Hold on Tight! (K-2)
Lesson Plan

Overview

In this two-day lesson, students will explore the close connection between plant roots and the soil in which they grow. Students will learn that roots (1) anchor plants in the ground and keep them from tipping over and (2) cling onto soil in a way that slows erosion. Students will explore roots of plants, make models of plant roots using pipe cleaners, and examine photos and images that will help them understand the strong connection between plant roots and soil.

Suggested Lesson Sequence	Please see Foundations: Plants and Soils module description.
Lesson Level	Entry
Science Connections	· Students will explore the connection between **plants** and **soil** by investigating the **root mass** of plants
Technology Connections	· Students will view satellite images to help them understand the relationships among **roots**, **soils**, and **erosion**
Lesson Assessment Tools	· Assessment and Standards Table (Word) · Assessment Activity Description · Authentic Assessments

Materials

- One small pail of dirt or soil
- A small clump of grass (sod)
- A small potted plant for each group (a flat of 2 inch seedlings works well). They may be small, but the plants should be healthy enough to have developed a substantial root system. They also should be potted in a container that can be easily removed so that students can observe the roots without breaking them.
- Pencils
- Wire pipe-cleaners
- Newspaper
- Plastic cups with sand/dirt
- Dust Storms in Africa! slideshow (Powerpoint) to be viewed together as a class
- Observing Roots Activity Sheet (Word)
- Hold on Tight Assessment (Powerpoint) to be viewed together as a class

Vocabulary Words

Roots: The underground part of a plant that supports the structure of the plant, draws food and water from soil, and stores nutrients for the plant.
Root ball: A network of roots for a single plant.
Erosion: When natural material on the surface of the Earth (sand, soil, rocks) are moved by natural processes such as wind, water, or gravity.
Soil: The top layer of the Earth that supports living plants.

Procedure

I. Assessing Prior Knowledge

To introduce this lesson while at the same time measuring the prior knowledge of students, invite children to think and wonder about one individual blade of grass. Because grass is such a common ground cover, children do not often think of grass in the same way that they think of other plants they see (a tomato plant, for example, with one identifiable stem and a root system). To begin the activity, encourage students to draw a picture of grass, what it looks like above ground, and what they think it looks like below ground. After sharing a few examples of these drawings, help students think about root structures of plants – and grass in particular – by showing them a small chunk of grass sod. With the piece of grass sod, ask the children to hypothesize what will happen if you use scissors to cut one individual blade of grass as close to the soil as possible. The interesting observation to steer children toward is that, although the blade of grass can stand up on its own, as soon as it is cut near the roots, it falls over and cannot again stand upright. Why is that? Have children share their thinking with a partner and then open it up for whole class discussion. Listen in particular for children to express knowledge of the supportive role that roots provide to stabilize plants.

2) Contextual Preparation

Prepare to show students the Dust Storms in Africa! Photo Essay. In this slide show, satellite images are used to show students the powerful effects of wind on loose soil. Wind erosion is one natural force that can radically shape and change the surface of the Earth. Later in this lesson, students will be asked to make the connection between root systems and soils. Hence, help children begin to think about the coincidence that blowing sand usually occurs in places where there is little vegetation. This can be seen from the satellite images. Specific questions for discussion might include:

- Where is Africa?
- What does the ground look like in places where the wind is blowing sand? (Response: There is a lack of vegetation – a lack of growing plants.)

- Where do you think the sand actually blows? (Response: Sand from African deserts has been traced to many locations across Africa, into Europe, and even into the Western Hemisphere (North and South America).
- Would the land in these images be good places to plant a garden? What is left on the ground when the wind blows away all the topsoil? (Response: These two related questions might lead students to think about the difficulty of supporting plant life when all the topsoil has been eroded away.)
- How might plants help keep soil in its place (instead of blowing away)? (Response: This final question leads students into the hands-on activity of the lesson in which they will explore the interaction of plant roots and soil.)
- Notes about the satellite images: These images were captured by a combination of NASA satellites (courtesy of NASA's Earth Observatory):
  "The image of Lake Chad was taken by taken by the Terra satellite on November 10, 2003. As recently as the 1960s, Lake Chad filled an area in the depression roughly the size of Lake Erie in North America, but lack of rain and increased demand for irrigation water have shrunk the shorelines of the lake, leaving much of the Bodele depression dry. Now dust storms in the Bodele depression are common. The low-lying area is a major source of windblown dust in Europe, the Middle East, and the Western Hemisphere. Seen as streaks of white against the orange desert sands in this true-color image, the dust partially obscures the northern shores of Lake Chad (lower left) from view" (Earth Observatory: NASA).
  "For a fourth day, a large plume of dust was blowing off the Sahara Desert and out over the Atlantic Ocean. This Moderate Resolution Imaging Spectroradiometer (MODIS) image was captured by Terra satellite on April 30, 2003." (Earth Observatory: NASA).

