Standard Operating Procedure

Potential Carbon Mineralization

Scope

This document describes the measurement of the abundance of carbon dioxide (CO_2) produced over 24 hours from the rewetting of air dried, sieved soil. The CO_2 production can be measured with various methods such as an alkaline trap or by gas analysis following a 24-hour incubation period. Results are reported as milligram CO_2-C per kilogram of dry soil per 24 hours.

Equipment

2-mm (10 mesh) sieve
Air-drying facility (minimum temperature: 30 °C)
Coarse-grinding apparatus (e.g., rolling pin, flail mill)
Analytical balance (±0.1 g sensitivity)
40 mL perforated plastic beaker (1 per sample)
Glass fiber filter (1 per sample)
Half pint mason jar (1 per sample)
Incubator (capable of 24°C)
Bottle-top dispensette
Deionized water
25 mL graduated cylinder

Procedure

1. Transfer the sample to a paper bag or spread out on a tray before drying. Dry the soil sample at temperatures below 30°C to constant weight at ambient temperature. Forced air circulation is recommended to speed the drying process.
2. Break up the soil and pass through a 2-mm sieve. When working with large samples (e.g., composite samples), a subsample may be taken prior to sieving using a sample splitter or by spreading the soil sample across a flat surface, dividing the soil into sections (e.g., a rectangular grid or pie), and collecting all material within multiple non-adjacent sections. Visually verify that the proportions of large to small aggregates/particles are similar for the subsample and the bulk soil sample, as soil aggregates will separate by size during sample handling.
3. Place a glass filter in the bottom of a 40 mL perforated plastic beaker.
4. Weigh and record 40 (± 0.5) g of dried and sieved soil.
5. Place soil in the bottom of the 40 mL perforated plastic beaker on top of the glass filter.
6. Place the beaker into a labeled half pint glass jar.
7. Measure and add 20 mL of deionized water inside the glass jar, but not inside the beaker.
8. Seal the jar tightly with a compatible lid.
9. Place the jar into an incubator (set at 24°C) for 24 hours. Note the time of when the samples were placed in the incubator.
10. After 24 hours (± 1 hour), remove the jar from the incubator and measure the CO_2 produced

11. Discard soil and glass filters. Wash the 40 mL plastic beaker, glass jar, and lid with tap water and air dry for reuse.

CO_2 measurement

There are two main approaches to measure the CO_2 produced during the incubation: alkaline chemicals to trap the CO_2 in the jar or quantifying the change in CO_2 concentration in the jar before and after the incubation. While the results from these methods are highly correlated, it is not recommended to switch between analysis methods in a single study.

1. Various alkaline compounds, such as potassium hydroxide or sodium hydroxide, can be used as a chemical trap. An open container of the alkaline compound is placed inside the mason jar. The CO_2 in the jar is absorbed, and its mass be quantified by measuring changes in electrical conductivity or by titration after accounting for the background level of CO_2 in a control jar with no soil (Franzluebbers and Veum 2020).
2. Any instrument capable of measuring CO_2 concentration (e.g. gas chromatograph or infrared gas analyzer) can potentially be used to quantify the change in CO_2 concentration in the mason jar due to the soil respiration. These instruments tend to be quite expensive, but there have been attempts to make cheaper options (Joshi Gyawali et al. 2019). The difference in CO_2 concentration before and after the incubation can be converted to mg carbon using the ideal gas law. With these methods a lid compatible with the method to collect gas in a syringe or to connect to an instrument must be used.

Calculations

1. Raw data is measured as CO_2 before being converted to units of mg CO_2-C per kilogram of dried soil per 24 hours.

QA/QC

1. It is recommended to do duplicates for 5 to 10% of the samples. Duplicate measurements should differ by no more than 10%.

References

Franzluebbers, A.J., R.L. Haney, C.W. Honeycutt, H.H. Schomberg, and F.M. Hons. 2000. Flush of carbon dioxide following rewetting of dried soil relates to active organic carbon pools. Soil Science Society of America Journal. 64:613-623.
Franzluebbers, A.J., Veum, K.S. 2020. Comparison of two alkali trap methods for measuring the flush of CO2. Agronomy Journal. 112:1279-1286.

Joshi Gyawali, A., Lester, B. J., & Stewart, R. D. 2019. Talking SMAAC: a new tool to measure soil respiration and microbial activity. Frontiers in Earth Science *7*:138. *doi: 10.3389/feart.2019.00138*

NOTE

A full description of a method using a KOH trap is located on the Cornell Soil Health Lab Website (https://soilhealthlab.cals.cornell.edu/resources/)

This SOP was developed by SHI, for SHI communication, and developed after Franzluebbers et al. (2000). For any specific questions, contact Dr. Liz Rieke erieke@soilhealthinstitute.org.