USING LEGUMES TO SUPPLEMENT NITROGEN

The world may be easing its way into post-pandemic normality, however latest market research shows that this will have limited impact on the historically high prices of nitrogen and imported fertilisers for Australian farmers. By Paulette Baumgartl

According to Rabobank's 2022 Fertiliser Affordability Index Report, despite predictions that the global price of fertilisers will fall in the coming months, Australian farmers will enjoy no such reprieve.

Contributing to these high prices are Australia's heavy reliance on imported fertilisers, unpredictable bulk freight rates, ongoing currency and interest rate challenges, and domestic freight and logistics constraints.

With prices of urea still hovering around $1300-$2000/tonne, understanding alternative, cheaper ways to add nitrogen to the soil is more important than ever.

THE BIOLOGY OF 'CHEAP NITROGEN'

The many benefits of cover crops are well-documented. When legumes are part of the cover crop, the benefits extend to adding atmospheric nitrogen, of which there is an abundance, to the soil.

The process of fixing nitrogen from the atmosphere into the soil is called biological nitrogen fixation (BNF). This process occurs when legume plants form symbiotic (i.e., mutually beneficial) relationships with nitrogen-fixing bacteria, such as rhizobia, which live in root nodules.

TIPS TO GET THE MOST NITROGEN OUT OF YOUR LEGUME COVER CROP

- If nitrate levels are low in the soil, select and grow a vigorous legume cover crop; the more biomass grown, the more nitrogen fixed and added to the soil.
- Add the right rhizobium inoculant for your selected cover crop to ensure maximum results.
- If nitrate levels are too high, a mixed crop can remove nitrate form the soil, paving the way for effective fixation from legumes, which provides better long-term results.
- The timing of the cover crop is important to ensure nitrogen is available when the potatoes need it most.

In this process, the bacteria convert atmospheric nitrogen (N_2) into a plant available form, for example ammonia (NH_3) or nitrate (NO_3). By way of thanks, the plant then provides the bacteria with energy in the form of sugars produced through photosynthesis (Figure 1). Once the nitrogen has been fixed, it is available for the plant.

EXPLORE FURTHER

Watch the recent webinar *Legumes in rotation with potatoes - an alternative nitrogen source*. In this webinar, Dr Kelvin Montagu and Peter O'Brien discuss the principles of using legumes as an alternative nitrogen source, the importance of legume inoculants and considerations for best results in rotation with potatoes.

http://bitly.ws/BS77

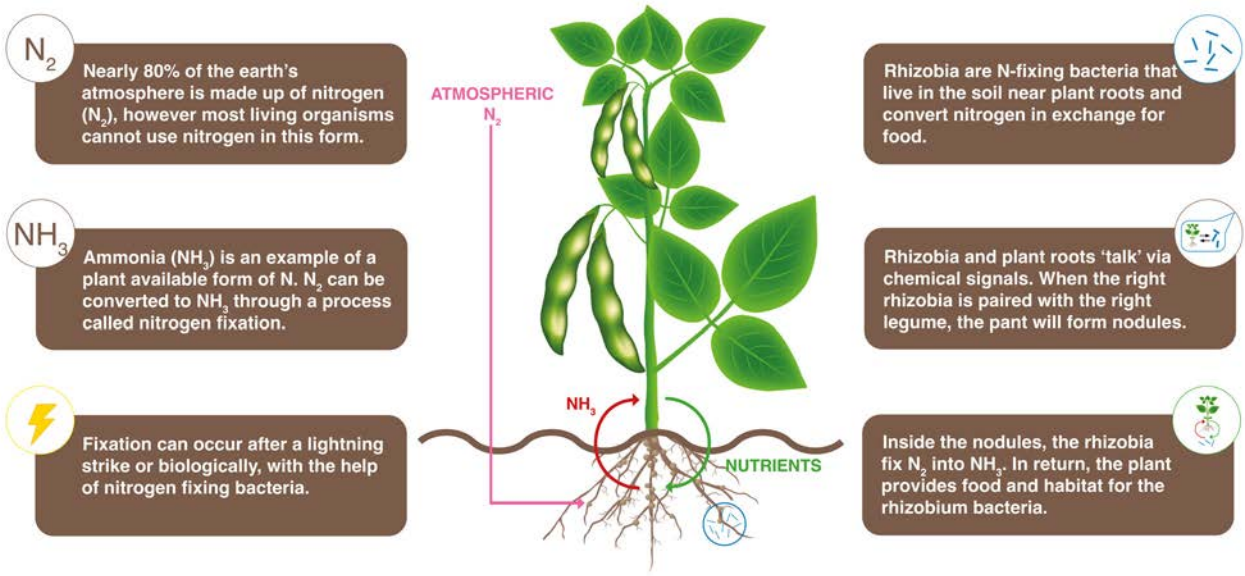

Figure 1. Converting atmospheric nitrogen to plant available nitrogen through biological fixation. (Based on figure from https://xitebio.ca)

