Faba bean nodulation demonstration

Project delivered by

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Background

Modern agriculture utilises agrochemicals to improve plant production, with chemical pesticides used to treat a range of identified pest species. In recent times the impacts of these chemicals on the environment and soil health have been questioned. Only about 0.1% of the total applied pesticides reach the target site/ organism, while the remaining bulk contaminate the soil environment. Consequently, sizable amounts of pesticides reach soil directly and indirectly, which affects the composition of soil microflora (Nandanwar et. al. 2018).

Rotation of paddocks with legume crops is a well-established practice for improving soil fertility, by increasing soil nitrogen through nitrogen fixing Rhysobium bacteria. Legume crops grow nodules on their root system and it is within these nodules that a relationship develops with Rhysobium bacteria and allows the conversion of atmospheric nitrogen to ammonia and other sources that are available to plants.

The results of a recent study (Fox et.al. 2023) has demonstrated that one of the environmental impacts of pesticides and containments in the soil environment is the disruption of chemical signalling between host plants and nitrogen fixing Rhysobium bacteria, which is necessary for efficient symbiotic nitrogen fixation and optimal plant yield.

Project description

This project aimed to demonstrate if there were any differences in nitrogen fixation between faba bean seed treated and untreated with a fungicide coating, by assessing the number of nodulations per plant and if those nodulations were actively fixing nitrogen (pink/red in colour when cut).

Demonstration management

The paddock is located in Bengworden (Vic), with part of the area sown to Treatment A (fungicide applied to the seed) and part to Treatment B (no fungicide applied to the seed).

The crop was sown with an air seeder (Seedhawk 800C), but due to a malfunction at seeding, the crop had a lighter sowing rate than planned.

Pre sowing paddock treatments were applied in March 2023 and included 2 t/ha poultry manure and 0.6 t/ha gypsum.

Table 1: Details of treatments

Activity	Treatment A Fungicide applied	Treatment B No fungicide applied
Seed variety	Nura Faba Bean 80 kg/ha* Canola 44Y94 2.7 kg/ha	Bendoc CL 80 kg/ha* Canola 44Y94 2.7 kg/ha
Starter fertiliser	MAP 50 kg/ha SOA 50 kg/ha	MAP 50 kg/ha SOA 50 kg/ha
Seed treatment	Fungicide: Vibrance (pickled) Inoculant: Nodule N by New Edge Microbials	Fungicide: NIL Inoculant: Nodule N by New Edge Microbials
Sowing date	18/05/2023	18/05/2023
Post sowing paddock treatments	4/08/2023 Clethodium 500 ml/ha (ryegrass) Hasten 500 ml/ha	4/08/2023 Clethodium 500 ml/ha (ryegrass) Immense 750 ml/ha (broadleaf) Hasten 500 ml/ha

* Sowing rate was to be 175 kg/ha, but due to machinery malfunction was sown light

Due to the very poor seasonal conditions post sowing (no rain), this crop was considered a failure and no in crop spring fertiliser was applied. As expected, yields were very low with 1.2 t /ha harvested, whereas in comparison, an average season would have yielded been two to three times more. For this reason, yield data was not included in the project findings and discussions.

Project findings and discussions

The four step “nod check” developed by the Grains Research Development Corporation (Grow Notes 2017: Tips and Tactics Legumes & Nitrogen Fixation) was used to assess the legume nodulation of the demonstration.

Each treatment area was assessed across a transect line, with 20 sample areas selected, chosen at even interval across the length of the paddock. At each sample area, 5 faba bean plants were picked (using a shovel so to not damage root zone), with a total of 100 plant samples collected per treatment area collected.

Each plant (with roots intact) was washed in fresh water, then the number of nodules per plant was counted and recorded. In addition, 5 nodules per plant were cut open to determine if they were actively fixing nitrogen, recorded as either green/white (not active) or red/pink (active).

