SUPERIOR

Soil Microbiology

The ‘engine room’ of the farm

In our fertiliser programmes we emphasise the need to correct the base saturation elements calcium (Ca), magnesium (Mg), potassium (K) and sodium (Na) first as these elements have a big influence on the soil structure and pH, and also on the release of plant available nutrients. The ‘ideal’ soil has a balanced pH of around 6.0 – 6.5 and a soil structure that holds 25% air and 25% water – the optimum environment in which the soil microbiology can thrive.

For a farming operation, the soil structure and soil chemistry is only two-thirds of the equation[2]; to maximise farm productivity you need a dynamic system in which the soil microbiology – the real ‘engine-room’ of the farm[1] – is working for you.

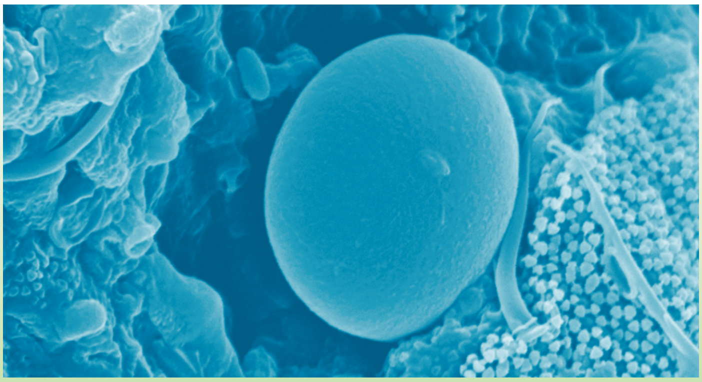
Your fertiliser programme is the key to creating the ideal environment for the soil biota. Correcting the balance of calcium and magnesium is the key to creating the ideal soil porosity. While magnesium can pull a sandy soil together, calcium can condition a tightly held water-logged clay soil, opening up the soil and creating more air space. Earthworms also play a part in aerating and conditioning the soil.

Correcting the base saturation elements of calcium (Ca), magnesium (Mg), potassium (K) and sodium (Na) relative to the holding capacity of the soil will create a balanced pH of between 6.0 – 6.5. Other elements in your fertiliser provide essential minerals not only for crops, but also for the soil microbiology to function. For example, molybdenum is vital for nitrogen-fixing bacteria to operate in legume root nodules.

If using microbiological inoculants; you still need the soil physics and chemistry to be correct to create a home for the microbes to thrive in. If you don’t have the right soil conditions for the biological products to work they are not going to do a good job[2].

A fertiliser programme that does not consider the role and function of the soil biology can stifle a huge potential contribution to your productivity. For example, the overuse of nitrogen fertilisers can adversely affect the natural nitrogen cycle of the soil leading to a drop in the nitrogen (and other nutrients) provided naturally by microorganisms[1]. Once the soil microbes have been ‘switched off’ in this way a greater and more frequent use of fertilisers will be required for crop response.

The benefits of working with the soil biology, utilising natural systems and cycles within your farming operation, are numerous.



Decomposition of organic matter and release of plant available nutrients

The recycling of organic matter, breaking it down into humus – which acts as a store for nutrients – and later releasing plant-available minerals to plant roots, is an important role for the soil microbes. The microbial biomass itself functions as a store of nutrients, released when the bacteria and fungi die.

Soil bacteria and fungi, in particular the mycorrhizal fungi that live in close association with plant root hairs, are largely responsible for the release of nutrients from soil and for breaking down fertilisers, making them into plant-available forms. Mycorrhizal fungi is especially important for releasing nutrients such as phosphorus which otherwise stays locked up in the soil.

Earthworms also have a role in shredding and decomposing plant matter with digested soil (in worm casts) containing higher amounts of plant available N, P, K, Mg, Ca and Mo than the undigested soil1.

Nitrogen fixation

If the soil structure is excellent and the base saturation elements are in balance the soil microbiology should flourish, resulting in up to 70% of crop nitrogen requirements coming from nitrogen fixation bacteria in legume root nodules and by soil microbes releasing nitrogen tied up in organic matter[2]. This only leaves 30% of the nitrogen requirement to be supplied from another source. You can save on fertiliser expenses if the soil microbes are working for you.

Conversion of fertilisers to plant available nutrients:

Both organic and inorganic sources of fertiliser undergo transformations in the soil to convert the minerals to plant-available forms. These transformations are the same, regardless of the input source. The soil microbiology plays a big part in these conversions.

For example nitrogen in the form of urea ($CO(NH_2)_2$) is hydrolysed to ammonium (NH_4^+) by a natural chemical process. Ammonium, because of its positive charge, is attracted to and held by the negative charges in the soil. Bacteria then converts the ammonium to nitrite (NO_2^-) and very rapidly on to nitrate (NO_3^-). Ammonium and nitrate are the only types of nitrogen taken up by plants and used by other soil organisms[4].

Phosphate is available to plants only when it has been converted to inorganic P (either (HPO_4^{2-}) or ($H_2PO_4^-$)) and is present in the soil solution[4]. Unfortunately this form quickly binds to calcium in the soil, becoming difficult for plants to access – thus earning itself the name 'the reluctant nutrient'. Once tied up, correcting the soil pH helps to release the phosphate, but it is largely made available by the action of soil microbes, in particular the action of mycorrhizal fungi, excreting the enzyme phophatase to unlock these compounds[3].

Production of other compounds beneficial to crops

Soil microbes also contribute to the soil structure and water-holding capacity of the soil and produce plant growth hormones and compounds that stimulate root growth and protect the plant from pathogens1.

By taking care of the soil – correcting the soil chemistry to influence the soil structure and pH, and avoiding overuse of nitrogen fertiliser – you harvest all the benefits of a thriving soil microbiota.

References

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