COVER CROPS, BIOMASS, AND NITROGEN

Potatoes are a nitrogen-hungry crop. The nitrogen budget in a crop cycle depends on many factors, including yield, soil type and how much in-crop nitrogen fertiliser was used, and whether cover crops are part of the crop cycle on the paddock.

While all cover crops add some nitrogen to the soil, legume cover crops are the big contributors, owing to their ability to fix nitrogen. On average, for every tonne of shoot biomass grown, approximately 20kg of nitrogen will be added. A good legume cover crop with the right inoculant can produce 8-10 tonnes of shoot biomass, which equates to 160-200kg of nitrogen added. Cover crop roots can add a further 30-100kg of nitrogen.

Which cover crop is best will depend on local factors, including soil type and climate. For help with choosing the right legume for your area, the *Cover Crops for Australian Vegetable Growers* poster provides a handy overview.

Cover crop mixes add less nitrogen and sometimes this is the preferred option when growing a potato crop, particularly in soils with high soil nitrate levels. Plants, like humans, will favour the easy option, so if free nitrogen is available in the soil, legumes are less likely to make the effort to enter a partnership with rhizobium bacteria to create nitrogen.

Before selecting a cover crop, it is worthwhile to conduct a soil test to determine nitrate levels:

- At nitrogen levels of 50kg per ha (to 30cm), the legumes will add lots of nitrogen.
- At nitrogen levels above 200kg per ha, the legume will not add much nitrogen.

In soils with high nitrogen levels, a mixed cover crop of a sunn hemp, sorghum and tillage radish for summer, or oats and vetch mix for winter, could be a good option. The cereal and broadleaf species will recover and store the nitrogen, while 'forcing' the legume to fix its own nitrogen.

The nitrogen stored in the biomass can be later re-released when the crop is terminated and left as green manure.

WHEN TO GROW A COVER CROP

Generally, it is best to grow a legume cover crop prior to the potatoes. Although legumes can host some diseases, for example grey mould, this rarely presents a major problem.

As the nitrogen demands of the crop vary at different stages, controlling the amount of available nitrogen is important. Too much in the first few stages can delay tuber initiation and cause some internal defects; conversely too little in stage 4 will have an impact of tuber bulking.

Matching nitrogen supply to the nitrogen demand requires systematic soil and tissue testing, both before and during a season. Understanding the movement and release of N from legume biomass (or other forms of biomass) is also useful.

There are three important factors to consider about nitrogen and potatoes:

1. Potatoes require most nitrogen during stage 3.
2. Too much nitrogen before tuber initiation (growth stage 2) can delay initiation.
3. Potassium must also be present during the middle growth stages. Excess nitrogen with limited potassium is associated with reduced specific gravity, an important consideration for processing potatoes.

Therefore, terminating a legume cover crop in summer, six weeks prior to planting an indeterminate potato variety (some varieties are not impacted by too much nitrogen) is not advisable as there would be too much nitrogen still present at stage 2.

