SUPERIOR

Nitrogen

Essential for all plant growth

Why is nitrogen important?

Nitrogen is essential for plant growth as it is required to form chlorophyll, protein, amino acids and nucleic acids. In total, nitrogen makes up 2–6% of plant tissue. It is also needed for the breakdown of crop stubble and green manures that have been ploughed in.

The nitrogen cycle

Although the atmosphere contains nearly 80% nitrogen gas, it is unavailable to plants in this form. Since the only forms of nitrogen that can be used by plants are ammonium (NH_4+) and nitrate (NO_3-) how is this gas converted?

Nitrogen (N) is continually cycling, being transformed – with organic N being 'mineralised' to inorganic forms – which can then be 'immobilised' back to organic N.

How nitrogen enters the soil

The main source of all soil N is from fixation of nitrogen from the air carried out by Rhizobium bacteria in legume root nodules and by some soil algae.

Commercial fertilisers also come from nitrogen in the air, but are converted via a chemical manufacturing process into concentrated soluble sources of inorganic N; as either a urea $CO(NH_2)_2$, ammonium (NH_4+), or nitrate (NO_3-) form.

Organic nitrogen is added in manures and decomposing organic matter, e.g. decomposing plants, insects, worms and microorganisms.

There are three major forms of nitrogen in the soil

Organic nitrogen is found in the organic matter or humus in the soil, but needs to be broken down and converted to inorganic nitrogen by the action of soil microbes before it can be used by plants. Organic nitrogen makes up 97–98% of the total nitrogen in the soil.

Ammonium nitrogen (NH4+) is held by the soil colloids, the fine clay and humus particles in the soil. This makes it less available to plant roots than nitrate. Less than 1% of the total soil nitrogen is in the form of ammonia.

Nitrate nitrogen (NO_3-) and other soluble compounds make up 1–2% of the total nitrogen available in the soil. Plants can readily use nitrate nitrogen.

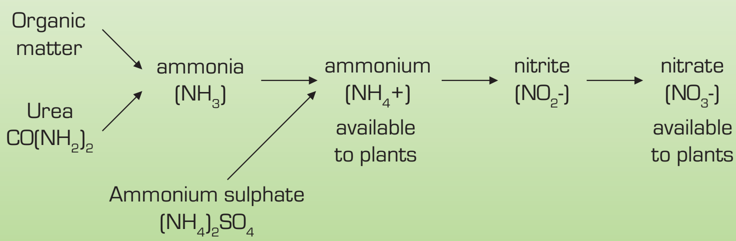
Nitrogen transformations in the soil

Once in the soil, both the organic and inorganic forms of N are transformed. Organic N becomes part of the soil organic matter.

Some will then be 'mineralised' to inorganic N by the action of soil microbes, and in the reverse reaction inorganic N can be 'immobilised' back to organic N.

The organic matter that is mineralised is converted to ammonia (NH_3) then further transformed to ammonium (NH_4+), nitrite (NO_2-) and on to nitrate (NO_3-) in a process called 'nitrification' Ammonium and nitrate can be taken up by plants or used by other soil organisms.

Fertilisers come as urea $CO(NH_2)_2$, ammonium (NH_4+), or nitrate (NO_3-) forms. Once in the soil, urea is hydrolysed to ammonium in a natural chemical process. This is further transformed to nitrite and nitrate by soil microbes.



How nitrogen is removed from the soil:

Because of its positive charge, ammonium is held in the soil colloids, where it is made available to plants by the action of soil microbes. A small amount of ammonium remains in solution along with the negatively charged nitrite and nitrate which are not held in the soil. These compounds are easily lost by leaching in soil water. Harvesting crops and soil erosion also removes N from the soil.

If soil temperature and soil pH are both high, ammonium can be lost through conversion to ammonia gas ('volatilisation'). In wet or poorly drained soils bacteria can convert nitrate to a gas ('denitrification') which is then lost to the atmosphere.

