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Biology

MAKING SENSE OF BIOLOGICAL INDICATORS

Biological indicators give information on living organisms in soil. Biological indicators of soil quality therefore measure *dynamic* soil properties, i.e. properties that change over time and/or with management. It is important to monitor biological indicators as they respond more quickly to changes in management or environment than physical and chemical indicators.

For most biological indicators, there is little evidence currently available which directly links the value of the indicators to productivity or, in some cases, the risk of adverse environmental impact. However, there is good evidence from field trials carried out on a range of soils in Australia of links between biological indicators and soil processes. These have been used to create guideline ranges for the biological indicators, similar to those used for the dynamic physical and chemical indicators.

- Indicators falling in the **RED** zone are high risk and need to be investigated urgently.
- Indicators falling in the **AMBER** zone are moderate risk and should be investigated further.
- Indicators falling in the **GREEN** zone are low risk, regular monitoring should be continued.

Diseases and Nematodes

Indicators of soil inoculum status for soil borne disease and/or nematode abundance are used to guide practical paddock by paddock decisions about using control measures. The pathogen–host cycles are complex and affected by a range of environmental, crop and management factors (see Take-all Disease, Cereal Cyst Nematode, Root Lesion Nematode fact sheets). Because the pathogens are highly variable across a paddock, it is very important to use an appropriate sampling strategy to gain results that are representative of the paddock (figures 1 & 2). A medium or high value obtained as part of routine soil monitoring may not lead to a high risk of the disease or significant yield loss. Approaches to managing pathogens need to be specific to each paddock and farmers should seek the advice of an appropriately qualified agronomist.

Risk rating for Disease and Nematodes

below detection	low	medium	high

Figure 1: *Cereal cyst nematode will cause distinct patches of yellowed and stunted plants. Note the likeness of symptoms to poor nutrition or water stress. (Photo by Vivien Vanstone, DAFWA, Nematology.)*

Figure 2: *Patchiness in crop caused by Root lesion nematode. (Photo by Vivien Vanstone, DAFWA, Nematology.)*

Total organic carbon

Organic matter in soil refers to all the materials that are or were associated with living organisms. It is difficult to measure directly and total organic carbon (usually expressed as %C—the percentage of carbon in the soil), is measured instead. The value for total organic carbon can be converted to give tonnes of carbon per hectare using information about bulk density and gravel content (see Total Organic Carbon fact sheet). Low levels of total organic carbon can indicate that there might be problems with unstable soil structure, low cation exchange capacity and nutrient turnover. Where total organic carbon in a paddock is lower than the soil's capacity to store organic matter it may be increased by increasing ground cover, reducing fallow, retaining stubble, increasing the proportion of pasture in the rotation or other management strategies that increase inputs of organic materials into the soil.

Total organic carbon (%C) in sand soil

Total organic carbon (%C) in loam soil

Total organic carbon (%C) in clay soil

Total organic carbon can be separated into its components (termed fractions or pools) which differ in their chemical structure. The labile pool which turns over relatively rapidly (<5 years), results from the addition of fresh residues such as plant roots and living organisms. In contrast, resistant residues are slower to turn over (20–40 years) because they are physically or chemically protected. Soils in Australia also contain charcoal as a result of burning which is almost totally recalcitrant. The proportion of total organic carbon in the labile fraction can be used to identify soils with low amounts of regular residue input. In sand soils, 10% of the total organic carbon should ideally be in the labile fraction; in loam soils 15% and in clay soils 20%.

Microbial biomass

The size of the soil microbial biomass (measured as mg C per kg) is affected by climate and many soil properties (see Microbial Biomass fact sheet). Microbial biomass is the powerhouse of almost all biological processes in soil (figure 3). Generally up to 5% of the total organic carbon can be found in the living tissues of the microbial biomass.

Microbial biomass (mg C/kg soil)

Microbial biomass (% of total organic carbon)

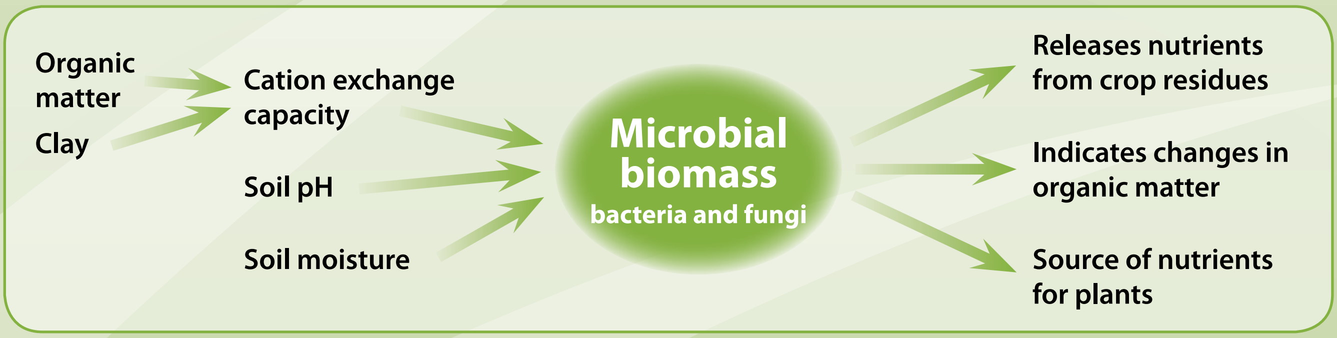

Figure 3: *The main soil properties affecting the microbial biomass and factors influenced by it.*

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wheatbelt natural resource management

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