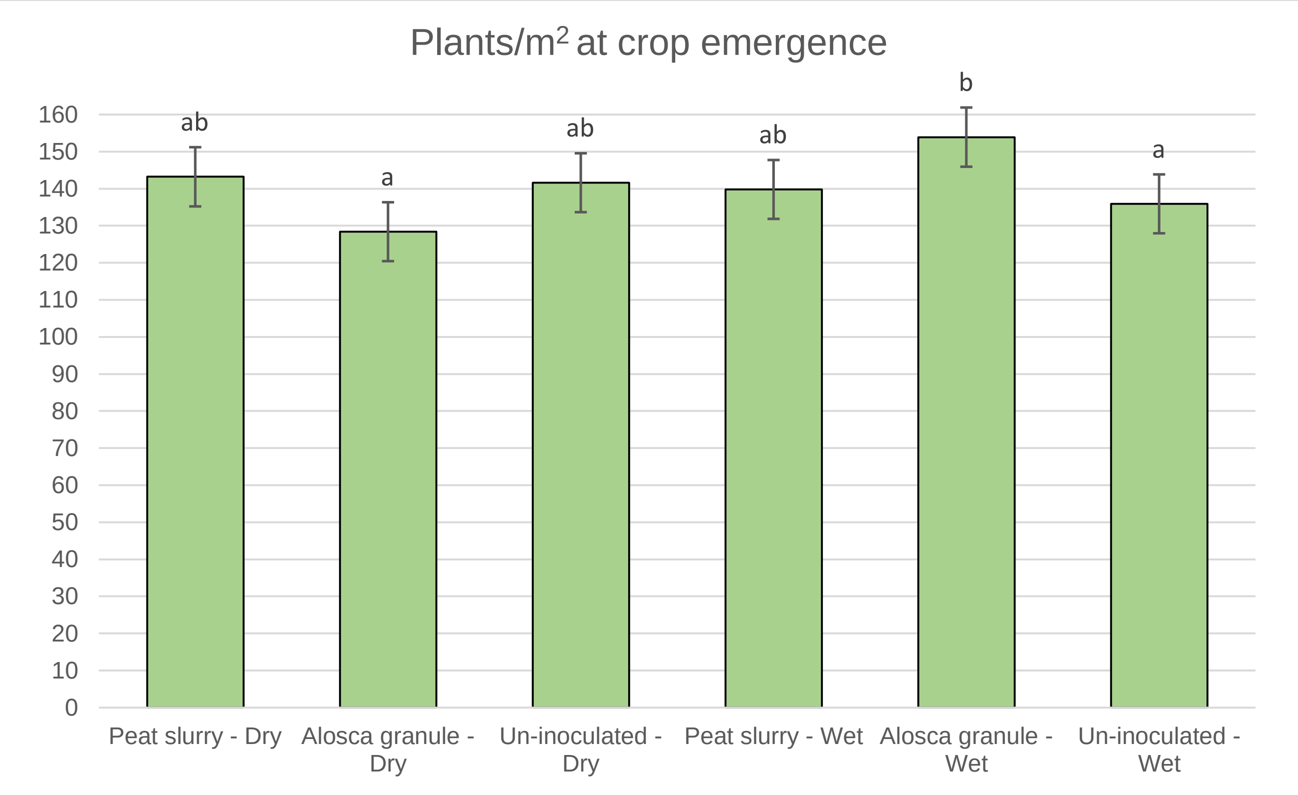

Figure 1. Mean plant number per m^2 at crop emergence. Columns with the same letter indicate statistically similar numbers ($P<0.05$).

There was no significant difference between any of the treatments for mean total nitrogen content in the plant tissue at GS24 (Table 1). It is recommended that at GS24 cereal crops have around 5.5% nitrogen content, with levels of 4.5% or less considered deficient and levels of 4% or less considered marginal once the crop reaches GS30. The plant tissue test results suggest that no inoculation treatment or sowing timing gave the recommended minimum nitrogen levels for the wheat crop at its relevant growth stage.

