INTERPRETING MICROBIAL BIOMASS CARBON

Key points

- Microbial biomass is a measure of the weight of microorganisms in soil.
- A challenge in interpreting values of microbial biomass is knowing the attainable microbial biomass for a given land use and what level may constrain production.
- The best way to use microbial biomass values in soil quality monitoring is to measure microbial biomass regularly over time using soil collected during the summer months.
- An estimate of the attainable microbial biomass carbon is 5% of the organic carbon in soil.

Background

Microbial biomass is a measure of the weight of microorganisms in soil, which mostly consists of bacteria, fungi and other microbes called archaea. Measures of microbial biomass usually measure either the weight of carbon or nitrogen in soil microorganisms.

A challenge in interpreting values of microbial biomass is the difficulty of knowing the attainable microbial biomass for a given land use and what level of microbial biomass may constrain production.

Microbial biomass to monitor soil quality

Microbial biomass is a useful indicator of soil quality. Soil microorganisms are involved in several processes that influence soil quality and microbial biomass changes rapidly in response to changes in soil properties (see Microbial Biomass fact sheet).

Single measurements of microbial biomass can be difficult to interpret, but trends over time are a relatively simple way of assessing the effect of management on soil microorganisms.

Increases in microbial biomass over time are considered beneficial. They may indicate an increase in beneficial biological functions in soil and a future increase in organic carbon content in soil. In contrast, a decline over time is considered to have a negative effect on soil quality.

The best time to sample microbial biomass is during the dry summer months when soil is collected for chemical analysis by commercial laboratories. Microbial biomass varies greatly during the year, however during summer, it is more stable because both organic carbon inputs and soil water are low (see Microbial Biomass fact sheet).

Soil type determines the potential microbial biomass

The potential microbial biomass of a soil is the maximum microbial biomass that could be sustained by the soil if no other factors were limiting microbial biomass. It is determined by inherent soil properties, especially clay content and soil pH (figure 1). The potential microbial biomass of a soil is rarely achieved because climate factors decrease microbial biomass.

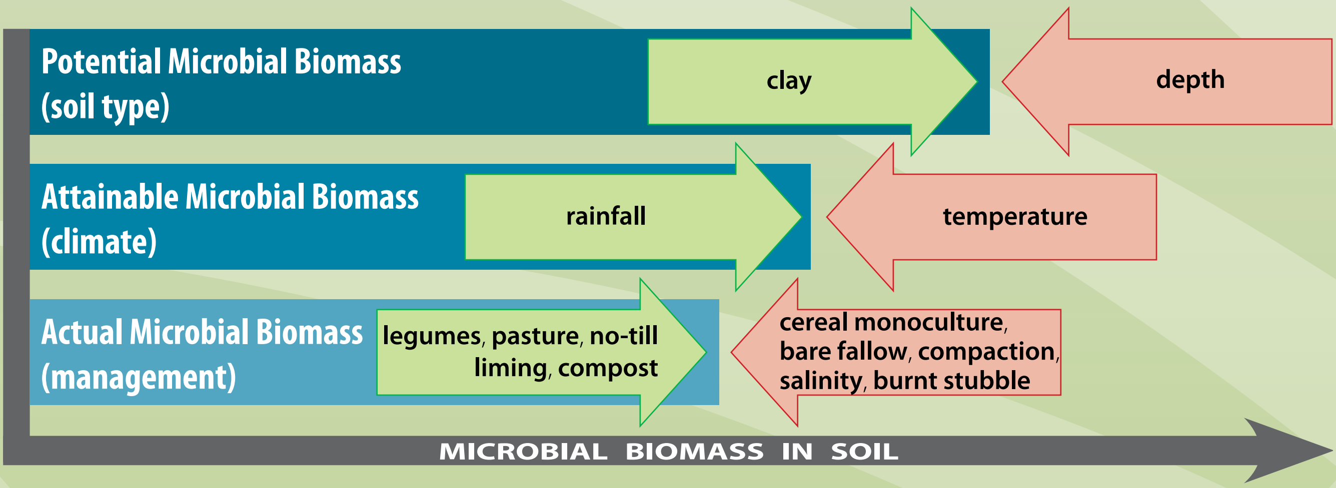

Figure 1: *How soil type, climate and management influence the potential, attainable and actual microbial biomass for a given soil. Based on concepts in Ingram and Fernandes (2001).*

Climate determines the attainable microbial biomass

The attainable microbial biomass is the maximum level that can be expected in a soil under a particular land use. It is mostly determined by the climate because climate influences soil water content and inputs of organic carbon to soil (figure 1). Low soil water content and low inputs of organic carbon are the two factors that most limit microbial biomass in Australian soils.

