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Soil Life Monitor

Testing for Life

Fact sheet

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OFF-DO-08 V1

Soil Life Monitor explained

Healthy soil is resilient soil. Healthy soils can better cope with various stresses, such as drought, floods, extreme temperatures, pests, diseases, and land-use changes. Balanced soil life is, therefore, the basis of resilient soil, and of sustainable agriculture and natural systems. Soil Life Monitor (SLM) is used by farmers, advisers, and research institutes because it provides information on the microbial life in the soil by mapping the microorganisms, a.k.a. microscopic miracle workers, present.

Bacteria and fungi break down organic matter, and in the process, nutrients are mineralized. These nutrients can be taken up by the plants. High microbial activity is therefore beneficial to plants. A rich microbial ecosystem has less room for pathogens to grow because of competition. Microbial life flourishes at high amounts of organic matter. Organic matter stores carbon, coming from CO_2 in the atmosphere, and increases the water-holding capacity of the soil.

The test results of Soil Life Monitor can be used for benchmarking and comparison between different management styles. SLM can help you to answer many questions, such as whether the addition of compost positively affects the microbial biomass and what the effect of no-tillage has on the fungal community in your soil. Depending on your concern, you can decide how often you want to measure the microbial life. Using the results, you can work in a targeted way to improve soil health towards a resilient soil.

Analysis

Soil Life Monitor is based on Phospholipid Fatty Acids (PLFA) analysis. PLFAs make up the cell membranes of bacteria and fungi. They degenerate quickly, therefore by analysing them, we measure only the living organisms present in the soil. The wet chemistry method we use is GC-MS (Gas chromatography-mass spectrometry), which can determine 120 different PLFAs. PLFAs are specific to different groups of bacteria and fungi, so through this analysis, we can determine the defined groups that are present (bacteria, fungi and protozoa) and their relative quantities.

NIR

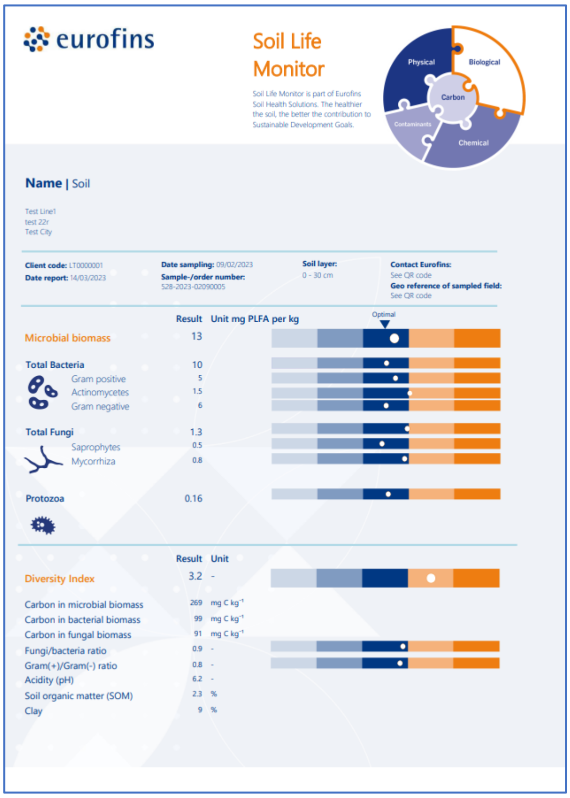
Eurofins Agro also measures PLFAs using near-infrared spectroscopy (NIRS), a quick, innovative, and reliable method. NIRS analysis uses PLFA GC-MS as the wet chemistry reference method. By analysing many samples with both wet chemistry and with NIRS, the NIRS analysis is calibrated to provide an optimized measurement of PLFAs in the soil sample.

Report

The report shows the amount of bacteria and fungi present in the soil. The measurements are compared to target values on a scale from low to high, relative to an optimum value. This evaluation is based on a database of earlier measurements and is corrected for the presence of organic matter. Higher levels of organic matter generally accommodate more microbial biomass.