Table 1. Total nitrogen percentage of wheat plants sampled at GS24, analysed by CSBP Soil and Plant Laboratory using the Dumas high temperature combustion method (Leco analyser). Means followed by the same letter indicate statistically similar values (P<0.05).

Treatment No.	Treatment	Mean Total Nitrogen (%)	
1	Peat slurry Dry	3.785	a
2	Alosca granule Dry	3.467	a
3	Uninoculated Dry	3.45	a
4	Peat slurry Wet	3.635	a
5	Alosca granule Wet	3.485	a
6	Uninoculated Wet	3.56	a
LSD	0.3786		

Plant biomass was measured at G65 using two 0.25m^2 quadrats (two sowing rows) per plot, oven dried and the weighed. Despite the lower nitrogen content observed in the plant tissue testing, plant biomass seemed to be unaffected suggesting nutrient availability in the soil was adequate for growth even without any fertiliser at seeding or post emergence. At flowering (GS65), the average dry matter yield of wheat in the trial was 15.4 t/ha with no significant difference between any of the treatments (Figure 2).

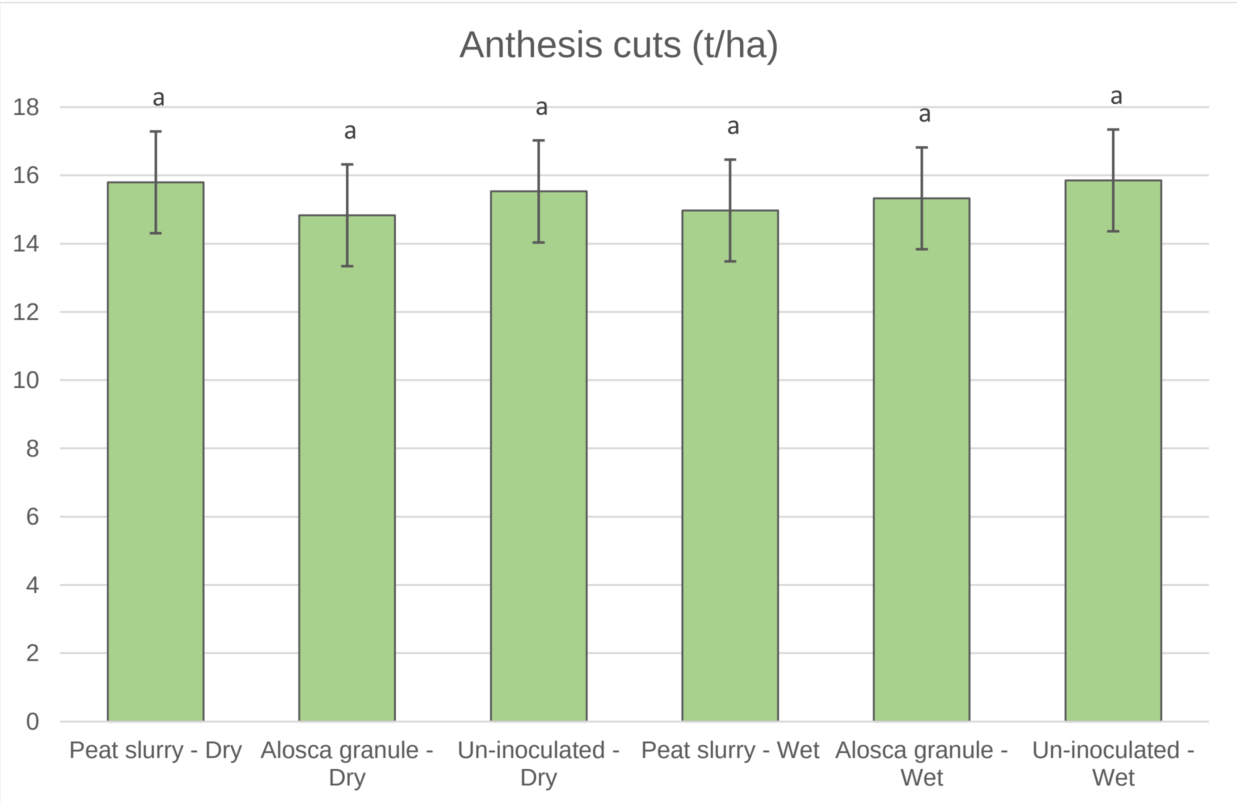

Figure 2. Mean dry plant biomass (t/ha) from anthesis cuts taken at flowering. Error bars represent LSD and columns with the same letter indicate statistically similar numbers (P<0.05).

With good decile 7 growing season rainfall and a heavy soil type, the plots in the trial yielded well above average for the area. All treatments yielded 4.42−4.69t/ha of grain which is well above average for the area and suggests extremely good water use efficiency (Figure 3). Plots sown in the dry sown treatments yielded 0.12−0.22 t/ha higher than the best wet sown treatment; however, the difference was not statistically significant. The grain yield of these treatments could suggest that the residual N level present in the soil was more than sufficient for wheat production under the seasonal conditions. Yield results also suggest that the below optimum nitrogen levels observed in the plant tissue tests earlier in the season had minimal, if any, impact on yield. It is assumed that there were sufficient levels of other key nutrients such as phosphorous which are required for cereal grain production.

