SoilWealth
NURTURING CROPS

Integrated Crop Protection
PROTECTING CROPS

DECEMBER 2020

HOW DO YOU KNOW YOUR SOIL IS HEALTHY?

TOP TIPS FOR VEGETABLE GROWERS

KEY MESSAGES

- ✔ **A healthy soil is productive, sustainable and profitable.**
- ✔ **Soil health is the condition of the soil in relation to its inherent or potential capacity to sustain biological diversity, maintain environmental functions, and support healthy plants and animals.**
- ✔ **A soil health status or soil condition can provide insights into a soil's capacity to fulfil all soil functions.**
- ✔ **This fact sheet outlines how soil organic matter and soil organic carbon can indicate the physical, chemical and biological benefits associated with soil health.**

WHAT IS SOIL HEALTH?

Soil health is not a consistent attribute that applies to all soils. It is not absolute, or the same, for all soil types, environmental and management conditions.

It is therefore more appropriate to talk about a soil health status or a soil condition.

A **soil health status** can be described as the difference between a current soil condition and the potential (optimum) condition of a soil in a certain environment under a specific management regime.

The soil health status determines a soil's capacity to fulfil all soil functions, including nutrient cycling, carbon storage and turnover, water maintenance, soil structure arrangement, regulation of aboveground diversity, biotic regulation, buffering and the transformation of potentially harmful elements and compounds.

Soil condition is the result of complex interactions between many soil properties, all of which are determined by environmental factors (e.g. climate, topography), inherent soil properties (e.g. soil type, texture) as well as land use type and management practices (on a farm and landscape scale).

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Soil impacts

The impacts of adding organic matter/biomass to land can be hard to differentiate from other aspects of farm management that aim to reduce carbon loss, maintain or increase organic carbon levels in the rootzone such as:

- reducing fallow periods (e.g. via cover crops and maintaining soil cover in perennial crops and pastures)
- reducing tillage (i.e. less aeration of soils and thus burning of organic matter and reducing weight of machinery and equipment that cause soil structure decline (compaction))
- grazing management in pasture systems (keep soil cover, avoid compaction via stocking rates and grazing rotations)
- importing organic carbon sources via soil amendments.

Soil condition aspects

Soil condition aspects are often described under three broad categories (see Figure 1):

- **physical** characteristics that can describe the soil condition (texture, structure, pore size and distribution, bulk density)
- **chemical** (pH, electrical conductivity, contaminant, caution exchange capacity) and
- **biological** (microbial activity, organic matter).

Soil organic matter has an essential function for all three categories.

Soil organic matter and soil health

Soil organic matter (SOM) describes the organic carbon, hydrogen, oxygen, nitrogen and other nutrients that are part of organic compounds in soils.

Soil organic carbon (SOC) is the carbon present in organic forms and is derived from living things. SOC is generally measured as a function of SOM.

The greater the SOC level (as an indicator of SOM), the greater the benefits to the soil. SOC makes important contributions to:

- land surface porosity and infiltration of irrigation/ rainfall
- the soil particulate surface which improves the capacity to hold ions (nutrient holding capacity)
- carbon availability in the soil which is essential as a soil microbe energy source
- increases in microbial activity which in turn increases the availability of released nutrients
- binding particles into aggregates which maintains porosity, houses organisms, increases water infiltration and soil aeration
- increases in stable aggregates which improves resilience to compaction
- reductions in erosion, acidification, salination and resistance to disease.

Loss of organic matter from soils is often cited as the main reason for reduced agricultural productivity and flow-on effects of increased reliance on synthetic growing mediums, fertilisers and crop protection products.

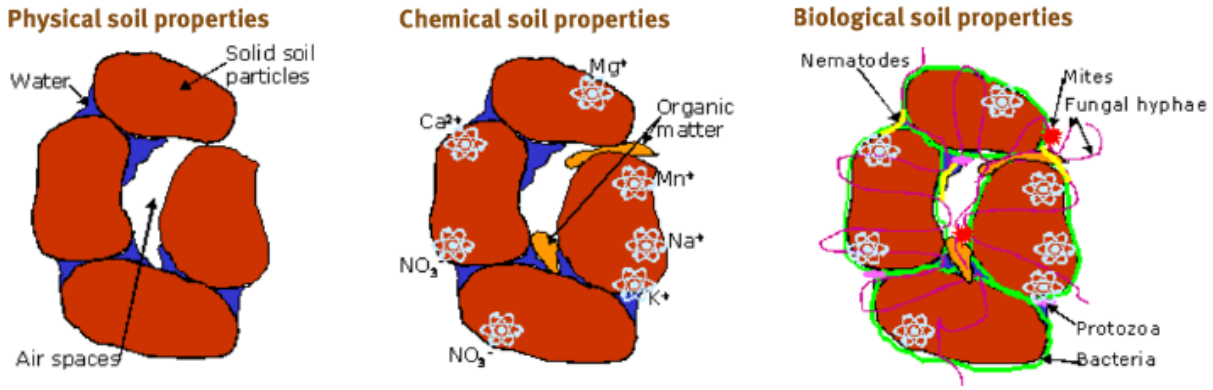

Figure 1: Illustration of broad soil condition categories (adapted from Pattison et al. 2010).

