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This article contains information most relevant to the less than 350 mm rainfall mallee farming region

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Identifying herbicide impacts on nitrogen fixation of legumes

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The Issue

Early observations from the Mallee Sustainable Farming Project identified a lack of rotational response in cereals following legumes in the Mallee farming regions of southern Australia. A number of herbicides recommended for use in legumes (peas, vetch and lentils) have been found to reduce nodulation of plants and nitrogen (N_2) fixation in field trials.

With a shift towards more sustainable broad-acre farming practices, such as reduced tillage, direct drill sowing and intensive cropping, there has been a significant increase in the use of herbicides. In Australia alone, herbicide sales doubled between 1995 and 1998 from $450 million to over $800 million. While herbicide use is recognized as a necessity for both ecologically and economically sustainable agriculture, the impact of herbicides on grain legume production and N_2 fixation is of increasing concern.

How legumes increase soil nitrogen

Legumes form a symbiotic relationship with soil bacteria called rhizobia. Rhizobia form nodules on the legume roots where N_2 fixation occurs. The plant provides the nodules with energy to transform atmospheric nitrogen to a plant available form (Figure 1).

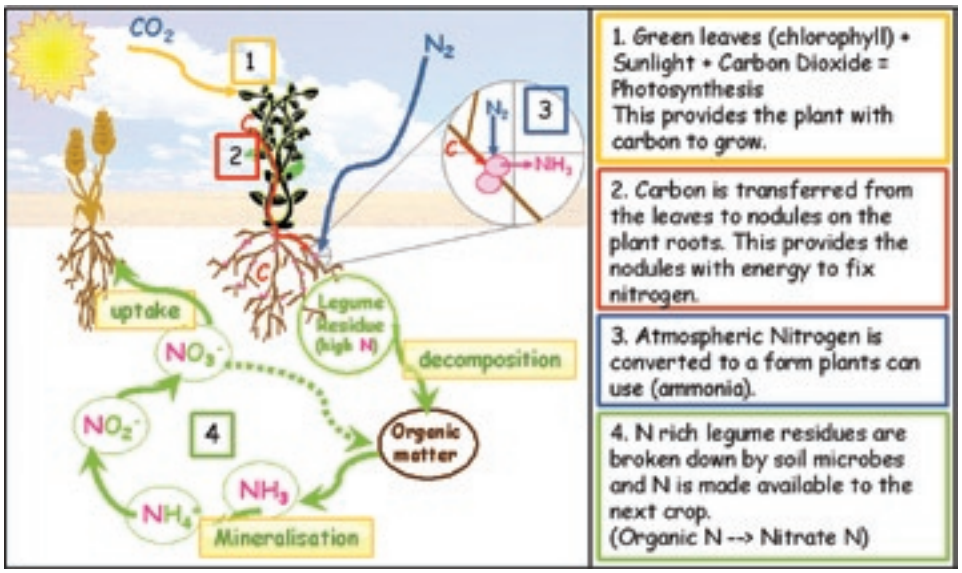
When legume residues breakdown, the nitrogen is released into the soil and becomes available to the following crop.

What we know about Herbicide effects on Nitrogen Fixation

• Both grass-specific (group A) and broad leaf herbicides (Groups B, C, D) can significantly reduce the nodulation and nitrogen fixation of peas, vetch and lentils.

▸ In 2003 a single post-emergent application of some group A and B herbicides to peas at Waikerie reduced N_2 fixation from 50kg/ha to as low as 20kg/ha; a significant 60% reduction.

Figure 1: How legumes fix nitrogen.



- The degree of herbicide damage varies greatly with the herbicide applied, the crop species and variety and the time of application. Hence clear rules of application cannot be provided.

• Herbicide effects also vary significantly with location and season. While the environmental parameters controlling the degree of herbicide damage are not understood, the importance of their influence is well recognized. In two years of field trials across South Australia, negative impacts due to herbicides were greatest and most consistent at Waikerie in the Murray Mallee.

Identifying herbicide effects
Transient crop yellowing of legumes, 2-3 weeks following post-emergent herbicide applications, is a common phenomenon (Figure 2). In the Mallee, a relationship has been identified between crop yellowing (peas) and nodule number following herbicide application. The more severe the crop yellowing (intensity and percentage of crop effected), the more likely a reduction in nodule number, and consequently N_2 fixation.

Figure 2. Crop yellowing in peas following a post-emergent herbicide application; comparison of unsprayed (a) and sprayed (b) plants.

What it means

Growing pulse crops in the Mallee has always been a high-risk rotation option. Growers need to identify the reasons they are growing pulses. If it is for weed management then pulses are still a viable option. However if it is primarily to replenish soil nitrogen then growers need to be aware they may be underachieving their aim.

Where to next

To assess the degree of herbicide damage to a legume crop, farmers can include an unsprayed test strip in their paddock.

- Compare the amount of leaf yellowing between the sprayed and unsprayed sections of the crop 2-3 weeks following herbicide application.

- Dig-up some plants from the sprayed and unsprayed sections of the paddock and rinse in a bucket of water. Compare nodulation of plants (Figure 3). If plants in the sprayed section have noticeably less nodules than those from the unsprayed section then you may be at risk of over-estimating N_2 fixation by the legume crop at the end of the season.

Adopt an integrated weed management approach to reduce weed populations on farm and potentially reduce the number of herbicide applications required in a legume crop.

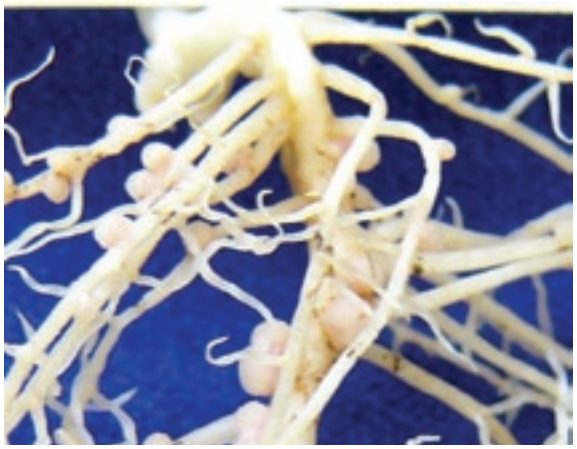


Figure 3. Pink nodules on pea roots.

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