SOIL NITROGEN SUPPLY

Key points

- The release of mineral nitrogen from decomposition of organic matter is a significant source of nitrogen for grain crops in Australia.
- Soil nitrogen supply is a laboratory test that reflects the release of mineral nitrogen from organic matter.
- Soil nitrogen supply reflects how much mineral nitrogen may be released from organic matter but not when the nitrogen will be released.

Plant uptake of soil nitrogen

Plants require more nitrogen (N) than any other nutrient but only a small portion of the nitrogen in soil is available to plants; 98% of the nitrogen in soil is in organic forms. Most forms of organic nitrogen cannot be taken up by plants, with the exception of some small organic molecules.

In contrast, plants can readily take up mineral forms of nitrogen, including nitrate and ammonia. However, mineral nitrogen in soil accounts for only 2% of the nitrogen in soil. Soil microorganisms convert organic forms of nitrogen to mineral forms when they decompose organic matter and fresh plant residues. This process is called mineralisation.

Soil nitrogen supply

Soil nitrogen supply is a laboratory test that reflects the release of mineral nitrogen from organic matter by soil microorganisms. It is measured in milligrams of nitrogen per kilogram of soil (mg/kg) and is also known as potentially mineralisable nitrogen. The laboratory test is simple but time-consuming.

Values of soil nitrogen supply can be classed into one of five descriptive categories from "Very Low" to "Very High".

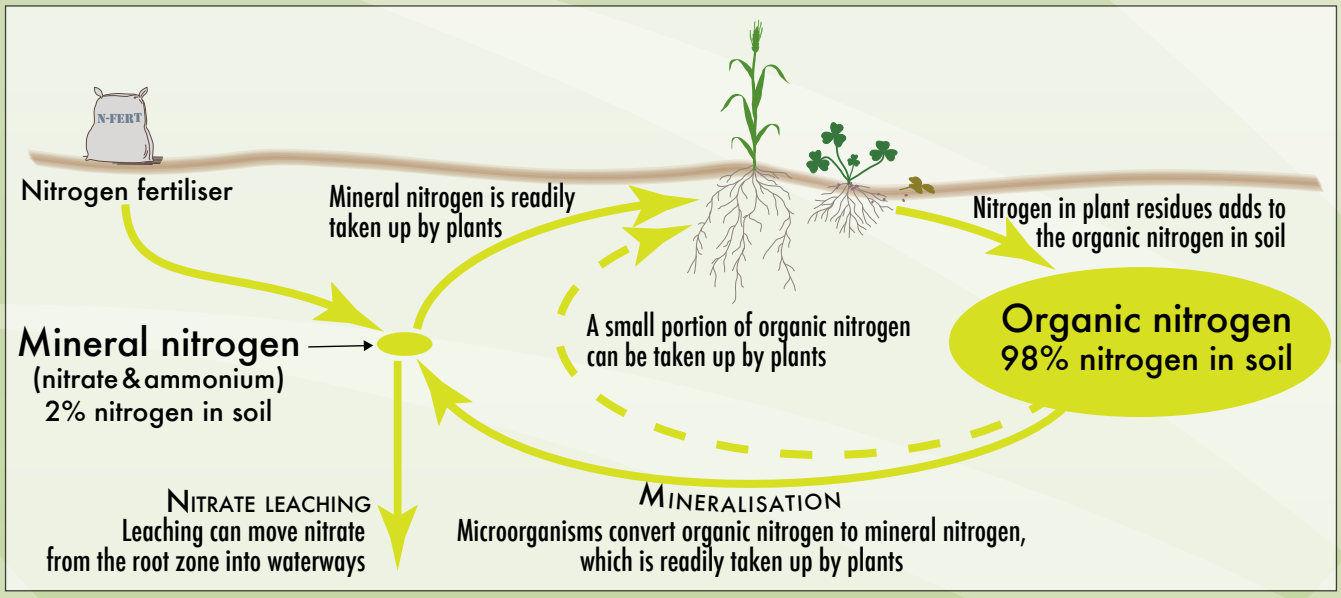
The higher the value for soil nitrogen supply the more likely it is that the microorganisms in a soil will convert more organic nitrogen into mineral nitrogen for plant uptake.