III. Student Activities

In this activity portion of the lesson, students will examine root systems of plants, and develop a model to help them see the important relationship between roots and soil. Procedure steps include:

1. Give each group (3-4 students) a small potted plant. (Flats of small potted plants are readily available at most local gardening stores or nurseries.)

2. Have students discuss their predictions about what they will observe when they pull on the stem of the plant, lifting the plant out of the container. (Anticipated responses: Students may predict that the plant roots will come out cleanly, or will come out with some dirt attached, or that the plant stem might break because the plant is so firmly rooted.)

3. Distribute the Observing Roots Activity Sheet. This activity sheet is designed to help students record observations of their plants. After preparing their table with newspaper covering, instruct students to gently tug on the stem of the plant to remove the "root ball" from the container. Groups may get different results when they pull the plant out. The entire root ball may come out intact because to root network has thoroughly developed, or if the roots are less developed, the root ball may partially fall apart. Some students may pull out a fairly clean ball of roots. Some groups may notice the differences between the "above ground" portion of the plant and the root system. Variable results will offer a rich context for discussing how roots secure the plant into the soil and how the soil is held together by the roots.

4. Give students ample time to observe, talk about, and draw the entire root ball on the Observing Roots Activity Sheet. As they do so, you should encourage them to gently "dissect" the root ball so they can observe it more closely and examine its structure.

6. Observing with a model: To learn even more about how roots work, give each group of students a cup of sand/soil, a pencil, and a pipe cleaner. You might wish to emphasize that real scientists often use models of real things in order to learn more about how they work. In this case, the pencil and pipe cleaner are intended to be simple models of plant roots. The intent of this activity is twofold: To help students see that soil supports plants, and to see that roots cling to soil.

   Students should begin the activity by attempting to stand the pencil on end on the top of the desk or table. Obviously, in most cases the pencil immediately topples over. Encourage the students to predict what will happen when they stick the end of the pencil into the sand. What might happen, and why? After predicting, they may place the pencil in the soil. This activity is intended to illustrate how soils help to support plants. A connection may be made back to the opening activity with the blades of grass.

   Next, students will use the model to think about how roots can cling to soil. Have the kids stand the pencil *and* pipe cleaner up in the sand. They should then slowly pull each out of the sand. Repeat this process several times. Coach the students to observe the process (and particularly the pipe cleaner) not only by sight, but also by feel. (Children should notice that the pipe cleaner is more difficult to pull out, and that the particles of sand are mixed into the fibers of the pipe cleaner. These fibers might be thought of as the "roots" whereas the smooth pencil without roots comes out more easily and does not cling to any sand.) You might want to guide this activity with the following questions.

   - What did the pencil look like when you pulled it out?
   - What did the pipe cleaner look like when you pulled it out?
   - What did you *feel* as you pulled these models of plants out of the sand? Any

differences?

- How are these observations the same or different than what you saw with the real plants.

IV. Assessment

1) A second photo essay, Hold on Tight Assessment, may be used to evaluate students' understandings of the content of this lesson. The photo essay contains several pictures related to the lesson, each with an accompanying question to which students should respond as noted below:

- Photo #1: This photograph shows the root structure of a large pine tree that was blown over. Within the root ball, students can see dirt and large rocks trapped within the clinches of the roots.
- Photo #2: This photograph shows a picture of large sand dunes. Students are asked to notice a lack of vegetation at the sand dunes, and then asked to explain where the sand might have come from and how it got there (wind).
- Photo #3: This photograph shows two old pictures of a looming dust storm from the American "Dust Bowl" of the 1930's. Farmers of the day did not practice conservation methods to prevent wind erosion of topsoil in the same way they do today. The drought conditions and high winds of that time led to the loss of thousands of tons of topsoil. Students are asked to consider the great clouds of dust in the air, and to think about how living plants might have helped stop the great Dust Bowl.

2) As a supplement to the previous photo essay, you may also choose to use the following discussion questions to assess students' understanding of the relationship between plant roots and soils:

- Why are plants able to stand up? Or, why are soils important for plants?
- How do plant roots help soils? (These networks of roots create a "webbing" that can hold tightly to the soil.)
- When strong winds and rains occur, what would happen to soils if there were no plants growing in them? (Answer: they would be carried away through a process called *erosion*.)

Acknowledgements

We would like to acknowledge NASA's Earth Observatory for providing the satellite images in this lesson. These Moderate Resolution Imaging Spectroradiometer (MODIS) images were captured by the Terra satellite in 2003.