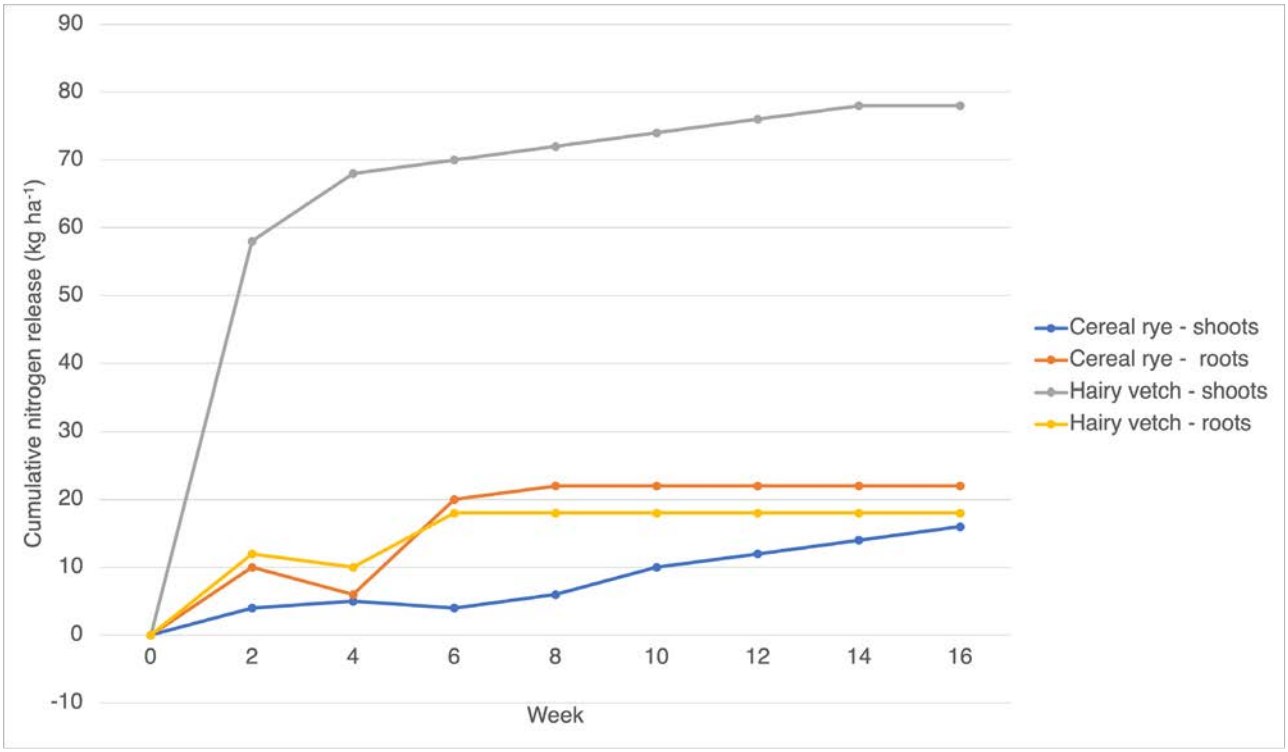

Figure 2. Estimated cumulative nitrogen release of cereal rye and hairy vetch residual biomass over 16 weeks of decomposition with potato growth stages. (Based on Sievers and Cook, 2018)

However, if it was terminated and left to dry out (no rain or no irrigation), the release would be timed in a way that would be suitable for potato growth, i.e., the residual cover crop would not start releasing nitrogen until the potatoes were planted and irrigated.

Figure 2 illustrates some results from an American study showing the release of nitrogen from different cover crop biomass residues, following termination with herbicides. Rate of decomposition is effected by the carbon:nitrogen ratio - cereal rye biomass residues decompose much slower and may also immobilise N as it has a higher C to N ratio than vetch. However, although a cover crop like hairy vetch contains more N and releases it more quickly, the rapid, early release may not suit potatoes.

THE IMPORTANCE OF ADDING THE RIGHT RHIZOBIA

Rhizobium bacteria do much of the heavy lifting in fixing nitrogen, and if they are not present in the soil, the legume cover crop cannot do its job.

Compatible, effective rhizobia must be present before nodulation and N fixation can occur. When a legume is grown for the first time in a particular soil, it is unlikely that the correct rhizobia will be present. Therefore, the rhizobia must be supplied in a highly concentrated form as inoculants.

However, if the legume crop was grown in the field previously, there is a good chance that the soil already contains the correct rhizobia species for nodulation.

Each species of legume has a specific strain of rhizobium that it needs for this process. To ensure adequate plant growth, it is important to inoculate legume seed at planting with the correct strain of rhizobium. A number of reliable resources are available to help select the right rhizobium.

The Australian Inoculant Research Group (AIRG) curates a selection of suitable rhizobia for inoculant products. These products have a green tick and have been independently tested for Australian farming conditions.

Currently there are 42 strains covering over 100 species and cultivars of grain and pasture legumes approved by the AIRG and the National Rhizobium Steering Committee.

Root development and nodulation on different cover crops - D Long

EXPLORE FURTHER

Download the *Cover crops for Australian vegetable growers* poster - **http://bitly.ws/BULf**

Read more about the AIRG and the list of inoculants -**http://bitly.ws/BULg, http://bitly.ws/BULj**

SOURCES

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