The importance of soil organic matter

By Marcel Essling

What is soil organic matter and is it different from soil organic carbon?

Soil organic matter (SOM) is the portion of the soil made up of decomposed plant and animal materials as well as microbial organisms. It is composed mainly of carbon, hydrogen and oxygen as well as small amounts of other elements including nitrogen, phosphorous, sulfur, potassium, calcium and magnesium. As carbon is the main 'building block' (58%) of SOM, soil organic carbon (SOC) is commonly measured as a proxy for SOM. To estimate SOM from SOC, the formula SOM = SOC x 1.72 can be used.

What is soil organic carbon?

Carbon exists in two forms in soils – inorganic and organic. Inorganic carbon is mineral–based and is relatively stable. Organic carbon includes decaying plant matter, soil organisms and microbes. Organic carbon is of interest because it is often associated with soil health and can be influenced by land management practices.

Should I be trying to increase my soil carbon?

Soil organic matter fulfils many important functions and higher levels of SOM/SOC are associated with benefits including:

- improved nutrient availability to plants and soil microbes
- better stabilised soil structure less prone to erosion
- increased water-holding capacity
- increased water penetrability.

As climate is predicted to become hotter and drier in many wine-growing areas of Australia, higher levels of SOC in vineyard soils would be beneficial to improve the buffering capacity of soil by increasing its potential water-holding capacity.

Wine-grapes do not require high rates of nutrient inputs. Significant changes to nutrient and water availability can influence yield, vegetative growth and fruit composition. Before embarking on a program to increase SOC it is important to assess current vineyard performance (yield, fruit and wine quality) and consider the impact that a change in soil fertility may have on vine balance and fruit quality. It is also important to accept that Australia has a naturally 'weathered' landscape and Australian soils are typically low in organic matter by world standards. While there are management practices that are detrimental to SOC and alternatives to these should be found, the pursuit of increasing SOC should consider the limitations of the Australian soil and climate, so time and resources are not wasted.

What is the right amount of soil organic carbon for my vineyard?

The amount of SOC in a soil right now is a function of the inherent characteristics of the soil, climatic factors and how the land has been managed. Soil-specific factors including clay content, bulk density and depth are inherent characteristics and difficult to change. Climatic factors such as rainfall, temperature and solar radiation will have site-specific impacts on SOC. Land management decisions that influence SOC levels in vineyards include:

- cultivation
- the amount and weight of traffic
- the presence or absence of midrow and under-vine swards
- the types of groundcover planted
- the application of compost or mulch.

White and Krstic (2019) provide an indication of optimal values for SOC by soil type: sand > 1%, loam >1.6% and clay > 2%. These optimal SOC targets show the difference that might be expected based purely on clay content and highlight the importance of considering SOC targets on a vineyard by vineyard basis. If a vineyard's soil is badly degraded and tests indicate SOC lower than optimal levels, improvements can be made by changing management practices (e.g. increasing plant groundcover and biomass). Alternatively, if tests indicate that a soil already has adequate levels of SOC for the soil type, temperature and rainfall, it may take a large amount of effort and resources to achieve increases in SOC and it is less likely that the gains will be stable.

What are some of the options to increase soil organic carbon?

The SOC in a vineyard is the difference between the inputs (plant material) and losses (from microbial decomposition, erosion and light or heat damage) (Carson 2020). On the input side, maintaining volunteer swards, planting cover crops and applying compost will increase SOC. Applications of mulch will help protect the soil surface from heat and erosion and if the mulch is an organic substance (see Proffitt 2014 for differences in mulch types) it will add to the carbon cycle as it breaks down. Actions to reduce compaction and minimise cultivation will improve soil structure and avoid the carbon losses that can occur when soil is disturbed.

Cover crops or volunteer sward

Allowing plant growth or sowing the midrow with a cover crop can improve SOC. As a groundcover grows and senesces, leafy tissue, plant roots and root exudates provide an important source of carbon to the soil system. This living cover protects the soil from erosion (water and wind) and light and heat damage. Reductions in surface crusting, improvements to soil structure and higher levels of soil microorganisms are among the benefits observed from growing cover crops.

Compost application

Compost is an organic material that has undergone controlled biological and chemical decomposition resulting in a stable substance resistant to further decay (Proffitt 2014). When environmental conditions are suitable,

a surface application of compost will increase topsoil OM levels. This results in benefits to soil structure, water infiltration and aeration, water- and nutrient-holding capacity and enhanced microbial biodiversity and abundance.

Mulch application

Mulch is any material (not necessarily an organic material) placed on the soil surface. In vineyards it is typically applied under vines and is used to improve soil moisture retention, reduce topsoil temperature variation, reduce erosion and suppress weeds. The protection of topsoil from erosion and the soil moisture retention achieved through the use of mulch are beneficial to SOC.

Cultivation

Clay particles and aggregates in soil physically protect organic matter from decomposition. This is because it is more difficult for microorganisms to come into contact with organic matter when it has been adsorbed to clay surfaces, coated with clay particles, or buried inside small pores or aggregates. Cultivation of clay soils breaks up the soil aggregates and gives microorganisms access to the OM. If OM is brought to the soil surface it will also be subjected to climatic factors such as heat and light that lead to its decomposition.

Recommendations

Soil organic carbon is important to the physical, chemical and biological processes in a healthy soil. Actions that allow a soil to reach its SOC potential given the constraints of a site should be encouraged. The key opportunities in viticulture involve allowing growth in midrows and undervine; minimising soil disturbance and heavy traffic; and applications of mulch and compost.

References and further reading

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