

Preliminary assessment of nodulation on broad bean root systems

Background

There has been a history of problems with poor nodulation of broad bean on Kangaroo Island. It appears there are two main causes, one being highly acidic soils (i.e. pH(CaCl₂) less than 5) and the other being waterlogging.

What was done

Broad bean root systems were sampled on four properties in the spring of 2014 and an assessment of nodulation was made. At each property, one or two paddocks were sampled, with three sets of 10 plants being dug at approximately 50 metre intervals in each paddock, unless specified otherwise, starting 20 metres from the edge, to avoid sampling headlands. Extra treatments were applied in one paddock, in an attempt to improve nodulation.

After sampling, the roots were washed carefully and individual plants were scored as having adequate or inadequate nodulation compared to a set of photos (Nodulation assessment guide, found at <http://www.agwine.adelaide.edu.au/research/farming/legumes-nitrogen/legume-inoculation/>). The '% adequate nodulation' was calculated for each sample location and the numbers were averaged across the three sample locations. Overall nodulation was considered good if the average nodulation scores were at least 70% 'adequate'.

A well-nodulated bean plant should have 20 - 100 pink nodules (i.e. for adequate nodulation, 70% of bean root systems should have approximately this number of nodules), depending on soil texture (we expect larger numbers of nodules in heavier soils; FIGURE 1).



FIGURE 1: **Good nodulation (inoculated with granules in furrow)**

In one paddock (Property 1 A), there was very good nodulation. In a nearby paddock (Property 1 B) on a completely different soil type, the situation was very different, with only 18% of plants having adequate nodulation. The soil pH in paddock A was much higher (pH 6.0) than paddock B which had a pH of only pH 4.17 (extremely low).

Results

Results are presented in TABLE 1.

TABLE 1: **Nodulation assessments on broad beans, Kangaroo Island, 2014.**

| Property | Soil type / pH _(CaCl₂) | Variety | Rhizobium inoculation | Mean nodulation score (% adequate) | Comment |
|---|--|-----------|---|--|--|
| 1 A | Red earth pH 6.0 | Aquadulce | Peat on seed | 83% = good | 1 sample only |
| 1 B | Grey loam pH 4.2 | Aquadulce | Peat on seed | 18% = poor | 4 samples |
| 2 | Grey sandy loam pH 4.8 | Aquadulce | Liquid in furrow plus other treatments e.g. "Calsap" | 15% = poor | |
| 3 | Loamy sand with ironstone pH 5.2 | Aquadulce | Peat on seed | 58% = reasonable | Range 36% to 88% |
| 4 (a control – no applied rhizobium plus two other treatments) | Sandy loam with ironstone pH 4.8 | Kareema | Nil Granules (G) (BASF); Tag Team on seed (TT) (Novozymes) | Nil: 40% G: 56% TT + G: 36% Overall Inoculation level 46% = below desired level. | Based on limited sampling; Nodulated vetch plants present at all sample locations. |

Property 3 had the best average result, but even here nodulation was patchy with '% adequate nodulation' ranging from 36% to 88% between sample locations. The overall average did not reach the desired level of 70% adequate nodulation.

At property 4, the preliminary results suggest that inoculation may not have improved nodulation. However, the presence of nodulated vetch plants in this paddock indicates there were sufficient rhizobia of the correct type in the soil at sowing time to nodulate beans even if they were not inoculated. It is possible though, that beans grown from inoculated seed were fixing more nitrogen, than the un-inoculated beans which had to 'find' their own rhizobia from the soil. This is because the freshly inoculated commercial strains can be more efficient at fixing nitrogen than rhizobia from the general soil population.

On samples taken at properties 2, 3 and 4, it was common to see root systems with just one or two extremely large nodules (e.g. up to 2 cm diameter; FIGURE 2). While there may be a large amount of nitrogen being fixed in these plants, this nodulation pattern illustrates that successful nodulation was a relatively rare event, and in this situation it would be easy for a plant not to be nodulated at all and therefore not fix any nitrogen.

Liming of soils to raise the pH, ideally above pH 5, would lead to improved nodulation and therefore nitrogen fixation by broad bean crops. In-furrow and seed treatments to increase pH locally around the seed may also be effective in improving nodulation. Trials are needed, to test and compare treatments.



FIGURE 2: **Poor nodulation – one very large nodule**

Take home messages

- Nodulation can be very poor and very patchy, and measures to improve both the level and consistency of nodulation are needed.
- Growers are encouraged to take root samples of legume crops in late winter or early spring to assess nodulation. A nodulation assessment guide that includes photos of plants with poor and good nodulation is available online.
- AgKI has received funding through GRDC for bean nodulation trial work in 2015 – so hopefully next year's Ag Trial booklet will have good news about how to improve nodulation!

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See also <http://www.agwine.adelaide.edu.au/research/farming/legumes-nitrogen/legume-inoculation/>