Microbes and soil structure intimately linked

Each teaspoon of soil contains about one billion bacteria which, along with other soil microbes, control the physical and chemical health of a soil. This article introduces a new series called 'know your microbe' which will use close-up images to highlight the critical role micro-organisms play in farming systems.

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A better understanding of soil biology is the next frontier in increasing crop yields, enhancing soil structure and developing more sustainable farming systems.

Soil is fast becoming recognised as a living organism — with, per hectare, its underground 'livestock' (soil organisms) frequently outweighing those which graze above ground.

Scientists now realise many of the factors limiting crop productivity relate to the biological interactions between crop roots, soil microbes and the physical and chemical nature of the soil.

In fact, without soil microbes such as bacteria and fungi soils could not form aggregates (structure) or deliver nutrients to plants.

Put simply, soils without soil organisms would be just useless dirt.

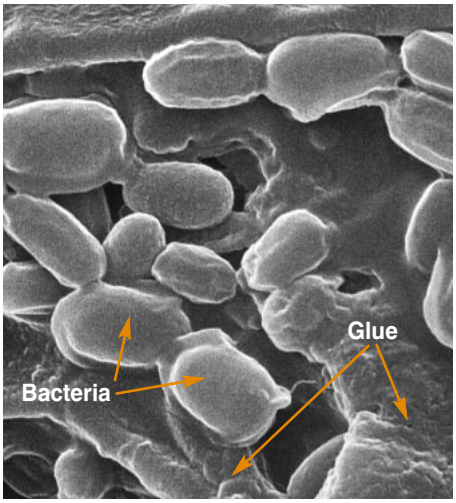
Soil structure

Aggregates are the basic unit of soil structure, consisting of primary particles (sand, silt and clay) along with organic matter and living organisms, all bound together in different-sized clusters (see photos).

While adding organic matter to improve soil structure has been appreciated for centuries, few realise that without soil microbes, organic matter would have very little impact on soil structure at all. Only when organic matter is digested or broken down by soil microbes, do microbes produce the critical 'glue', which binds soil particles together into aggregates.

Along with glue, fungi physically entangle soil particles into aggregates with a vast network of hyphae.

If a bacteriocide or fungicide is applied to soil to inhibit microbial growth, aggregate formation ceases — further evidence of the crucial role microbes play in the development of soil structure.



Photos: CSIRO Land and Water

Microbial 'glues' produced by soil bacteria like those pictured help to bind soil particles into aggregates. Aggregates determine a soil's structure and nutrient and water-holding capacity.

Aggregates control soil health

The size, arrangement and stability of aggregates determines a soil's physical, chemical and biological properties.

While microbial glues control the formation of aggregates, it is the way aggregates are connected that impact on microbial movement and growth.

The size and continuity of pores which form between aggregates, determine how easily microbes can move and multiply.

So, soil structure and soil biology are intimately connected and it is a deeper understanding of this relationship which will ultimately deliver soil management tools to farmers.

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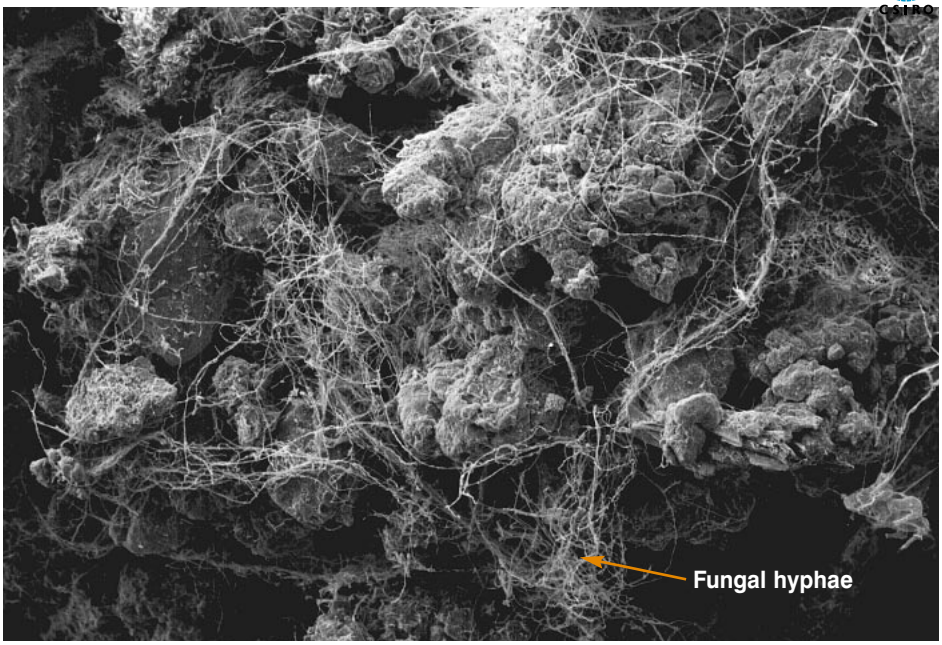
At a glance

- Well-structured soils provide an optimal environment for crop production.
- Mucus produced by soil bacteria and fungi, binds with soil particles to form aggregates.
- In addition, the vast network of thread-like fungal hyphae hold soil particles together, improving soil stability.
- Soils with good aggregation can support more soil organisms and are less prone to wind and water erosion.

Next issue

'Know your microbe' features pythium



Soil-borne fungi produce mucus and a vast network of thread-like hyphae which bind individual soil particles together and improve soil structure and stability. Effective soil structure is critical to minimising erosion and conserving the nutrient- and biota-rich topsoil. Minimum tillage systems enhance soil structure by reducing mechanical disruption of soil aggregates and the microbes they contain. Stubble retention also aids soil structure by stimulating microbial growth and subsequent aggregate formation.