# The Plant-Soil Relationship

**Overview:** Students investigate the relationship between plants and soil.

**Grade Level/Range:** Grades 3-5

**Objective:**

Students will learn:

- Soil helps anchor plants and provides them essential elements of water and nutrients.
- Plants prevent soil erosion and provide organic matter.

**Time:** 1 hour for discussion and to set up demonstration; 2 weeks to observe

**Materials:**

- Student observation journals
- Chalkboard or dry-erase board

**Background Information:**

Although many factors contribute to a thriving garden, any seasoned gardener will stress the importance of good soil. In addition to anchoring roots, 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 insects and disease.

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 filled with water and half filled with air. The other 50 percent 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. Having fewer air spaces, they 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 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.

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, 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 strucutre. (Recently, researchers have discovered that living plants secrete excess carbohydrates through their roots to encourage growth of microbes!)

**Advanced Preparation:**

This lesson requires a soil sample. If your schoolyard does not have a place where you can dig or if you are concerned about possible lead contamination in your school's soil, bring in a sample from an alternate location.

**Laying the Groundwork:**

1. As a class, discuss whether and how soil is important for plants. Ask, *What do you think soil does for plants?* (Provides a place to anchor roots, nutrients, water, air.) 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. Ask, *Do plants need soil?*
2. Delve deeper into the plant-soil relationship. 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.

**Exploration:**

1. Find out what your students know or assume about the plant-soil relationship. Ask, *Plants need soil, but does soil need plants? Why?* Record all answers and supporting reasoning; then visit the schoolyard or a nearby park to make observations. Have teams investigate the soil in different areas (e.g., garden beds, lawns, weedy patches, woods, a compacted area along the edge of a driveway or sidewalk) and record their observations in their journals. Make a second chart, summarizing these findings and take a vote. Ask, *Who thinks soil needs plants?*
2. Collect some soil from your schoolyard. Put it in a large zippered plastic bag along with some organic materials (vegetable scraps, plant clippings, old leaves). For comparison, add these same organic materials to a second bag, but do not add soil. Moisten the contents of the "compost" bags, seal them, punch a few air holes in them, and leave them in a warm part of the classroom for a week or two, while the class observes what happens. Then 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?*

**Making Connections:**

Discuss the explorations. **Ask:**

- *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?*
- *Why do you think materials might break down quickly in soil? What do you think might happen to once-living things that decompose in soil? How might these once-living things help to support life?*

**Branching Out:**

**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 a 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.