soilquality.org.au

MICROBIAL BIOMASS

Biology

Key points

- Microbial biomass (bacteria and fungi) is a measure of the mass of the living component of soil organic matter.
- The microbial biomass decompose plant and animal residues and soil organic matter to release carbon dioxide and plant available nutrients.
- Farming systems that return plant residues (e.g. no-tillage) tend to increase the microbial biomass.
- Soil properties such as pH, clay, and the availability of organic carbon all influence the size of the microbial biomass.

Background

The microbial biomass consists mostly of bacteria and fungi, which decompose crop residues and organic matter in soil. This process releases nutrients, such as nitrogen (N), into the soil that are available for plant uptake. About half the microbial biomass is located in the surface 10 cm of a soil profile and most of the nutrient release also occurs here (figure 1). Generally, up to 5% of the total organic carbon and N in soil is in the microbial biomass. When microorganisms die, these nutrients are released in forms that can be taken up by plants. The microbial biomass can be a significant source of N, and in Western Australia can hold 20–60 kg N/ha.

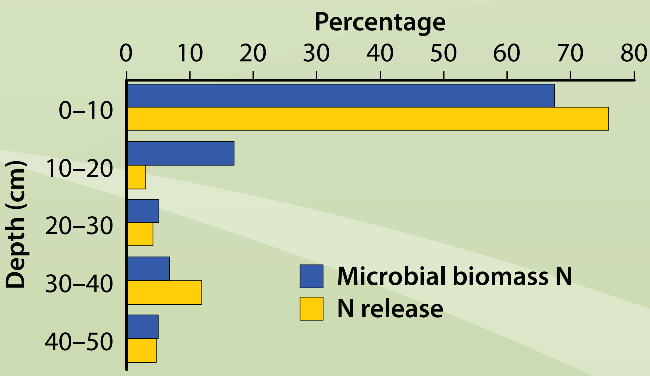

Figure 1: *The figure shows both microbial biomass nitrogen and release of nitrogen decreasing with depth (Murphy et al., 1998).*

Microbial biomass is also an early indicator of changes in total soil organic carbon (C). Unlike total organic C, microbial biomass C responds quickly to management changes. In a long term trial at Merredin, no significant change in organic C was detected between stubble burnt or retained plots after 17 years. Microbial biomass C in the same plots had increased from 100 to 150 kg-C/ha (Hoyle *et al.*, 2006a).

In soil the microbial biomass is usually 'starved' because soil is too dry or doesn't have enough organic C. The amount of labile carbon is of particular importance as this provides a readily available carbon energy source for microbial decomposition. Soils with more labile C tend to have a higher microbial biomass.

Important sources of organic carbon as food for the microbial biomass are crop residues and soluble compounds released into the soil by roots (root exudates).

Factors affecting microbial biomass

The microbial biomass is affected by factors that change the water or carbon content of soil, and include soil type, climate and management practices. Rainfall is usually the limiting factor for microbial biomass in southern Australia (figure 2). Soil properties that affect microbial biomass are clay, soil pH, and organic C (figure 3). Soils with more clay generally have a higher microbial biomass as they retain more water and often contain more organic C (figure 4). A soil pH near 7.0 is most suitable for the microbial biomass.

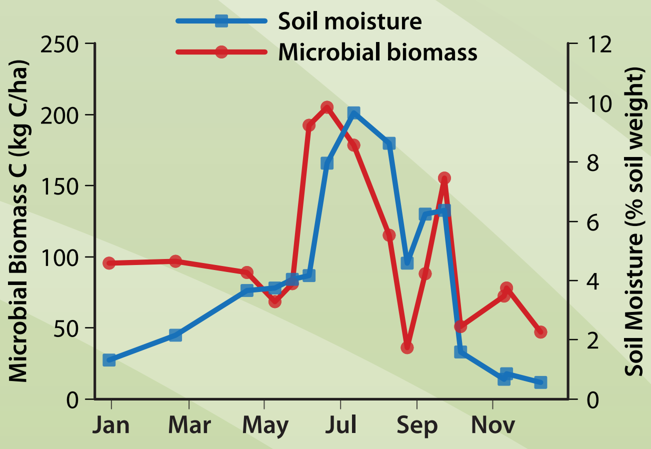

Figure 2: *Microbial biomass carbon over a year from a soil near Meckering, WA.*

Management of crop residues influences microbial biomass as they are one of the primary forms of organic carbon and nutrients used by the microbial biomass. Retaining crop residues rather than burning them provides a practical means of increasing the microbial biomass in soil by increasing the amount of organic carbon available to them (table 1).

