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primefact

Nitrogen benefits of chickpea and faba bean

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Introduction

Chickpea and faba bean provide many benefits in northern cropping rotations, including the ability to fix atmospheric nitrogen (N_2), resulting in more soil N for following cereal crops. The amount of nitrogen fixed is determined by how well the pulse crop grows and the level of nitrate in the soil at planting. Soil nitrate suppresses nodulation and nitrogen fixation. Thus, high soil nitrate means low nitrogen fixation.

Important terminology

Before considering the nitrogen budgets of chickpea and faba bean, it is important that terms are clearly defined and understood.

- **Total nitrogen fixed** – is the nitrogen fixed in both above-ground (shoots) and below-ground (roots and nodules) biomass. With chickpea, 50% of total crop nitrogen is below-ground. With faba bean, it is about 30%.
- **Nitrogen (N) balance** – is the difference between nitrogen inputs to the pulse crop (nitrogen fixation + fertiliser nitrogen applied) and nitrogen outputs (nitrogen harvested in grain or hay + nitrogen volatilised [lost] from the crop and soil). The values for N balance may not have much significance for a farmer, who will be more interested in the extent to which the legume increases levels of nitrate-N in the soil that will be available for the following crop.
- **Nitrate-N benefit** – in experimental systems with pulse–cereal and cereal–cereal rotations side-by-side, the nitrate-N benefit is the extra nitrate-N available at sowing in soil that grew the pulse crop in the previous season, compared with soil that grew the cereal crop. In farmer paddocks, the nitrate-N benefit of a pulse crop is best described as the additional nitrate-N in the soil at sowing following the pulse, compared with the soil nitrate level when the pulse was sown, i.e. the nitrate-N increment for the 12-month period. This is how the nitrate-N benefit is calculated for the tables on the following page.

Nitrate-N benefit for following cereals

The nitrate-N benefit from chickpea and faba bean, over a range of grain yields, is shown in the following two tables. The values in the tables were calculated using a number of simple functions (algorithms) that were derived from extensive research in the northern grains region. The algorithms have been bundled together into an N management tool called ‘NBudget’, which can be used for such calculations as well as for estimating fertiliser N requirements for cereal and oilseed crops. Calculations were for a medium fertility no-till paddock, located at Moree.

For chickpea growing in the low nitrate soil, the nitrate-N benefit is consistently positive, ranging between 27 kg and 43 kg nitrate-N/ha over the range of yields (1.0–3.5 t/ha). In the moderate nitrate soil, the nitrate-N benefit of chickpea essentially disappears.

The simple message to take from this is that chickpea should be grown in low nitrate soils so that they can fix large amounts of nitrogen, add to the soil’s nitrogen fertility (balance) and, importantly for short-term productivity, increase the amount of nitrate-N in the root zone.

Faba bean is stronger at fixing nitrogen than chickpea, particularly when grown in moderate nitrate soils. Across the six yield levels, the average nitrate-N benefits were 42 kg and 18 kg N/ha, for the low and moderate soil nitrate scenarios respectively (compared with 33 kg and −2 kg N/ha for chickpea).

Harvest index (HI) and crop biomass

For different crops, the relationship between shoot dry matter and grain yield (i.e. HI) may vary according to season and management. In years with good winter growth, followed by a hot, dry spring, crops will produce less grain and therefore have a lower HI. Faba bean is likely to be more affected than chickpea under these conditions. Disease may also have an impact on HI as may subsoil constraints and frost and cold temperatures, particularly with chickpea. A lower than normal HI would mean a greater N balance and nitrate-N benefit for a given shoot dry matter. The calculated values in the tables for shoot dry matter at the different levels of grain yield are reasonable estimates.

Measuring crop biomass

The most accurate way to measure crop biomass is to take a number of representative dry matter cuts (10 × 1 square metre cuts) at the stage of peak shoot dry matter. This occurs just before physiological maturity, when the pods start to yellow. Other less time-consuming methods to estimate crop biomass, such as crop density or crop height, have been found to be too unreliable, being too specific to the crop, the variety and the season.

How can this information be used?

By understanding the development of crop biomass and the factors that influence harvest index, better nitrogen and rotation management decisions can be made. The decision to green manure a crop needs to be weighed up against taking the crop through to grain yield and should be made in consultation with an experienced agronomist. The timing of green manuring will influence the amount of nitrogen available to the following crop.

Chickpea

		Low soil nitrate at sowing (50 kg N/ha)			Mod soil nitrate at sowing (100 kg N/ha)		
Grain yield (t/ha)	Shoot dry matter (t/ha)	N fixed (kg/ha)	N balance (kg/ha)#	**Nitrate-N benefit (kg/ha)**	N fixed (kg/ha)	N balance (kg/ha)#	**Nitrate-N benefit (kg/ha)**
1.0	2.7	37	1	**35**	22	−14	**16**
1.5	3.9	72	18	**28**	50	−5	**3**
2.0	5.1	110	40	**27**	80	9	**−5**
2.5	6.2	152	62	**30**	115	25	**−9**
3.0	7.2	195	88	**35**	150	43	**−10**
3.5	8.2	240	115	**43**	188	63	**−8**

Faba bean

		Low soil nitrate at sowing (50 kg N/ha)			Mod soil nitrate at sowing (100 kg N/ha)		
Grain yield (t/ha)	Shoot dry matter (t/ha)	N fixed (kg/ha)	N balance (kg/ha)#	**Nitrate-N benefit (kg/ha)**	N fixed (kg/ha)	N balance (kg/ha)#	**Nitrate-N benefit (kg/ha)**
1.0	3.1	47	9	**40**	42	4	**20**
1.5	4.2	75	18	**38**	70	12	**16**
2.0	5.2	104	29	**38**	96	21	**15**
2.5	6.1	133	40	**40**	123	30	**16**
3.0	6.9	162	50	**44**	150	37	**19**
3.5	7.5	190	58	**50**	180	48	**23**

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