The report also includes ratios (e.g. fungi/bacteria, Gram+/Gram-) that indicate quality or soil disturbances, and a diversity index, based on the Shannon-Wiener index. Physical parameters are also measured and included on the report, as these can influence microbial life.

The report consists of two pages. The first page includes measurements, calculated parameters and the evaluations thereof. The second page of the report includes an explanation of the parameters.



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Soil Life Monitor

Soil Life Monitor is part of Eurofins Soil Health Solutions. The healthier the soil, the better the contribution to Sustainable Development Goals.

Physical | Biological | Carbon | Contaminants | Chemical

Name | Soil

Test Line1
test 22r
Test City

Client code: LT0000001
Date report: 14/03/2023
Date sampling: 09/02/2023
Sample-/order number: 528-2023-02090005
Soil layer: 0 - 30 cm
Contact Eurofins: See QR code
Geo reference of sampled field: See QR code

	Result	Unit mg PLFA per kg
Microbial biomass	13	
Total Bacteria	10	
Gram positive	5	
Actinomycetes	1.5	
Gram negative	6	
Total Fungi	1.3	
Saprophytes	0.5	
Mycorrhiza	0.8	
Protozoa	0.16	

Optimal

	Result	Unit
Diversity Index	3.2	-
Carbon in microbial biomass	269	mg C kg^{-1}
Carbon in bacterial biomass	99	mg C kg^{-1}
Carbon in fungal biomass	91	mg C kg^{-1}
Fungi/bacteria ratio	0.9	-
Gram(+)/Gram(-) ratio	0.8	-
Acidity (pH)	6.2	-
Soil organic matter (SOM)	2.3	%
Clay	9	%

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Diversity Index

Soil biodiversity represents the variety of life belowground.
A diverse mix of soil life creates healthy soils, with increased resilience.

Physical | Biological | Carbon | Contaminants | Chemical

Explanation

The biological parameters are based on the phospholipid fatty acids (PLFAs) that are present. PLFAs occur in the cell walls of living organisms. Different functional groups have a unique composition of PLFAs. By measuring the composition of the PLFAs, a fingerprint of the microbial community can be given. The target values are corrected based on the organic matter percentage.

Microbial biomass

The sum of all PLFAs is an indication of the amount of microbes. Because PLFAs are rapidly degraded after an organism dies, it mainly represents the living microbial biomass. The microbial biomass is an indicator of the general disease suppression. The more microorganisms there are, the more competition there is with pathogens for space and food. The microbial biomass can be increased by adding effective organic matter such as compost, solid manure, green manures or cultivating grains (incl. straw). Other examples of measures are reduced soil tillage, permanently covering the soil, temporary grassland or less ploughing up of permanent grassland.

Bacteria

Certain groups of bacteria break down (simple) organic material, fix nutrients, bind atmospheric nitrogen, convert ammonium into nitrate nitrogen, form stable aggregates, increase disease resistance and form breakdown products that can weaken or kill pathogens. Bacteria are stimulated by easily degradable materials with a low C/N ratio such as slurry.

Actinomycetes

Actinomycetes are a group of Gram positive bacteria that form threads that resemble fungal hyphae and are able to break down complex materials. Actinomycetes are important for disease resistance, because some species can excrete antibiotics or parasitize pathogens. They can also compete with pathogenic fungi for space and food. Actinomycetes prefer airy conditions and develop poorly in compacted soil or acid conditions (pH <5).

Fungi

Fungi cause degradation of complex forms of organic material, form stable aggregates, excrete organic acids which improve the availability of some nutrients and increase disease resistance through competition or predation. Fungi are stimulated by recalcitrant materials with a high C/N ratio such as straw and compost.

Arbuscular Mycorrhiza

The PLFA analysis gives insight in the biomass of the active mycelium (network of hyphae) of arbuscular mycorrhiza. These fungi live in symbiosis with plant roots and thereby increase the root surface. In exchange for sugars, the plant receives water and nutrients such as phosphorus and potassium. Crops that are not able to form a symbiosis with arb. mycorrhiza are crucifers (e.g. cabbage and yellow mustard) and the goosefoot family (e.g. spinach and beet). A high available phosphate content will reduce the development of mycorrhizas.