The use of nitrogen

Nitrogen is an essential element, but it is the hardest fertility to assist with. Creating a fertiliser recommendation for nitrogen usage is not straightforward.

Working to enhance the natural biological function of your soil can create a nitrogen efficient farming operation. In the long term there are a number of ways to improve nitrogen efficiency:

1. **Create the ideal environment for the soil biology to thrive**

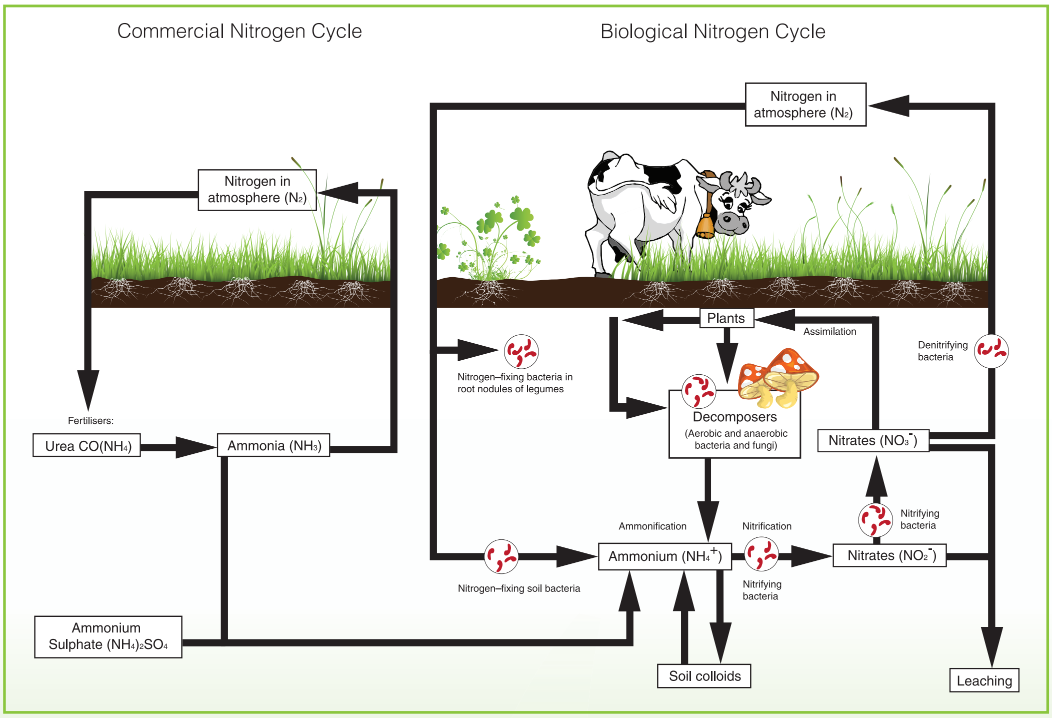
- Correct the soil chemistry to create the ideal soil structure and soil pH for the soil biology to thrive
- In optimum conditions up to 70% of the nitrogen required by crops can be supplied by nitrogen fixation from the soil microbes.

2. **Build/conserve organic matter in the soil**

- Focus particularly on building humus – the organic matter that has been completely decomposed by soil microorganisms – as this is key to a greater and more varied microbial population; better water and fertiliser holding capacity, and to more plant-available nutrients
- For example: 5% organic matter in the soil will equate to 110 kg N available for that year's crop
- To build soil organic matter - correct the soil chemistry and structure to encourage activity of the soil biota as this biota increases the soil's total organic matter – add animal or green manures
- Organic matter can be lost from the soil if the soil is worked while too wet. Also, big applications of nitrogen fertilisers will stimulate microbial activity which will 'burn-up' crop residues and humus.

3. **Provide nitrogen required to grow the crop**

- Of the total nitrogen required to grow a crop, a portion will be supplied by nitrogen fixation, some from the soil's organic matter and the balance supplied from other sources.



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