The attainable microbial biomass varies depending on land use because different land uses support different inputs of organic matter to soil. In the same paddock the attainable microbial biomass will generally be lowest under cropping, higher under pasture and highest for forestry.

Management determines actual microbial biomass

The actual microbial biomass is determined by management practices (figure 1). The microbial biomass is increased by management practices that increase inputs of organic carbon to soil and improve the chemical and physical conditions experienced by microorganisms in soil.

Estimating the attainable microbial biomass

Land managers can estimate the attainable microbial biomass for their soil using the organic carbon content of the soil. Microbial biomass carbon is rarely more than 5% of the total organic carbon in soil. Therefore 5% of the organic carbon content of the soil represents an estimate of the attainable microbial biomass carbon for that soil. The actual microbial biomass is generally lower than the attainable microbial biomass (figure 2).

Another way to determine the attainable microbial biomass is to estimate the microbial biomass for a 'best-practice' land use on a similar soil in the same region. For example, in a Western Australian catchment computer modelling was used to determine the microbial biomass under perennial pasture for soils with a range of clay contents, as indicated by cation exchange capacities. These values were used as an estimate of the attainable microbial biomass for the catchment. When the attainable microbial biomass was compared to the actual microbial biomass values for the catchment, it showed that few soils in the catchment were achieving the attainable microbial biomass (figure 3).

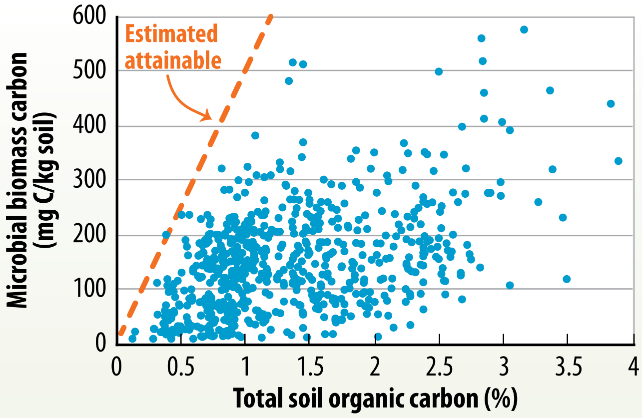

Figure 2: *In most agricultural and horticultural soils in Western Australia, the actual microbial biomass carbon (dots) is lower than the estimated attainable microbial biomass carbon (5% of total organic carbon) (line) (Gonzalez-Quinones et al. 2011).*

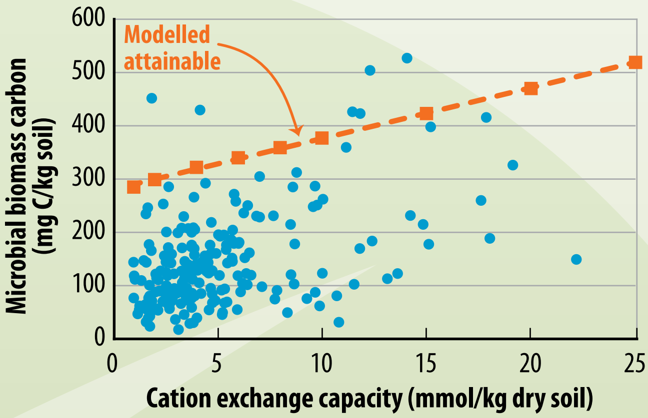

Figure 3: *Actual microbial biomass carbon for agricultural soils in a Western Australian catchment (dots) was usually lower than the attainable microbial biomass predicted by modelling (line) (Gonzales-Quinones et al. 2011).*

Further reading and references

Gonzalez-Quiñones V, Stockdale EA, Banning NC, Hoyle FC, Sawada Y, Wherrett AD, Jones DL, and Murphy DV (2011) 'Soil microbial biomass—Interpretation and consideration for soil monitoring', *Australian Journal of Soil Research*, **49:** 287–304.

Ingram JSI and Fernandes ECM (2001) 'Managing carbon sequestration in soils: Concepts and terminology', *Agriculture, Ecosystems & Environment*, **87:** 111–117.

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The National Soil Quality Monitoring Program is being funded by the Grains Research and Development Corporation, as part of the second Soil Biology Initiative.

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