Healthy levels of soil algae lift plant growth

CSIRO Land and Water scientist Megharaj Mallavarapu explains the contribution of algae and cyanobacteria to soil fertility and plant growth. Next month's *Farming Ahead* will look at the impact of pesticides on soil biota.

Increased populations of soil microflora such as algae and bacteria will help improve soil fertility and plant growth.

But despite these benefits, little is known about how soil algae and cyanobacteria can contribute towards maintaining fertility in Australian agricultural soils.

CSIRO research is investigating the role soil microflora play in soil fertility and crop growth, as well as the possible adverse effects of management practices such as pesticide application.

The soil is a living system and the living components are soil organisms. Aside from their role in soil forming, these organisms are vital for plant growth due to their effect on soil fertility levels.

Microscopic plants (microflora) are particularly important, as these help in decomposing organic residues and releasing available nutrients: processes which contribute to pollution control and plant growth.

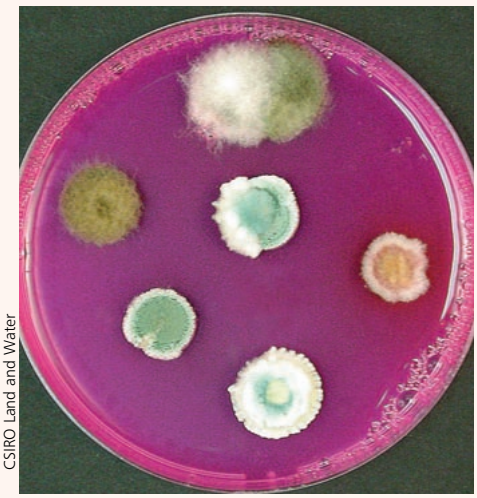
Micro-organisms represent one of the largest reservoirs for essential soil nutrients. They include bacteria, fungi, actinomycetes and algae and can be considered as a living pool of organic matter. One gram of soil may contain populations as high as four billion bacteria, one million fungi, 20 million actinomycetes and 300,000 algae.

Soil algae benefits

Soil algae contain chlorophyll and like higher plants they are capable of photosynthesising their own food. They are found in nearly all environments, and can be divided into four groups including blue–green, green, yellow–green and diatoms. Significant amounts are present at the soil surface and within sub-surface layers of moist soils.

in brief

- Increased numbers of soil microflora such as soil algae and cyanobacteria can improve soil fertility and crop growth.
- Soil algae and cyanobacteria decompose organic residues and release available nutrients for growing plants and pollution control. Cyanobacteria also improve soil structure.
- Adequate moisture, sunlight and phosphorus levels will promote the growth of soil algae.



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Healthy levels of soil micro-organisms including fungi (pictured) algae and cyanobacteria can improve soil fertility and crop growth. Moisture, sunlight and phosphorus all promote soil algae growth.

On agricultural land, algae are a major component of soil microflora, accounting for up to 27 per cent of total microbial biomass on a dry weight basis.

Generally algae, and cyanobacteria in particular, serve a vital ecological function by maintaining soil fertility. They do so by fixing atmospheric nitrogen and carbon dioxide, synthesising and liberating growth-promoting substances which enhance plant growth and by solubilising insoluble phosphates, making phosphorus available to plants.

Cyanobacteria also improve soil structure and are the primary colonisers of barren soils assisting in soil revegetation and restoration.

While microalgae and cyanobacteria are present in all irrigated agricultural soils, including crops like wheat and barley, these beneficial microflora are the predominant organisms in rice ecosystems.

The nitrogen fixing ability of cyanobacteria has been recognised as the main reason for increased rice yields.

Other possible beneficial effects associated with algae in rice fields include weed competition, excretion of organic acids, which increases phosphorus availability to rice, and the production of plant growth regulators which enhance rice growth.

Biofertilisers

Cyanobacteria have significant potential as biofertilisers. Because they are free living and derive carbon from sunlight they do not need to compete for carbon with resident microflora, which in turn allows the organisms to grow and multiply on the surface of moist soils.

Cyanobacteria's ability to protect nitrogen enzymes in an oxygenated environment enables fixed nitrogen to be made available to crops through the slow leaching of nitrogen from living filaments as well as the mineralisation of dead biomass.

Algalisation technology for rice fields was developed in India, Japan and China.

The technology starts with the isolation of superior nitrogen-fixing strains of cyanobacteria, which are then mass cultured in a soil-water medium in shallow ponds. The resulting cyanobacteria are harvested and inoculated onto soil as dry algal flakes.

Yield increases of up to 50% in rice due to cyanobacterial nitrogen fixation have been reported from field trials carried out in India, Japan and the Philippines.

Cyanobacteria have also increased yields in oats, barley, rye, sugarcane, lettuce, chilli and other vegetables.

Research shows crops which are dependent on irrigation favour algal colonisation and reproduction. This may reduce the need for using synthetic nitrogen fertilisers and minimise pollution.

Pollution indicators

Soil algae can serve as indicators of soil quality due to their abundant distribution across a range of soil types and environments (including arid, semi arid, deserts and ice) and their location as the food chain base. They are easy to sample, easy to handle and culture, and chemical assays are relatively cheap and cost effective.

Soil algae populations are already being used to monitor pollution and disturbance in agricultural lands.

In the tropics where soils are prone to organic carbon depletion due to rapid mineralisation, algal fertilisation helps improve organic carbon levels.

While the presence of diverse algal species in agricultural soils indicates a healthy soil, microscopic laboratory examination is needed to determine the precise nature of these diverse microalgae and cyanobacteria.

Adequate moisture and phosphorus, together with sunlight will promote the growth of soil algae and their contribution to agricultural productivity.

Most research to date has focused on rice crops and there is now scope for more work in other crops.

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