Protozoa

Protozoa are single-cell micro-organisms that contain a cell nucleus (eukaryotes). The most important function of protozoa is to make nutrients available to the plant by "grazing" on microorganisms (mainly bacteria). The activity of protozoa is highly dependent on the presence of moisture in the soil. The radius of action of protozoa is limited to water films and water-filled pores.

Fungi/bacteria ratio

The fungi/bacteria ratio indicates the proportion between the fungal and bacterial biomass (expressed in mg C / kg). In general, undisturbed ecosystems have a higher fungi/bacteria ratio than disturbed systems. Organic and low-input systems have a higher fungi/bacteria ratio compared to enriched conventional systems. Disturbances such as tillage and removal of crop residues can lower the fungi/bacteria ratio.

PLFA diversity

The Diversity Index (Shannon - Wiener index) is an indicator of the diversity of the soil life. The index uses the number of species and their abundance as inputs. Higher diversity is often related to better stability and resilience. Disturbances, lack of diverse input from food sources and an intensive crop rotation can decrease the diversity.

Gram(+)/Gram(-) ratio

Gram(+) bacteria are generally larger than Gram(-) bacteria and can form spores. This makes them more resistant to drought and water stress. Gram(+) dominant populations (>1) are more common at the start of the growing season and typically move to a more balanced community when the soil conditions become more favorable throughout the growing season. Gram(-) dominant populations (<1) are often associated with other forms of stress such as plowing and pesticide use. Gram(-) bacteria can better tolerate these forms of disturbance due to the presence of an outer membrane.

Contact & info

After this report has been sent, the sample will be stored for another two weeks for you at Eurofins Agro, if the nature and testmethod of the sample so permit. Within that period you may complain and/or request additional tests.

Parameters on report

Microbial biomass

The microbial biomass (mg PLFA per kg) is the sum of all PLFAs that are measured with the PLFA method. It functions as an indicator of the number of microbes. Because PLFAs rapidly degrade after an organism dies, it mainly represents the living microbial biomass. The microbial biomass is also an indicator of general disease suppression. The more microorganisms there are, the more competition there is with pathogens for space and food. One possible way to increase microbial biomass is by adding organic matter.

Total bacteria

Total bacteria (mg PLFA per kg) is the sum of all PLFAs that make up the membrane of the bacteria which are present in the sample. Certain groups of bacteria break down (simple) organic material, fix nutrients, bind atmospheric nitrogen, convert ammonium into nitrate nitrogen, form stable aggregates, increase disease resistance, and form breakdown products that can weaken or kill pathogens. Bacteria are present in a higher abundance when easily degradable materials with a low C/N ratio, such as slurry, are available.

Gram positive

Bacteria can be divided into Gram(+) and Gram(-) bacteria. Gram(+) bacteria (mg PLFA per kg) are generally larger than Gram(-) bacteria and can form spores. This makes them more resistant to drought and water stress. Gram(+) dominant populations (>1) are more common at the beginning of the growing season and return to balance when soil conditions become more favourable.

Actinomycetes

Actinomycetes (mg PLFA per kg) are a group of Gram+ bacteria that form threads resembling fungal hyphae. They are able to break down complex materials. Actinomycetes are important for disease resistance because some species can excrete antibiotics or parasitize pathogens. They can also compete with pathogenic fungi for space and food. Actinomycetes prefer porous conditions and develop poorly in compacted soil or acid conditions (pH <5).

Gram negative

Gram- (mg PLFA per kg) dominant populations (<1) are often associated with forms of stress, such as ploughing and pesticide use. Gram- bacteria can better tolerate these types of disturbances due to the presence of an outer membrane.

Total fungi

Total Fungi (mg PLFA per kg) is the sum of all PLFAs that make up the membrane of the Fungi which are present in the sample. Fungi cause the degradation of complex forms of organic material, form stable aggregates, and excrete organic acids, which improve the availability of some nutrients and increase disease resistance through competition or predation. A higher abundance of fungi is present when there are more recalcitrant materials with a high C/N ratio, such as straw and compost.

