Cornell University
School of Integrative Plant Sciences

Soil Health Manual Series Fact Sheet Number 16-10

Soil Respiration

Respiration is a measure of the metabolic activity of the soil microbial community (Fig. 1). It is measured by capturing and quantifying carbon dioxide (CO_2) released from a re-wetted sample of air dried soil held in an airtight jar for 4 days. Greater CO_2 release is indicative of a more active soil microbial community.

How soil respiration relates to soil function

Respiration is a direct measurement of biological activity, integrating abundance and activity of microbial life. Thus, it is an indicator of the biological status of the soil community, which can give insight into the ability of the soil's microbial community to accept and use residues or amendments, to mineralize and make nutrients available from them to plants and other organisms, to store nutrients and thus buffer their availability over time, and to develop good soil structure, among other important functions. Soil biological activity influences key physical, biological, and chemical soil processes, and is also influenced by constraints in physical and chemical soil functioning.

Several individual enzyme and process activity assays are possible, as is quantification of microbial biomass size. However, measuring respiration by trapping evolved CO_2 gives a rapid, low cost, integrative measure of general microbial activity level.

Managing constraints and maintaining optimal soil biological activity

The soil's biological activity is improved by keeping the soil covered with plants or residues throughout the season, adding fresh, microbially degradable amendments, growing biomass in place by maintaining living roots for as much of the year as possible, increasing diversity of species in the system through rotations, interseeding, or intercropping, and by reducing the use of biocides such as pesticides, fungicides, and herbicides (Fig 2).

Beneficial soil biological activity tends to decrease with increasing soil disturbance such as tillage, heavy traffic, and compaction, as well as with extremes in low or high pH, or contamination by heavy metals or salts.

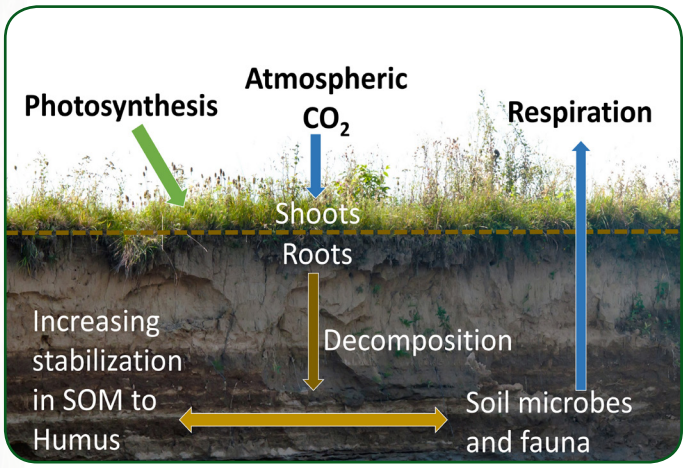

FIGURE 1. The soil respiration measurement is an indicator of soil microbial abundance and activity. A larger, more active community will maximize soil functioning such as accepting and using residues and making nutrients readily available for plants.

FIGURE 2. Mix of winter rye, wheat, barley, and hairy vetch. Cover crop mixes are an excellent way of accumulating plant biomass to build organic matter, alleviate compaction problems, feed soil microbes and suppress disease. Photo: Dorn Cox

Soil Respiration

Basic protocol

- 20.00 g of air-dried, sieved soil are weighed into an aluminum weighing boat, which is pre-perforated with 9 pin-holes through the bottom.
- The weighing boat with soil is placed on top of two staggered filter papers in the bottom of a standard 1 pint wide-mouth mason jar.
- A trap assembly (a 10 ml glass beaker secured to a plastic tripod 'pizza stool') is placed in the jar, and the beaker filled with an alkaline CO_{2-} trapping solution (9 ml of 0.5 M KOH) (Fig. 3 (a)).
- 7 ml of distilled, deionized water is pipetted into the jar onto the side, so that the water runs down and is wicked up into the soil through the filter paper.
- The jar is sealed tightly and incubated undisturbed for 4 days.
- Trap electrical conductivity declines linearly with increasing CO_2 absorption, as OH- concentration in the trap declines and CO_3^{2-} concentration in the trap increases.
- After incubation, the jar is opened and the conductivity of the trap solution is measured (b).
- CO_2 respired is calculated by comparison with the conductivities of the original trap solution, and a solution representing the trap if saturated with CO_2 (0.25 M K_2CO_3).

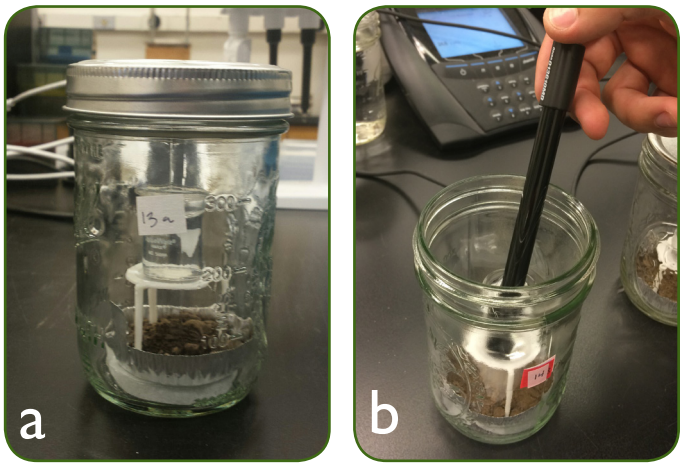

FIGURE 3 a and b. Soil Respiration is measured by capturing and quantifying CO_2 released from samples.

Scoring function

Figure 4 below depicts Soil Respiration scoring functions and upper value limits for coarse, medium, and fine textured soils. Scoring functions were combined for all classes because no effects due to texture were observed in the data set.

The red, orange, yellow, light green and dark green shading reflects the color coding used for the ratings on the soil health report summary page.

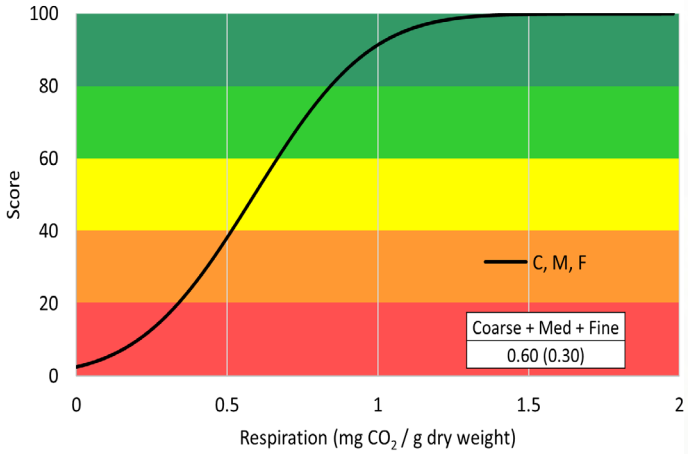

FIGURE 4. Soil Respiration scoring functions and upper value limits for Coarse (C), Medium (M) and Fine (F) textural classes. Mean and standard deviation (in parenthesis) is provided. In this case more is better. Higher respiration scores indicate the presence of a larger, more active soil community.

Cornell Soil Health Laboratory Soil Respiration Standard Operating Procedures (CSH 06) can be found under the 'Resources' tab on our website.

For a more comprehensive overview of soil health concepts including a guide on conducting in-field qualitative and quantitative soil health assessments, please download the Cornell Soil Health Manual at bit.ly/SoilHealthTrainingManual.

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