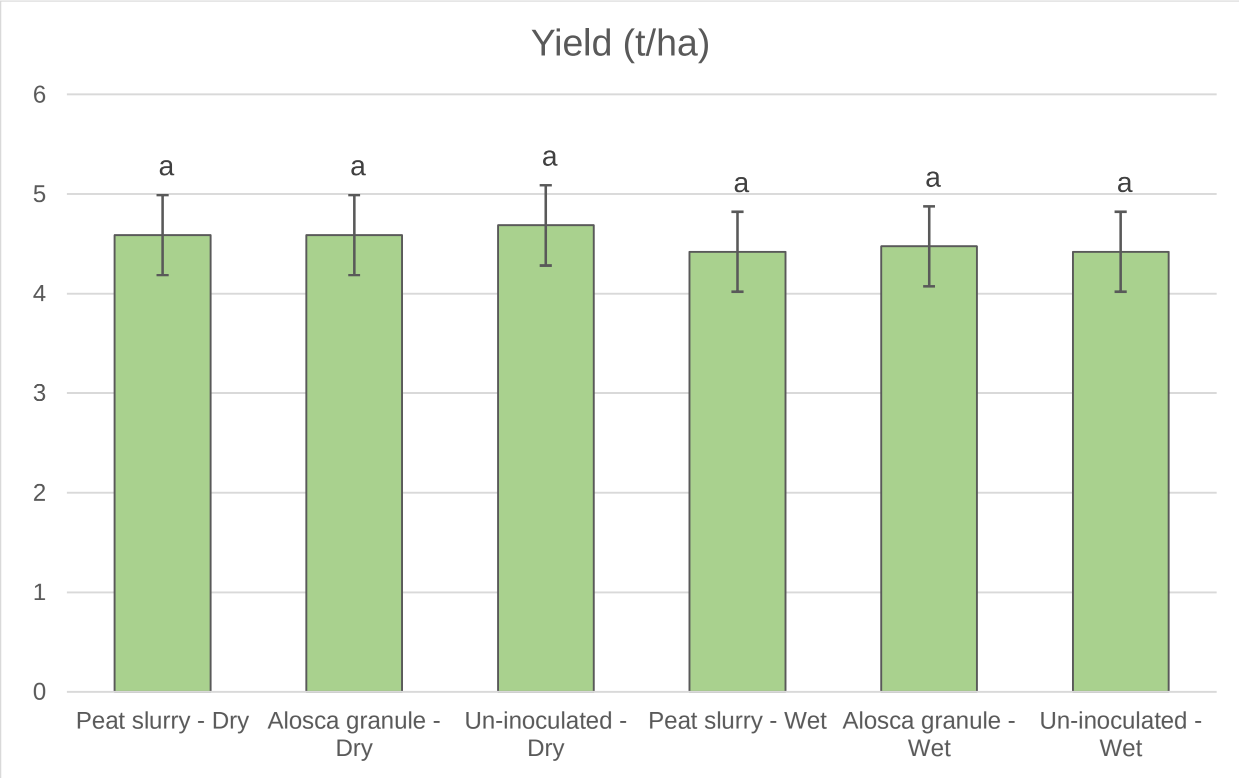

Figure 3. Mean wheat yield (t/ha). Error bars represent LSD and columns with the same letter indicate statistically similar numbers (P<0.05).

There was no significant difference in the harvest indexes between any of the inoculation treatments or sowing timing in the trial (Table 2). All treatments achieved a harvest index of at least 47% demonstrating good efficiency of all the treatments in converting biomass to grain.

Table 2. Harvest index (%) of wheat plots measured from cuts taken at harvest. Harvest index is a measure of the efficiency of a crop to produce grain compared to biomass. LSD (P<0.05).

Treatment No.	Treatment	Harvest Index (%)	
1	Peat slurry Dry	47.37	a

2	Alosca granule Dry	47.42	a
3	Uninoculated Dry	48.94	a
4	Peat slurry Wet	47.42	a
5	Alosca granule Wet	47.45	a
6	Uninoculated Wet	47.35	a
LSD	1.45		

There was no significant difference between inoculation treatments or sowing timing in grain quality analysis (Table 3); however, all treatments which included an inoculant (regardless of sowing timing) had protein levels above 11.5% which falls into the Hard 2 classification of the CBH receival standards. Treatments without inoculation did not reach this cut off and would fall into a lower grade of APWN (however this still achieves a premium price compared to feed wheat). This may suggest that nitrogen levels had begun to be depleted during the grain fill stage of the wheat crop where chickpeas were uninoculated, as would be expected.

Mean seed weight of the grain harvested from the uninoculated dry sown treatment was 38% more than the next highest weight, with all remaining treatments showing minimal difference, however this increase was not significantly different.

