LEGUMES AND NITROGEN FIXATION
—SOUTH AUSTRALIA

Key points

- Legumes can fix substantial quantities of nitrogen (N) and this can be maximised by ensuring low plant available N in the soil at sowing and inoculating the seed if a paddock has not had a host legume nodulated by the same rhizobia in the last four years.
- Acid soils will require more regular inoculation or liming (except for narrow-leaf lupin).
- The net N benefit from N fixation by legumes is dependent on the balance between atmospheric nitrogen (N$_2$) fixation and N removed as grain, hay or forage.
- Legume N residues can make an important contribution to N uptake and grain N of following crops.

Background

All plants are able to take up nitrogen from the soil in the form of ammonium (NH$_4^+$) or nitrate (NO$_3^-$); together these are known as available N. In addition to taking up available N from the soil, legumes (clovers, medics, peas and beans) are also able to acquire N from the abundant supply in the atmosphere via special soil bacteria (rhizobia) which are housed in nodules on their roots. With fully functioning nodules, legumes can grow in soils that are deficient in available N. These rhizobial ‘factories’ are subject to variation in establishment and performance and so a supportive environment must be provided to maximise N$_2$-fixation.

Rhizobia, nodulation, available soil nitrogen and nitrogen fixation

Rhizobia tend to be widespread in soils, however they are not all equally effective. While most are happy to reside in nodules, not all are able to efficiently fix (N$_2$). To ensure large numbers of efficient rhizobia are present in the legume nodules (figure 1), it is advisable to inoculate legume seed at sowing with the recommended strain of rhizobia if the paddock has not been inoculated with that rhizobia, or has not grown a crop of a suitable host legume for that rhizobia in the last four years.

Survival of rhizobia and legume nodulation will be reduced in acid soil (pH <5), except for narrow-leaf lupin. To maximise N$_2$-fixation in low pH soils, more regular inoculation and/or liming is required.

Where available soil N is low, the amount of N$_2$ fixed is directly proportional to legume dry matter production (figure 2). If legume crops in any one location have about the same total dry matter, then you would expect them...
Legumes and Nitrogen Fixation

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The National Soil Quality Monitoring Program is being funded by the Grains Research and Development Corporation, as part of the second Soil Biology Initiative.

A healthy and productive field pea crop could fix up to 200 kg N/ha to fix about the same amount of N (table 1), while equally productive pastures tend to fix more N.

<table>
<thead>
<tr>
<th>LEGUME SHOOT DRY MATTER (t/ha)</th>
<th>CHICKPEA</th>
<th>FIELD PEA, FABA BEAN</th>
<th>LUPIN</th>
<th>ANNUAL CLOVERS</th>
<th>LUCERNE</th>
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</table>

How much N do legumes contribute to following crops?

At maturity 30–40% of the N in legume crops is in the seeds, which are typically 25–30% protein. When this grain is harvested, much of the N that has been fixed will be exported off of the property. However, the N remaining in the shoot and root residues means that legumes usually make a positive contribution to soil N reserves in southern Australia.

Further reading and references

Drew E et al. (2012) Inoculating legumes: a practical guide, GRDC, Canberra. (online)


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