Please note, that these results are from an on-farm demonstration strip trial, they have not been fully replicated and randomised and therefore should be interpreted with care. The results cannot be

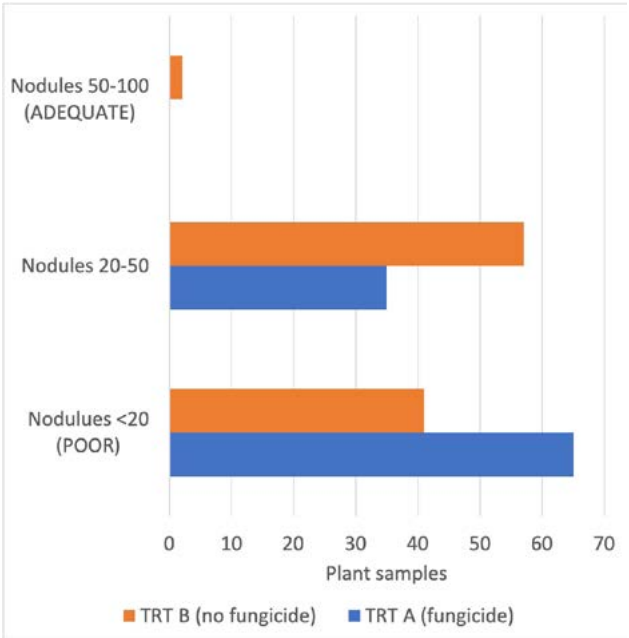
used to prove that a treatment caused the effect we observed, it may well have been caused by the treatment, but it may also have been a natural difference in soil, pests, disease, etc.

At each sample plot, the total number of nodules per plant were counted and averaged across the 5 plants samples taken, these averages were then averaged across all 20 sample plots. Treatment A (fungicide applied) had on average 17.95 nodules per plant and Treatment B (no fungicide applied) had on average 22.37 nodules per plant, a 24.6% difference.

The Grains Research Development Corporation (Grow Notes 2017: Tips and Tactics Legumes & Nitrogen Fixation) recommends that faba bean plants need between 50 to 100 nodules per plant to be deemed to have 'adequate' nodulation and that 70% or more of those nodules need to be active (pink/red in colour) to receive an 'adequate' rating for fixing nitrogen.

Graph 1 shows Treatment A (fungicide applied) has generally lower nodules per plant compared to Treatment B (no fungicide applied).

