Soil: The Great Decomposer Learning Activity

Purpose
To understand that soil, under different environmental conditions, changes its role in the decomposition of organic materials

Overview
Students use "bottle" experiments to observe changes in the decomposition of vegetable scraps.

Students vary temperature, moisture, and light conditions to determine the conditions that best facilitate the decomposition of organic material in soil.

Student Outcomes
Students will be able to identify soil conditions that promote the decomposition of organic matter in soils.

Science Concepts

Earth and Space Science

- Earth materials are solid rocks, soil, water, biota, and the gases of the atmosphere.
- Soils have properties of color, texture, structure, consistence, density, pH, fertility; they support the growth of many types of plants.
- The surface of Earth changes.
- Soils are often found in layers, with each having a different chemical composition and texture.
- Soils consist of minerals (less than 2 mm), organic material, air and water.
- Water circulates through soil changing the properties of both the soil and the water.

Scientific Inquiry Abilities

- Identify answerable questions.
- Design and conduct an investigation.
- Use appropriate tools and techniques including mathematics to gather, analyze, and interpret data.
- Develop descriptions and explanations, predictions and models using evidence.
- Communicate procedures and explanations.

Time
One class period to discuss and plan experiment, one class period to set up experiment, part of class period at daily (or every other day) intervals to record results, and one class period 2 weeks later to observe and discuss final results. Additional time may be desired to perform further investigations.

Level
All

Materials and Tools
- 12 glass jars or beakers or 2-liter plastic bottles (more for additional studies)
- Marking pen or labels
- Enough dry soil to add 10 cm to each jar. Use the same soil (loam or potting soil) for each jar.
- Enough chopped vegetable or fruit scraps (carrots, cucumbers, apples, etc.) to add two to three cm to each jar (use the same fruit or vegetable scrap mixture in all jars). Other sources of organic material include leaves (broken up), grass clippings, flowers, etc. *Do not use animal scraps*.
- Graduated cylinder or measuring cup to add specific amount of water to soil

For further studies:

- Earthworms (collect from local soil)
- Soils with mostly sandy or clayey textures

Preparation
Have soils, bottles, and vegetable scraps available. Ask students to bring in vegetable scraps on the day of the experiment.

Locate areas in the classroom that will provide variable conditions required for the experiment (warm, sunny site; cool, sunny site; warm, shaded site; cool, shaded site).

Prerequisites
None

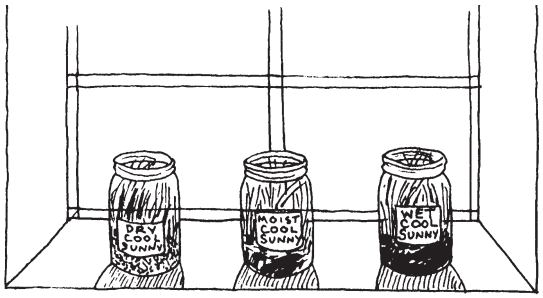
Background

Light, temperature and water content largely determine the rate of decomposition of organic matter in soil. Soil holds the moisture and heat required for microorganisms to thrive and perform the decomposition process, changing organic materials into soil material called humus.

Soils have different abilities to hold moisture, heat, and to support organisms. If the soil is too wet, too dry, or too cold, decomposition will be slow. Energy from the sun warms the soil and promotes evaporation, affecting the moisture content in the soil. Students will be asked to investigate what conditions contribute to rapid decomposition of organic material in soil.

What To Do and How To Do It

1. Set out 12 jars or beakers on table. Label each as follows:
    1. Dry, warm, sunny
    2. Moist, warm, sunny
    3. Wet, warm, sunny
    4. Dry, warm, shady
    5. Moist, warm, shady
    6. Wet, warm, shady
    7. Dry, cool, sunny
    8. Moist, cool, sunny
    9. Wet, cool, sunny
    10. Dry, cool, shady
    11. Moist, cool, shady
    12. Wet, cool, shady
2. Add equal amounts of soil (about 10 cm) to each jar.
3. Add equal amounts (about 2-3 cm) of vegetable material to each jar and evenly mix the soil and vegetable material. Use the same type of vegetable material in all jars.



4. In each of the 4 jars marked “wet,” saturate the mixture with water (allow water to cover the surface of the soil).
5. In each of the 4 jars marked “moist,” moisten the mixture with water.
6. Leave the mixture to dry in the 4 jars marked “dry.”
7. Place one wet, one moist and one dry jar in a warm place that is shaded (as marked).
8. Place one wet, one moist and one dry jar in a warm place that also gets sun for part of the day (as marked).
9. Place one wet, one moist and one dry jar in a shaded, cool place.
10. Place one wet, one moist and one dry jar in a cool place that also gets sun for part of the day (as marked).
11. Cover the jars but poke small holes in the top for air to circulate.
12. Every other day, saturate soils in jars that are marked “wet,” and moisten soils in jars marked “moist.” At this time, stir the soil/vegetation mixture in each jar.
13. For a period of two weeks, observe the jars daily (or every other day) and record observations. Note changes in water content and the condition of organic matter.

Discuss with the class how light, temperature, and water content affected the amount of organic material left in the soil after 2 weeks. Which jars (conditions) show the most decomposition? Which jars show the least decomposition? Can you rank the jars from the least to most decomposition after 2 weeks? What other changes have been observed in the soil (such as color, ponding, others)?

Once students have discussed their observations, have them design their own optimal decomposer using any combination of the variables in the investigation. Have them justify their choice of conditions and predict how each factor will contribute to decomposition.

Adaptations for Younger and Older Students

For Younger Students

Reduce the number of jars to either:

1. moist, wet, and dry (same temperature and light conditions), or
2. moist, warm and moist, cool (same light conditions).

Discuss the climates across the globe that would have these conditions, and compare them to the climate in your local area.

For Older Students

Discuss and relate how decomposition of organic material varies across the globe. What are the sources of organic material in different areas? How does climate affect how fast the organic material will become humus? Have them speculate on what climate conditions will promote the decomposition of organic material and what will inhibit the decomposition of organic material? How would decomposition in a tropical soil differ from that in a northern forest?

Further Investigations

Using soils with "optimal conditions," place Using soils with "optimal conditions," place earthworms in one jar and leave a second jar earthworm-free. Observe and record earthworm activity, rate of decomposition, and differences in soil properties after 2 weeks for each jar. You may also want to create a "worm farm" in a glass jar to observe worm behavior, decomposition, and changes in soil over a longer period of time.

Do a similar experiment as above but vary the soil texture. Include jars with predominantly sandy soil or clayey soil and observe differences as above.

Ask students to research composting.