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Physical benefits of SOM

The physical soil functions of SOM:

- improves the structural stability of soils at size scales ranging from the < 250 µm scale of microaggregates to large aggregates (> 250 µm)
- influences the hydrological properties of soil including the water holding capacity, infiltration properties and hydraulic conductivities of subsoil layers
- improves the friability and tilth of the soil
- improves aeration and alters thermal properties.

The structure of the soil impacts on its water holding capacity and the space available for plant growth. Indirectly, this also impacts on microbial activity and nutrient availability and retention.

Water holding capacity is a function of available pore space and the soil's ability to absorb and hold water. In two extremes water will pass through sand, and pool and run-off/evaporate from clay soils.

SOC (as indicator for SOM) can be used as an indicator for water holding capacity because the organic matter in the ground is directly related to retention of water by absorption; indirectly improves physical structure to be more complex and create more pockets for water to be held; and indirectly reduces compaction and increases the depth and area for water to be held.

Chemical benefits of SOM

The chemical functions of SOM:

- contributes to the cation exchange capacity and anion exchange capacity of the soil
- enhances the ability of the soil to buffer against changes in pH
- complexes cations and anions which can reduce the availability of toxic agents in the soil solution, and maintain the availability of nutrients such as phosphorus in a potentially available form (i.e. prevent them from becoming unavailable and prevent leaching losses)
- promotes the binding of organic matter to soil minerals
- interacts with herbicides and pesticides, reducing negative impacts and leaching.

SOM can lessen the effects of soil salinity and sodicity by:

- providing surface cover to prevent erosion
- absorbing some of the salt and anions and preventing plant interaction
- increasing water holding capacity to reduce salinity impact on a plant
- improving cation exchange capacity and holding capacity for calcium and potassium
- improving soil aggregation, aggregate stability and drainage, and reducing dispersion.

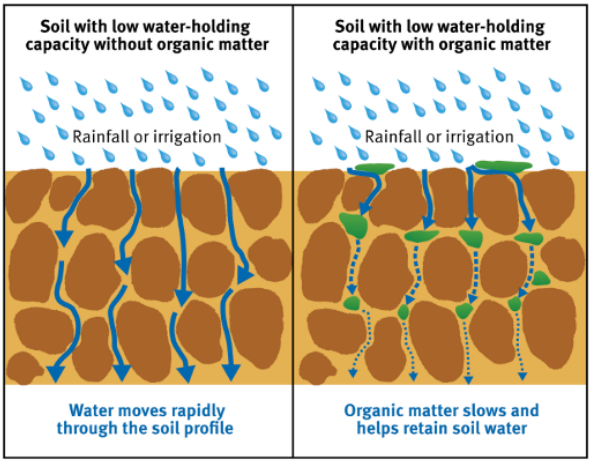

Figure 2: Illustration of organic matters' capacity to absorb and hold water. Source: Pattison et al. 2010.

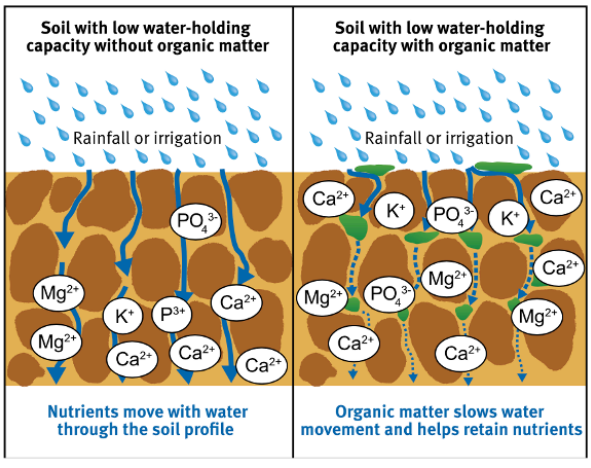

Figure 3: Illustration of organic matters' ability to hold nutrients. Source: Pattison et al. 2010.

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Biological benefits of SOM

The biological functions of SOM:

- provide a source of energy and food for microorganisms that are essential to biological processes in the soil and assist in fixing nitrogen, stabilising soil structure via improved aggregate stability and suppressing diseases of certain plant pathogens
- serve as large reservoir of nutrients (especially nitrogen but also phosphorus, sulphur and micronutrients) which are released to the plant available pool via decomposition processes (mineralisation)
- are essential for the recycling of nutrients
- can contribute to the biological control of disease organisms in the soil via supporting microbial diversity.

FURTHER READING

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