Table 3. Mean moisture and protein content (%), test weight (g), screenings (%) and 1000 seed weight (g/1000 seeds) of wheat plots. Moisture, protein and test weight was measured on a Foss Infratec grain analyser. LSD (P<0.05).

Treatment No.	Treatment	Moisture (%)	Protein (%)	Test weight (g)	Screenings (%)	1000 Seed Weight (g)
1	Peat slurry Dry	10.95	11.78	80.75	2.826	33.70
2	Alosca granule Dry	11.03	11.53	80.97	2.892	32.92
3	Uninoculated Dry	11.53	11.20	81.70	2.891	34.35
4	Peat slurry Wet	11.10	11.88	81.03	2.741	33.94
5	Alosca granule Wet	10.82	11.70	81.30	2.824	33.40
6	Uninoculated Wet	11.05	11.45	81.60	2.764	33.41
LSD		0.75	1.29	1.559	0.486	15.82

Conclusion

Both the inoculant formulation (peat based or bentonite clay granule) and sowing condition (dry or wet) of chickpeas showed no observable residual effects on the subsequent wheat crop. Some differences were visible in the growth of wheat grown where the previous year's chickpea crop was uninoculated compared to inoculated. However, this did not lead to any significant differences in final grain yield.

Nitrogen fixed by the previous crop seemingly provided sufficient nutrients to meet the requirements of the wheat crop grown in the following season. However, a lack of significant differences between wheat plants grown on inoculated and uninoculated chickpea plots suggests background nutrients may have been optimal. The mean grain yield from the trial plots was above average for the area in a year of average to above average growing season rainfall which further supports this idea.

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