# DETERMINING SOIL QUALITY

Driving Question

What is a healthy soil and what physical, chemical, and biological characteristics are needed to grow our food?

Materials and Equipment

|  |  |
| --- | --- |
| * Microwave oven (1 per class) | * Pipet, disposable |
| * Carbon dioxide sensor and sampling bottle | * Digging tool |
| * pH sensor | * Soil samples (from 3 different locations) |
| * Conductivity sensor * Beaker (4), 100-mL * Beaker, 50-mL * Graduated cylinder, 100-mL * Microscope with magnification up to 400x * Microscope with magnification up to 400x * Dissecting microscope * Microscope slides and cover slips (3) | * pH calibration solution, pH 4,7,10 * White household vinegar, 4 mL * Distilled or deionized water, 300 mL * Wash bottle containing distilled or deionized water * Plastic bags (4), sealable, about 1-L * Waste container * Permanent marker * Labeling tape |

Background

Soil quality, also referred to as soil health, is defined as the continued capacity of soil to function as a vital living agro-ecosystem that sustains plants, animals, and humans. This definition speaks to the importance of managing soils so they are sustainable for future generations. To do this, we need to remember that soil contains living organisms that when provided the basic necessities of life - food, shelter, and water - perform functions required to produce food and fiber.

Procedure

1. Collect 3 soil samples by doing the following:

* Using a clean trowel or soil sampling probe loosen the soil as deep as 10 centimeters and place about 200 ml into a plastic bag.
* Label the bag to indicate the soil’s location and seal it.

2. Connect the CO2 gas sensor.

3. Open the Soil respiration lab file from the experiments menu under Determining Soil Quality.

4. Using the 50-mL beaker, add approximately 40 mL (4 tablespoons) of soil from Soil Sample 1 to the sampling bottle. Lower the CO2 gas sensor into the bottle and cork it tightly using the attached stopper.

5. Start recording data for 600 seconds (10 minutes) then stop recording data and record it in the table 1 below.

6. For Soil Samples 2 and 3, repeat the steps above.

Table 1: Analysis of 3 soil samples

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Soil Sample | Data Run | CO2 Gas Generation (ppm) | Soil Salinity (conductivity) (μS/cm) | Initial Soil pH | Soil pH  After Adding 10% Vinegar | Change in pH |
| 1 | 1 |  |  |  |  |  |
| 2 | 2 |  |  |  |  |  |
| 3 | 3 |  |  |  |  |  |
|  | 4 |  |  |  |  |  |

7. Remove any rocks and sticks. Crush Soil Sample 1 into a fine dust with the end of the handle of your digging tool or other suitable instrument.

8. Place 40 mL of Soil Sample 1 into a 100-mL beaker. Label the beaker "#1". Mix 40 ml of distilled water into the beaker and shake or stir the mixture for at 5 minutes.

9. Repeat the steps for preparing the soil for the other two samples, rinsing the stirring rod after mixing each sample.

10. Pair the wireless conductivity sensor to the data collection system and monitor live data without recording.

11. Lower the conductivity probe into the soil-water mixture. Gently stir the solution with the probe during data collection. Wait for the measurement to stabilize (as long as 30 seconds). If necessary, adjust the sensitivity of the conductivity sensor.

12. Enter the soil salinity value in Table 1. Repeat the steps for measuring the salinity for the other two samples.

13. To determine the soil pH of soil samples 1, 2 and 3 repeat the steps for the soil salinity.

14. Rinse the pH probe with distilled or deionized water. Monitor live data without recording.

15. Lower the pH probe into the soil-water mixture, and gently stir the solution with the probe during data collection. Wait for the measurement to stabilize (as long as 30 seconds).

16. Enter the pH value in the "Initial Soil pH" column of Table 1 in the Data Analysis section.

17. Repeat the steps for collecting data for the other two samples.

18. Prepare 40 mL of a 10% vinegar solution.

* Pour 4 mL of vinegar into a graduated cylinder.
* Fill the cylinder to 40 mL with distilled water to make a 10% vinegar solution.
* Pour the solution into a 100-mL beaker.

19. Lower the pH probe into the vinegar solution and gently stir the solution with the sensor during data collection.

20. Determine the pH of the vinegar solution and record it here: \_\_\_\_\_\_\_\_\_\_\_\_\_

21. Add 10 mL of the 10% white vinegar solution to soil-water mixture number 1 and mix thoroughly. Rinse the pH probe with distilled water.

22. Lower the pH probe into the soil-water mixture and gently stir the solution with the probe during data collection. Wait for the pH to stabilize.

23. Enter the pH value in Table 1 in the Data Analysis section.

23. Repeat the steps of the subsection "Determine the buffering capacity" for the other two soil-water mixtures.

24. Place a small sample of soil (no larger than a penny) from each soil sample on a sheet of white paper.

24. Compare the soil color, texture, structure, and apparent moisture level of each sample, and enter your observations in a table like Table 2.

25. Identify the soil sample that has the highest CO2 level and place a 50-ml aliquot on a plastic container and expose it to microwaves for 120 seconds.

26. What happens to the living organisms in the soil sample when it is microwaved?

Table 2

|  |  |
| --- | --- |
| Location |  |
| Date/time |  |
| Soil color |  |
| Soil texture/Structure |  |
| Moisture |  |
| Observations |  |

Analysis & Questions

1. The rate of change of CO2 gas concentration is indicative of the rate of change in cellular respiration. What kind of soil would you expect to produce CO2 gas at a faster rate—dark, moist soil or dry, clayey soil? Why?

2. Which of the three soil solutions had the highest conductivity? Explain why it might be higher than the other two samples. Recall the location of the sample.

3. Each plant type possesses an inherent tolerance level to salinity. In general, a crop should tolerate salinity levels up to 700 micro Siemens per centimeter (µS/cm), without a decrease in yield; however, some plants tolerate even higher levels of salinity. If a soil contains more than this level of salt, what types of crops might be successfully grown in it?

4. List some possible remedies for the soil samples that seem to be less capable of supporting plant growth.