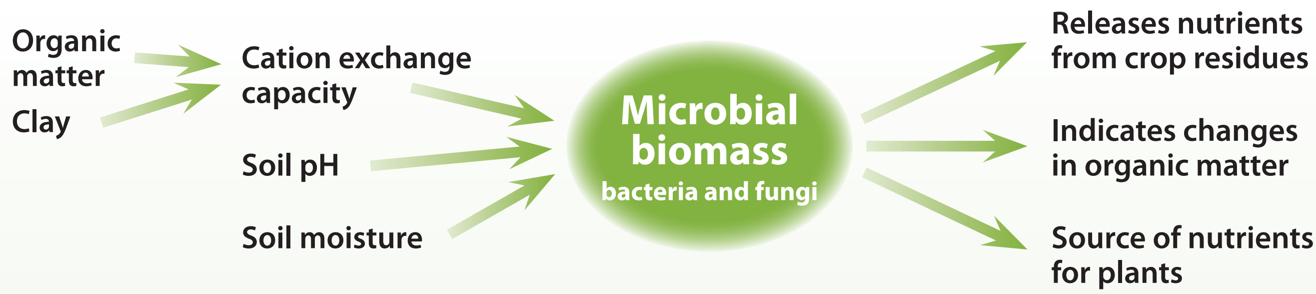

Figure 3: *The main soil properties affecting the microbial biomass and factors influenced by it.*

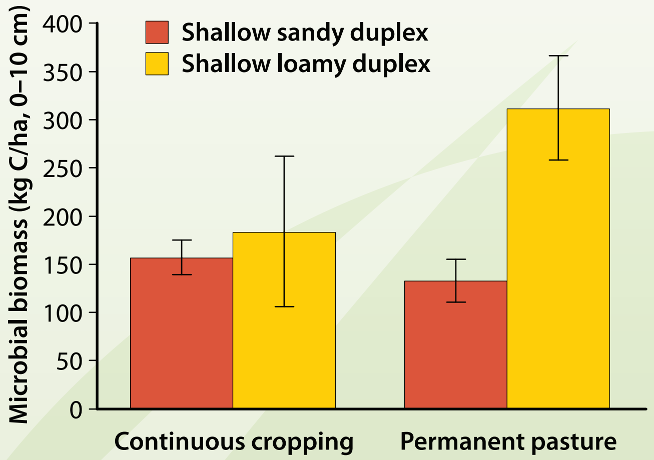

Figure 4: *Microbial biomass in soils with different clay contents and under different management. Soils with more clay generally have a higher microbial biomass because they retain more water and often contain more organic cabon.*

Table 1: *The effect of 17 years of retaining or burning stubble on microbial biomass carbon at different soil depths at Merredin, WA (Hoyle et al., 2006b).*

Soil depth (cm)	Microbial biomass carbon (kg/ha)	
	Stubble retained	Stubble burnt
0–10	229	165
10–20	112	93
20–30	69	58

Tillage practices that are less disruptive to soil can increase the microbial biomass. Less disruptive tillage increases the microbial biomass by increasing labile carbon in soil (figure 5). These management practices also protect soil aggregates and do not break fungal networks, which are an important habitat for the microbial biomass in soil.

The type of crops in a rotation can affect the microbial biomass. The residues of legume crops can increase microbial biomass due to their greater N contents. Rotations that have longer pasture phases increase microbial biomass because soil disturbance is reduced (figure 4). This may not be the case in sandy soils, where the lack of clay means organic matter is broken down rapidly. This leaves the microbial biomass 'starved'.

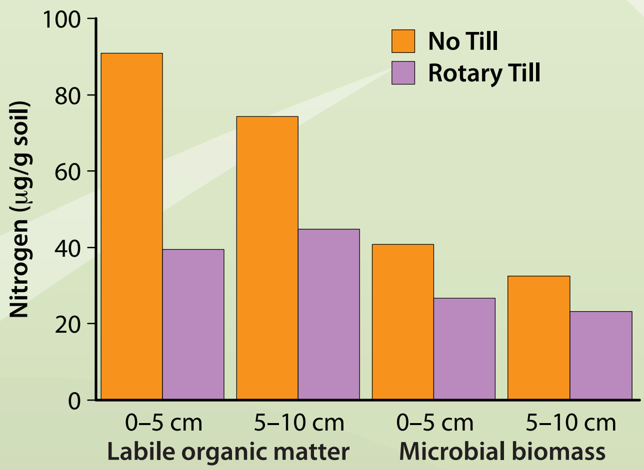

Figure 5: *The figure shows an increased nitrogen content in labile organic matter and the microbial bioass with no-till than rotary till in a 9-year field trial at Wongan Hills, WA (Cookson et al., 2008).*

Further reading and references

Cookson WR, Murphy DV and Roper M (2008) Characterising the relationships between soil organic matter components and microbial function and composition along a tillage disturbance gradient. *Soil Biology and Biochemistry* **40**: 763-777.

Hoyle FC, Murphy DV and Fillery IRP (2006a) Temperature and stubble management influence microbial CO_2-C evolution and gross transformation rates. *Soil Biology and Biochemistry* **38**: 71-80.

Hoyle FC and Murphy DV (2006b) Seasonal changes in microbial function and diversity associated with stubble retention versus burning. *Australian Journal of Soil Research* **44**: 407-423.

Murphy DV, Sparling GP and Fillery IRP (1998) Stratification of microbial biomass C and N and gross N mineralization with soil depth in two contrasting Western Australian Agricultural soils. *Australian Journal of Soil Research* **36**: 45-55.

Author: **Jennifer Carson** (The University of Western Australia)

This soilquality.org.au fact-sheet has been funded by the Healthy Soils for Sustainable Farms programme, an initiative of the Australian Government's Natural Heritage Trust in partnership with the GRDC, and the WA NRM regions of Avon Catchment Council and South Coast NRM, through National Action Plan for Salinity and Water Quality and National Landcare Programme investments of the WA and Australian Governments.