Fertile Grounds: The Right Mix

Soil is a mixture of minerals, nutrients, water, air, and living and dead organisms. Each of these influences the soil's ability to sustain terrestrial ecosystems. Acid rain also affects soils by altering soil acidity and nutrient content (see Section 3.6).

SKILLS MENU

- Questioning
- Hypothesizing
- Predicting
- Planning
- Controlling Variables
- Performing
- Observing
- Analyzing
- Evaluating
- Communicating

Purpose

To determine how soil supplements affect the water retention and holding capacity of soils, and to determine how acid rain influences the acidity and nutrient content of soils.

LEARNING TIP

Measuring Acidity

Scientists measure how acidic a solution is using the pH scale. This scale ranges from 0 to 14. A pH of 0 is the most acidic, and a pH of 14 is the least acidic. A pH of 7 is neutral.

Equipment and Materials

- 6 200 mL planting pots with screens over drainage holes
- electronic balance
- graduated cylinder
- tray
- soil test kit (for testing nitrogen, phosphorus, potassium [NPK] and pH)
- masking tape
- marker
- sandy soil mix
- 2 soil supplements (for example, peat moss, composted manure, crushed charcoal, crushed limestone, slow-release fertilizer)

  Note: All supplements must be dry before beginning the experiment.
- plastic spoon
- distilled water
- "acid rain" solution

Procedure

SKILLS HANDBOOK 3.B.4., 3.B.6.

Part A: Water-Holding Capacity of Soils

1. As a group, you will be assigned two soil supplements to test.
2. Obtain three pots and label them "Control" and the names of the two supplements to be tested. Write "Water Test" on each label.
3. Using the information in Table 1, prepare your soil mixtures.

Table 1 Soil Supplement Mixtures

	Control	Peat moss	Manure	Charcoal	Limestone	Fertilizer
supplement	none	50 mL	50 mL	30 mL	30 mL	0.5 mL
sandy soil	150 mL	100 mL	100 mL	120 mL	120 mL	150 mL

4. Thoroughly mix your soil samples using a plastic spoon.
5. Measure and record the total dry mass of each pot and soil mixture. Use a data table similar to Table 2.

Table 2 Water Retention Data Table

Water retention test	Dry mass	Saturated wet mass	Mass after 1 day	Mass after 2 days
control				
supplement 1				
supplement 2				

6. Place the three water test pots in a tray and use distilled water to saturate each soil mixture. This may require you to pour water through the soil mixture several times. When the soil is saturated, discard any extra water from the tray.

7. Determine the mass of each pot and record the saturated wet mass of the water test pots in your table. Over the next two days, you will allow these pots to dry out. You will find and record the mass of each pot each day.

Part B: Effect of Acid Rain on Soil Acidity and Nutrient Content

For this part of the activity, you will design an experimental procedure to compare the effects of neutral rainwater and acidic rainwater on the acidity and nutrient content of soils. You will use a soil test kit to determine the soil pH and to measure the amounts of nitrogen, potassium, and sodium in the soil. You are to conduct this part of the experiment using the same supplements you used in Part A.

8. Within your group, brainstorm how you will design your experiment. Write the steps of your procedure. Be sure your design uses proper controls and includes a description of what information you are going to collect. You may want to consider simulating the effects that several days of rain would have on your soil samples.
9. Add to your procedure any necessary safety precautions.
10. Create a table in which to record your observations.
11. Have your teacher approve your experimental design before proceeding with your experiment.
12. Perform your experiment and record your observations.

Analyze and Evaluate

(a) In Part A, how much water did each sample absorb when saturated? T/I

(b) Calculate the initial water holding capacity of each sample as a percentage of the dry mass using the following formula: T/I

$$\text{Water holding capacity} = \frac{\text{mass of water in saturated sample}}{\text{mass of dry sample}} \times 100\ \%$$

(c) Which type of soil supplement had the greatest water holding capacity? T/I

(d) Compare the ability of supplements to retain water by graphing mass over time. Plot all the data on one graph. C

(e) Which supplement had the least water loss? Which had the greatest water loss? T/I

(f) In Part B, which soil sample had the highest initial nutrient levels? T/I

(g) Were any of the nutrient levels influenced by the neutral rain or acid rain? Which soil samples were best able to maintain nutrient levels? T/I

(h) Was the pH of the soil influenced by the simulated neutral rain or acid rain? Explain. T/I C

(i) Were any of the supplements better able to neutralize the effects of the simulated acid rain compared with the control? Explain. T/I C

(j) After sharing your results with your classmates, rank the soil supplements on the following characteristics: T/I

(i) ability to absorb and retain soil moisture

(ii) ability to provide nutrients

(iii) ability to resist loss of nutrients by neutral rain

(iv) ability to resist loss of nutrients by acid rain

(v) ability to resist changes in soil pH

Apply and Extend

(k) What other characteristic(s) do you think growers must consider when choosing supplements to enhance soil quality? A

(l) Do you think there might be advantages to combining soil supplements? Which combination do you think might work best? Give reasons for your suggested combination. A

(m) Which soil supplements could be obtained from natural sources? How would their use influence sustainability of the agroecosystem? A

(n) Although charcoal itself contains no plant nutrients, it is considered to have great potential use as a soil supplement. Research the use of charcoal as a soil supplement and report on your findings. T/I

(o) Do you think that there would be any differences in your observations if plants had been growing in each pot? Suggest some possible effects plants could have caused. T/I