Saprophytes

Saprophytes (mg PLFA per kg) are a group of fungi that excrete enzymes to break down organic material. Nutrients present in the organic material become available when it is broken down. These nutrients are available for uptake by fungi and plants and therefore promote plant growth. Saprophytic fungi form hyphal networks through which the nutrients can be distributed.

Mycorrhiza

The PLFA analysis gives insight into the biomass of the active mycelium (network of hyphae) of arbuscular mycorrhiza. These fungi live in symbiosis with plant roots and thereby increase the root surface of the plant. In exchange for sugars, the plant receives water and nutrients, such as phosphorus and potassium, from the mycorrhizal fungi. Crops that are not able to form a symbiosis with arbuscular mycorrhiza include cruciferous (e.g. cabbage and yellow mustard) and the goosefoot family (e.g. spinach and beet).

Protozoa

Protozoa (mg PLFA per kg) are single-cell micro-organisms that contain a cell nucleus (eukaryotes). The most important function of protozoa is to make nutrients available to the plant by "grazing" on microorganisms (mainly bacteria). Protozoa activity is highly dependent on the presence of moisture in the soil. The radius of action of protozoa is limited to water films and water-filled pores.

Diversity index

The diversity index is calculated using the Shannon-Wiener index. The Shannon-Wiener index is a measure of ecological diversity. The index uses the number of species and their abundance as input. The lowest value of the index is 0 (meaning only one species is present), and the maximum value depends on the number of species when they are all present in the same quantity. In Soil Life Monitor, the Shannon-Wiener index is based on the six groups measured (gram+ bacteria, gram- bacteria, actinomycetes, arbuscular mycorrhiza, other fungi and protozoa). Higher diversity is often related to better stability and resilience. Disturbances, lack of diverse input from food sources, and poor crop rotation can decrease the diversity.

Carbon in microbial/bacterial/fungal biomass

Microbial biomass is an important indicator of soil health. Carbon in microbial biomass (mg C kg -1) is calculated from total microbial biomass (mg PLFA per kg). Carbon in microbial biomass is a measurement that is used often used in other measurements and studies. Carbon in microbial, bacterial and fungal biomass is shown on the report so that this parameter can be compared to other studies.

Fungi/bacteria ratio

The fungi/bacteria ratio indicates the proportion of fungal biomass in relation to bacterial biomass, and is expressed in mg C / kg. This ratio is calculated by dividing carbon in fungal biomass by carbon in bacterial biomass. In general, undisturbed ecosystems have a higher fungi/bacteria ratio than disturbed systems. Organic and low-input systems have a higher fungi/bacteria ratio compared to enriched conventional systems. Disturbances such as tillage and the removal of crop residues can lower the fungi/bacteria ratio.

Gram (+)/Gram (-) ratio

The Gram (+)/Gram (-) ratio (expressed in mg C/kg) is an indication of disturbances and stress. At a lower ratio, Gram(-) bacteria are dominant. These bacteria are better resistant to disruptions like ploughing and pesticides. A high ratio means that Gram(+) bacteria are dominant, these bacteria more resistant to drought and water stress. A balanced ratio is achieved when conditions are more favourable.

Acidity (pH)

The acidity (pH) of the soil is an important soil property to measure when looking at soil life, as acidity influences microbial growth. Fungi generally favour a lower acidity (pH 5,5) but can also grow at a higher acidity. Bacteria favour a higher and a smaller range of acidity (pH 6-7). At a higher acidity (pH 7), organic matter mineralizes quicker. In general, bacteria are more sensitive to changes in pH than fungi.

Soil organic matter (SOM)

Soil organic matter (%) is the collective term for all biomass in the soil that originates from micro-organisms, soil and plant material. Soil organic carbon is a major component of soil organic matter. As well as carbon, SOM also consists of oxygen, hydrogen, nitrogen, phosphate and sulphur. Organic matter has many important functions in the soil and is therefore one of the most important indicators of soil health. Organic matter is food for soil life and an engine for all soil functionalities.

Clay

Clay (%) is the percentage of clay that is present in the soil. The presence of clay influences the soil texture. A higher percentage of clay increases the water-holding capacity and creates smaller pores which are beneficial for certain micro-organisms like bacteria and protozoa.

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