However, in coarse textured soils with higher values of soil nitrogen supply, it is also more likely that nitrate will be leached down the soil profile out of reach of plant roots and possibly into waterways. Intermediate levels of soil nitrogen supply provide a balance between maximising nitrogen availability for plant uptake and minimising the risk of nitrate leaching.

The level of soil nitrogen supply that best balances the benefits and risks varies depending on the clay content of soil. In sand soils, the best balance is achieved by a "Moderate" soil nitrogen supply (25–50 mg N/kg soil). In contrast, in loam and clay soils "High" soil nitrogen supply is most suitable (50–75 and 75–125 mg N/kg soil respectively).

Soil nitrogen supply and crop growth

Conversion of organic nitrogen in soil into mineral nitrogen is a significant source of the nitrogen required by crops in



The soil nitrogen cycle showing the role of mineralisation in making organic nitrogen in soil available for plants to take up.

Australian agriculture. For example, a wheat crop must take up approximately 50 kg N/ha to achieve the average Australian yield of 1.9t/ha. It has been estimated that every year 2% of the organic nitrogen in soil is converted to mineral forms, releasing 70 kg mineral nitrogen per hectare—more than the total requirement of the wheat crop (Angus 2001).

Soil nitrogen supply is particularly important in rotations that include legumes crops and pastures. Nitrogen in the residues of legume crops and pastures is decomposed by microorganisms and can become available to subsequent crops. For example, 20–25% of the nitrogen fixed by a medic pasture was converted to mineral forms of nitrogen and taken up by the following crop (Angus and Peoples 2012).

In Western Australian grain growing regions, soil nitrogen supply has a strong effect on crop growth and grain yield. A study near Corrigin, Western Australia found it was possible to predict 21% of the final grain yield using the soil nitrogen supply six weeks after seeding. In contrast, using the amount of nitrogen fertiliser applied it was only possible to predict 10% of the grain yield. Also the amount of mineral nitrogen in soil six weeks after sowing had no effect on grain yield (Murphy et al. 2009).

Timing of nitrogen release from organic matter

Although soil nitrogen supply is useful to estimate how much nitrogen from organic matter will become available to a crop, there is a significant difficulty with this measurement. Soil nitrogen supply estimates the quantity of nitrogen released from organic matter without giving any information about when it will be released.

Most nitrogen release from organic matter occurs during the growing season, providing a steady, continuous supply of nitrogen to the crop. This is because the microorganisms responsible for releasing nitrogen from organic matter require some soil moisture.

However, it is likely that some of the soil nitrogen supply will occur when plants don't require nitrogen. When summer rainfall occurs it can lead to significant amounts of organic nitrogen being turned into mineral nitrogen.

Nitrogen released from organic matter during summer can be viewed as a pre-emergent application and in some years can be a significant source of nitrogen. However, it is also prone to leaching if heavy rainfall occurs before crop establishment. Soil testing helps to determine the value of this nitrogen.

Soil nitrogen supply and microorganisms

Research in Victorian grain growing regions shows that a greater abundance of soil microorganisms capable of decomposing organic matter is associated with high soil nitrogen supply. These microorganisms include those able to convert organic nitrogen to plant-available mineral nitrogen and thus contribute to the soil nitrogen supply.

Knowing that specific microorganisms directly influence soil nitrogen supply (and vice versa) allows us to understand how management practices affect soil nitrogen supply.

For example, when residues were incorporated into soil using a disc plough instead of being mulched the abundance of microorganisms able to convert organic nitrogen to mineral nitrogen more than doubled. As a result, disced soils contained double the amount of nitrate-N at sowing than soils where legumes residues were mulched. The mulched soils however, released nitrate-N more gradually over the next growing season than disced soils.

Further reading and references

Angus JF (2001) Nitrogen supply and demand in Australian agriculture, *Australian Journal of Experimental Agriculture* **41**: 277–288.

Angus JF and Peoples MB (2012) Nitrogen from Australian dryland pastures, *Crop and Pasture Science* **63**: 746–758.

Murphy DV, Osman M, Russell CA, Darmawanto S and Hoyle FC (2009) Potentially mineralisable nitrogen: relationship to crop production and spatial mapping using infrared reflectance spectroscopy, *Australian Journal of Soil Research* **47**: 737–741.

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