Microbial activity in soils

GLOBE		*Related SDGs:*	*Type of activity*
Sphere	**Protocols**		
Pedosphere	Soil characterization Soil pH Soil texture	4 Quality Education 12 Responsible consumption and production	Research

Overview

Soil microorganisms interact with plant roots and other soil substances, promoting and benefiting plant nutrition and growth; they also facilitate the development of the cycle of matter in the biotopes, which can be classified into **viruses, bacteria, fungi, and parasites**. In principle, a criterion can be established by the approximate size of the organisms studied by microbiology. Viruses are the smallest known pathogenic microorganisms and do not constitute living things. Therefore, capturing its presence and possible quantity in each soil we interact with through global biological activity is essential, which can be established by measuring "soil respiration." Specifically, microorganisms consume the organic fraction and oxygen, releasing carbon dioxide (CO_2). The measurement of the latter gives us an indirect reference to the biological activity of the soil.

Time

Six classes.

Prerequisites

General knowledge of:

- Oxidative processes
- Precipitates
- Salt formation
- Acid-base titration indicator.

School level

K - 8 to k-12.

Purpose

Qualitatively identify soil microbial activity through observation of its$_{CO2}$ production.

Student outcomes

- Indirectly recognize the presence of microorganism activity in the soil.
- Infer possible qualities from the comparative analysis of the results obtained.
- Establish a quantification employing chemical assessment (optional).

Introduction

The microbial activity of the soil has to do with relevant processes such as nitrification, solubilization, mobility of microorganisms, growth of bacteria, fungi, and actinomycetes, among other specific functions that are dependent on the presence of water, pH, oxidation-reduction potentials, temperature, among others. The interactive relationship of the factors described above determines the degree of mobility of microorganisms in the soil and their potential interaction with the roots of plants to facilitate their nutrition and growth.

Guiding Research Questions

- What are the differences between the actions of microorganisms and insects in soils?
- What are the essential effects deduced from the presence of microorganisms in soils?
- What could be the effects of integrating a bacterial culture in a given soil?

Scientific concepts

- Carbon Dioxide ($_{CO2}$)
- Oxidation (chemical process)
- Chemical valuation or titration

Materials and tools

- Glass jars (used to store jams) of approximately 1 l. capacity, with hermetic closure
- Wet soil sample of two or three types
- Small bottle or beaker, 50 cc capacity.
- NaOH 2M

- BaCl2 183 g/l
- Dropper
- HCl 1M (if you want to assess the dissolution of NaOH)
- Phenolphthalein (indicator if you want to assess the dissolution of NaOH)

What to do and how to do it

Beginning

- For each type of soil or horizon of each ground considered: at least 300 grams of fresh soil are taken and placed in a hermetically sealed canister (alternatively, consider reproducing directly in the flask the sequence of layers or horizons that form the soil or designing tests by specific horizon). In the small flask or beaker, arrange 20 ml of the 2M NaOH solution, insert it into the large flask to stand on the open soil sample in direct contact with the unoccupied space of the large container, close the canning jar, and allow two days to elapse, during which you should take note of the temperatures and incubation values (keeping the bottle tightly sealed).

Development

- After this time, the large bottle is opened, the glass of NaOH is collected, and a few drops of baric chloride ($BaCl_2$) are added. The solution acquires whitish turbidity (by precipitation of barium carbonate), proportional to the "respiration" of the soil. (When this method is used in specialized laboratories, it is normalized at a specific temperature and incubation time.)

- Proceed to the discussion of the results of the first stage, where each of the details of time and temperature is tabulated; determine with your working group the need to distribute some tests increasing or decreasing the amounts of sample to be used and the concentrations of the NaOH solution.

- On the fly, and according to your time and resources, define an experimental design with several samples or fractions of the same model under different temperature conditions and hermeticity times; also consider the possibility of testing with aggregation of leaves and organic matter to observe possible

variations. Optionally, you could use a chemical volumetric analysis technique (commonly referred to as valuation/titration) chemistry to have a qualitative background.

– ***Closing***

- Proceed to the organization of the data in graphs, tables, and diagrams; make the final discussion of the results obtained, substantiate with theoretical data, and then make a presentation to the community or a publication in the medium available for the purpose.

Frequently asked questions

-Why is pH measurement recommended?

Because it is a measure that provides a lot of information about the sample, a correlation can be established with the amount of organic matter present.

-Should there be special considerations for working on experiences?

Not necessarily; however, it will never hurt to wear aprons, glasses, and gloves.

Suggested Resources

- GLOBE flooring materials (www.globe.gov)

Bibliography

Badía D, (2008). "*The soil as a didactic tool*" http://www.icog.es/files/geoparque/4.pdf

Olalde V., and Aguilera L., (1998). "*Microorganisms and biodiversity,*" TERRA MAGAZINE VOL. 16 No. 3, retrieved in https://www.redalyc.org/pdf/573/57316312.pdf

Osorio-Vega, N. W. (2009). "*Soil microorganisms and their effect on the availability and uptake of nutrients by plants*". In Sociedad Colombiana de la Ciencia del Suelos & Centro Nacional de Investigaciones de Café (Eds.), Materia orgánica biología del suelo y productividad agrícola: Segundo seminario regional comité regional eje cafetero (pp. 43–71). Cenicafé. https://doi.org/10.38141/10791/0003_3.