Bacteria essential for crop nitrogen supply

Soil microbes play an essential role in supplying nutrients to crops. This article outlines the role nitrifying bacteria play in supplying nitrate nitrogen to plants and the soil management and environmental factors which affect this process.

by **Gupta Vadakattu,**
CSIRO LAND AND WATER
and Janet Paterson,
KONDININ GROUP

Nitrifying bacteria produce nitrate nitrogen for plants and, in doing so, lift the fertility of cropping soils.

In a process called nitrification, nitrifying bacteria convert the ammonia nitrogen found in organic matter and inorganic fertilisers into nitrate — a form of nitrogen plants can use.

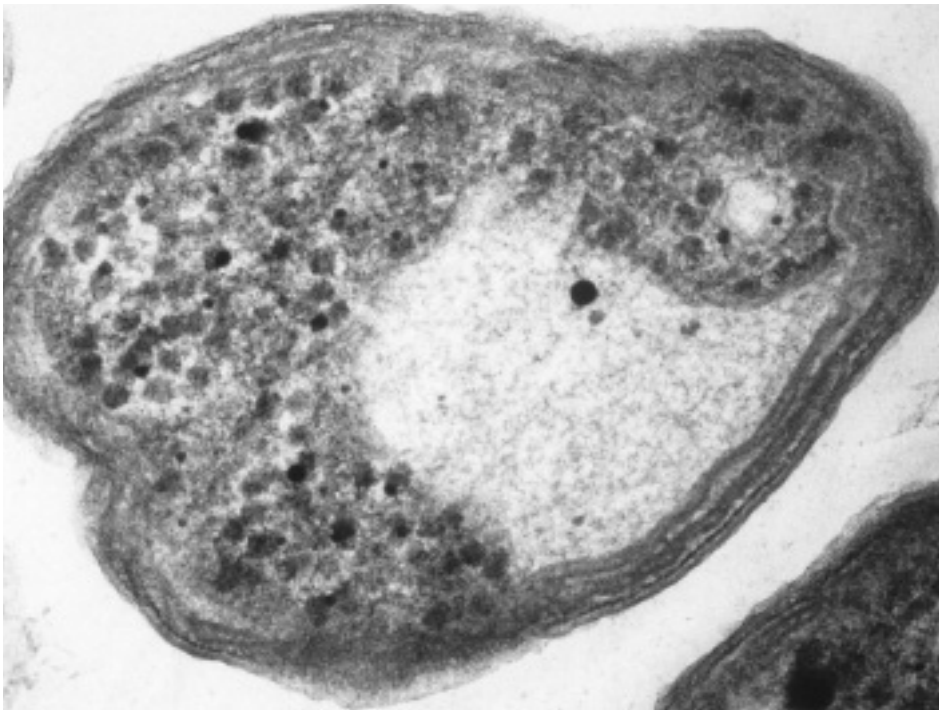
In Australian agricultural soils, populations of nitrifying bacteria can range from 100 to 10,000 per gram of soil. But their numbers can increase 1000-fold in the presence of ammonia, for example, near urea and ammonia fertiliser granules or within liquid nitrogen fertiliser bands.

Nitrifying bacteria are generally rod-shaped microbes ranging in length from 0.5–4.0 micrometres. There are two main groups of nitrifying bacteria — those that convert ammonia to nitrite nitrogen and those that convert nitrite to nitrate nitrogen.

Power-generating microbes

The nitrifying bacteria use the ammonia or nitrite as a source of energy to live and grow. The nitrifying microbe, *Nitrosomonas europea,* has power-generating membranes (long, thin tubes) within its cells which process the ammonia, extracting energy and producing nitrite nitrogen as a by-product.

Nitrosomonas europea uses the energy from ammonia to fix atmospheric carbon dioxide (in a process similar to photosynthesis) into organic molecules, which enable the microbe to grow and multiply.



Mary Ann Bruns, Pensylvania State University

Pictured is the nitrifying bacterium Nitrosomonas europea*, which converts ammonia nitrogen found in organic matter and inorganic fertilisers into nitrite nitrogen. The nitrite is then processed into the plant-available form, nitrate, by another group of nitrifying bacteria.* Nitrosomonas europea *contains power-generating membranes which process ammonia to produce energy. The energy is then used to fix carbon dioxide into organic products, which are used by the bacterium to grow and multiply.*

At a glance

- Nitrifying bacteria process ammonia in organic matter and inorganic fertilisers to produce nitrate, a form of nitrogen plants can use.
- Temperature, soil moisture, oxygen and pesticides all can impact on nitrification.
- Nitrification is highest during warm, moist springs and summers and lowest during dry, hot summers and cool winters.
- Some pesticides such as triazine herbicides can reduce the rate of nitrification in soils.

Nitrification and soil conditions

Nitrifying bacteria require oxygen to grow and perform. Waterlogging restricts the movement of oxygen within soil and therefore suppresses nitrification.

Temperature also affects nitrification with the process slowing at less than four degrees Celsius and more than 40ºC. Nitrification occurs at its fastest rate at about 30ºC.

Nitrification is generally highest during warm, moist springs and summers and lowest during dry, hot summers and cool winters. Nitrification is reduced significantly in soils with a pH less than six. Applying lime generally increases populations of nitrifying bacteria and the process of nitrification.

Agricultural chemicals

Pesticides and soil management practices can affect the process of nitrification.

Several herbicides and fungicides, including triazine, captan and thiram, have been shown to inhibit nitrifying bacteria.

For example, triazine herbicides reduced nitrification by at least 30 per cent in some South Australian soils. Chemicals such as diuron, imidazolinones and fluazifop-P have either no effect or even a stimulatory effect on the process of nitrification.

Soil type and other factors which affect herbicide degradation and persistence can interact to influence the impact of chemicals on nitrification.

Nitrate nitrogen is susceptible to leaching and also can be lost from the soil through denitrification.

Denitrification occurs when the soil becomes anaerobic (lack of oxygen), for example, during waterlogging.

In high-rainfall areas, where nitrogen leaching is a problem, the application of chemicals which inhibit nitrification can reduce the loss of nitrate nitrogen from agricultural soils.

For more information contact Gupta Vadakattu on gupta.vadakattu@csiro.au, phone (08) 8303 8579 or fax (08) 8303 8550.

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Next issue

Non-symbiotic nitrogen fixation