YCS Farm to School Committee

School Garden Curriculum

The Soil - Plant Relationship

Overview
Students investigate what soil and plants provide to each other.

Grade Level
3 - 5

Objective
Students learn that soil provides an anchor for plants and the necessities of water and nutrients. Students learn that plants provide soil with organic matter and help prevent erosion.

Time
45 minutes for discussion and setting up observation; short meeting times over two weeks to observe and record findings

Materials
Remote learning: Each student needs:

- two clear plastic bags (can be used bread bags, storage bags)
- About two tablespoons of soil (from outside)
- About half a cup of vegetable/fruit food scraps (peels, etc.)
- A way to label one bag “Waste” and the other “Compost”
- A notebook or paper or document to record observations

Background Information
This lesson is adapted from Lesson Plans- The Plant-Soil Relationship

Although many factors contribute to a thriving garden, any seasoned gardener will stress the importance of good soil. In addition to anchoring roots in place, soil provides life-sustaining water and nutrients. Plants in poor soils will struggle to grow, even if optimal water and light are available. In contrast, plants in good soils will grow to their fullest potential and experience fewer problems with insect pests and disease.

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Soil is composed of minerals and organic matter. Sand, silt, and clay are the mineral particles derived from rock broken down over thousands of years by climatic and environmental conditions (rain, glaciers, wind, rivers, animals, etc). The largest, coarsest mineral particles are **sand.** These particles are 2.00-0.05 mm in diameter and feel gritty in your fingers. **Silt** particles are 0.05-0.002 mm and feel similar to flour. **Clay** particles are extremely fine -- smaller than 0.002 mm -- feel sticky in your fingers when wet, and clump to the point that you can't see an individual particle without a microscope. Organic matter is the decayed remains of once-living plants and animals. Good plant growth and development depends on the mineral and nutrient content of soil, as well as its structure.

Soil is teeming with life, including microorganisms like bacteria and fungi (billions in a single teaspoon!) and larger animals such as worms and sowbugs. Many of these underground inhabitants feed on remains of plants and animals, breaking down their tissues. In the process, they create pore space and release nutrients that plants need and the cycle begins again.

Pore space -- the arrangement of soil particles in relationship to each other -- is an important component of soil structure. In an optimal situation about 50 percent of the volume of the soil would be pore space, with half of that space filled with water and half filled with air. The other 50 percent of the soil volume would be sand, silt, clay, and organic matter. Roots need air as much as they need water; plants can actually suffocate or drown if they are completely submerged in water for extended periods of time.

The proportion of these different-sized particles affects the amount of air, water, and nutrients available to plants, and how the soil 'behaves.' The smaller the soil particles, the more they stick together when wet. Thus clay soils can be sticky and difficult to work. With fewer air spaces, clay soils drain poorly and roots may suffer from a lack of oxygen, but clay soils can be rich in minerals. In contrast, sandy soils can drain water too quickly and be low in nutrients, but they are easier to work. Adding organic material (compost) can offset many of the problems associated with either extreme.

While there's no such thing as a perfect soil, particular plants grow best in particular soils. In general, common garden plants prefer **loam** -- soils with a balance of different-sized mineral particles (approximately 40 percent sand, 40 percent silt, and 20 percent clay) and ample organic matter and pore space, but some common plants grow better in sandy conditions, while others are well adapted to clay soils.

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Not only is soil important to plants, plants are also important to soil formation. Without plants, the earth would be barren, its surface unprotected from the effects of sun, wind, and rain, and its soil composition too poor to sustain life. Plant roots help to prevent erosion (from water or wind), and when plants die, they become the raw material for worms, insects, and microbes to build the nutrient-rich humus that supports robust food webs and promotes good soil structure. (Recently, researchers have discovered that *living* plants secrete excess carbohydrates through their roots to encourage growth of microbes!)

Procedure

As a class, discuss whether and how soil is important for plants.

1. Ask, *What do you think soil does for plants?* (Provides a place to anchor roots, nutrients, water, air.)
2. Ask, *Have you ever seen plants growing without soil*? *Where?* Explain that some plants, including certain aquatic and parasitic plants, have particular adaptations that allow them to meet their basic needs without soil.
3. Ask, *Do plants need soil? What plants do we eat that need soil?*

Delve deeper into the plant-soil relationship.

1. Ask, *Other than mineral particles, what is an important part of soil?* Share the background information about microorganisms -- fungi, bacteria, and other decomposers -- and discuss the role they play.
2. Ask, *Where does soil get organic matter?* Share how organic matter in soil comes from decomposing plant and animal matter, mostly plant.
3. Ask, *Does soil need plants?* Explain that soil needs plant roots to keep from washing or blowing away (erosion), and needs plants to decompose to enrich the organic matter content that is eaten by microorganisms and absorbed by living plants.

Summarize

Ask, *What have we learned about how plants need soil and how soil needs plants?*

Experiment

1. Have each student set up two bags and label one “Waste” and one “Compost”
2. For the Waste bag, have students
    a. Add half their food scraps
    b. Close the bag (tie or roll and tape the top)
3. For the Compost bag, have students
    a. Add their entire soil sample
    b. Add about a teaspoon of water
    c. Close the bag (tie or roll and tape the top)
    d. Gently use a pen or pencil to poke three small holes in the bag
4. Direct students to place both bags out of the way where they can be observed over time

Observation

1. Over the next two weeks, set up a few times for students to record their observations
2. Compare the contents of the Waste and Compost bags and share observations in class
3. After a few observation periods, discuss in class. Ask, *Are the contents changing? How? What do you think might be causing this change? Where have you seen examples of once-living things changing and decomposing outdoors?* (Rotting logs, moldy garbage, compost piles.) *Did some materials seem to decompose more quickly than others?*

Evaluation

Lead a discussion about the relationship between soil and plants

In what ways do you think plants depend on soil? Based on your observations, can you imagine how soil might depend on plants or animals? In what ways do animals -- including humans! -- depend on soil? What happens to once-living things that decompose in soil? How might these once-living things help to support life?

Extension Activities

Science **–** Conduct a simple simulation to introduce students to the concept of erosion. Fill two trays with soil. Leave one tray unplanted and then plant fast growing seeds such as ryegrass in the second. Wait two weeks as the grass grows. Then set the two pans up side by side, propping one end up about two inches at one end to create a slope. Set up a collecting basin below the pan for runoff. Holding a watering can a foot above the trays, sprinkle “rain” for a minute or two. If necessary, help students make connections between the simulation and what

can happen outdoors; then discuss the techniques farmers and gardeners use to reduce or prevent erosion. (Mulching, terracing, cover crops, adding organic matter to improve a soil's water absorption.)

History **–** Research the Dust Bowl of the 1930's and investigate both its causes and the lessons learned by farmers and ranchers. Ask a farmer to come speak to the class about how he or she prepares soil for crops today.