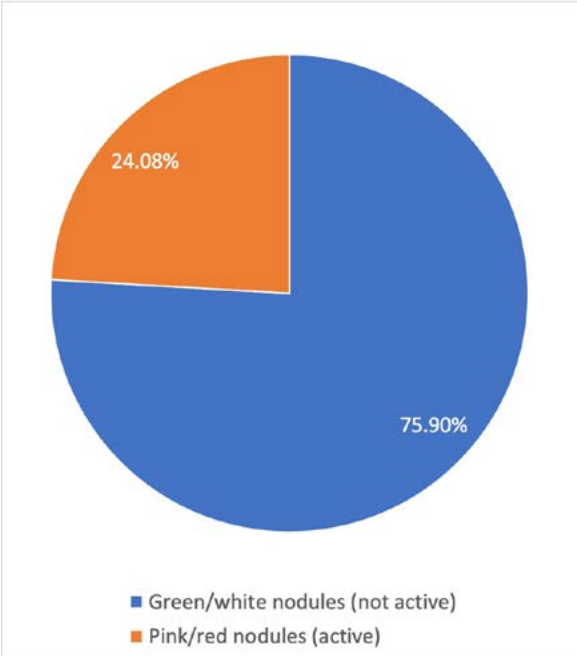
Graph 1: Total nodules per plant



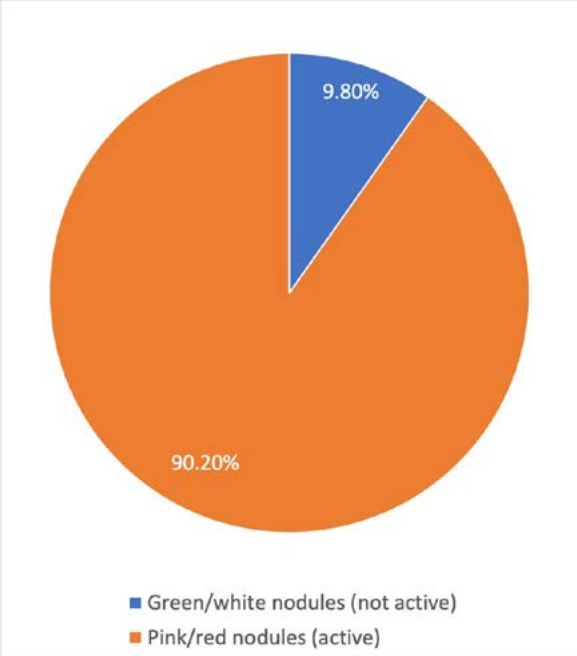
1. Difference in root structure between treatment samples (random selection) – Left Treatment A (fungicide applied), Right Treatment B (no fungicide applied)
2. Treatment Area A (left fungicide applied) and Treatment Area B (right no fungicide applied)

Graphs 2 and 3 show the collective percentage of the active and not active nodules on all plants sampled for each treatment. Treatment A (fungicide applied) had a total of 490 nodules sampled and Treatment B (no fungicide applied) had a total of 500 nodules sampled. The difference being Treatment A had 2 plants with no nodules present. The data shows that Treatment B with no fungicide applied, has a far higher percentage of nodules active compared to Treatment A with fungicide applied.

Graph 2: Nodule activity for Treatment A – fungicide applied



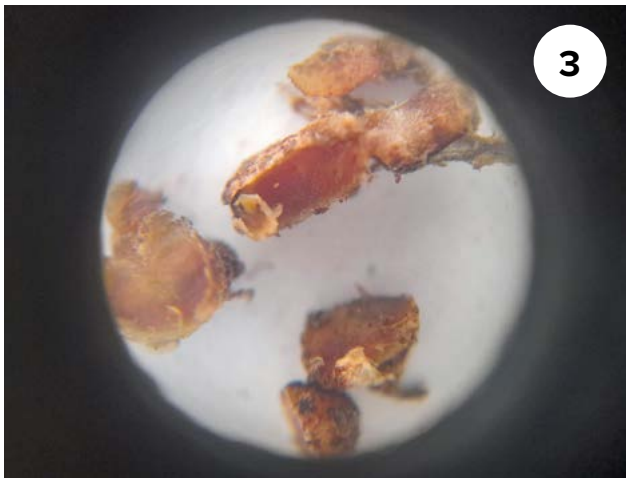
Graph 3: Nodule activity for Treatment B – no fungicide applied



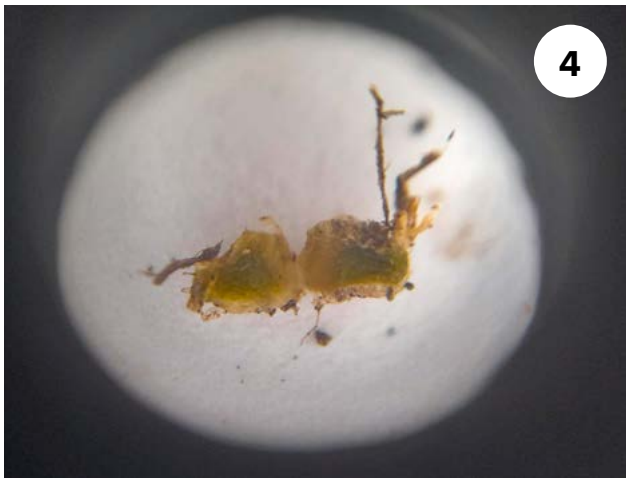
References

Fox. J, Gulledg. J, Engelhaupt. E, Burow. M, McLachlan. J (2023) 'Pesticides reduce symbiotic efficiency of nitrogen-fixing rhizobia and host plants'

Nandanwar. S, Yele. Y, Dixit. A, Goss-Souza. D, Singh. R, Shanware. A, Kharbikar. L (2018) 'Effects of Pesticides, Temperature, Light, and Chemical Constituents of Soil on Nitrogen Fixation'



3. Active nodule (pink/red colour)



3. Non active nodule (white/green colour)