

Seeds: Roots and Shoots

Rationale

Usually, the only parts of a plant visible above ground are the stems and leaves. Sometimes, the roots of trees and other plants are partially visible above ground. However, in most cases, one can only guess how many roots there are and how deep the roots of the plant travel into the soil.

In this activity, youth set up an arrangement that will allow them to observe the growth of the shoots and the roots simultaneously. They will track the relative growth of the shoots and roots of one kind of plant and observe their relationship (do the shoots grow faster than the roots? at the same rate?). They will be able to see how the roots grow, observe how they differentiate in their branching and the appearance of root hairs, and observe how deep they grow.

This arrangement can also be a context for a discussion about what a plant needs to grow. There is often a misconception about the role of dirt. (Youth may believe that dirt provides food for the plant).

Since no dirt is used in this arrangement, a guiding question can be posed: **What does the plant need to grow?**

Materials

For each group of 2 or 3 youth

- 1 piece of plastic cardboard (10 inches × 20 inches); available at some craft suppliers

NOTE: In place of plastic cardboard, you can use regular corrugated cardboard. However, you will have to set up the cardboard so that it does not get wet. Direction provided below.

- 1 wallpaper tray (shown at right; can be purchased from hardware or big box stores, such as Home Depot)
- 1 seed (a good seed to use is the scarlet runner bean)
- 1 dowel (1-1/8 inch in diameter, 3 feet long)
- 8 binder clips (medium size)



Photo courtesy Bernie Zubrowski

Wallpaper tray.

For the whole group

- 1 roll of plastic wrap (e.g., Saran Wrap)
- 1 grow lamp (if natural light is unavailable)
- white paper towels
- 4–5 boxes of T-pins
- masking tape (1/2 inch wide)
- digital cameras

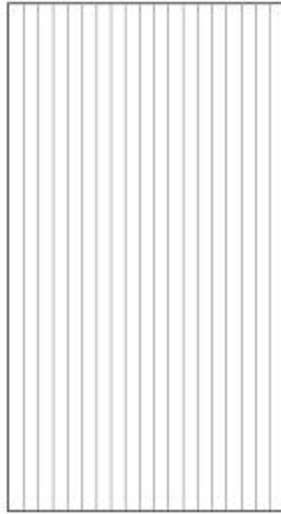
Preparation

Soak the seeds in water for several days before the session when the youth will be assembling their plant growing structure. Having them presoaked will result in the youth seeing changes in the seed more quickly.

To be able to help youth assemble their plant growing arrangement, assemble one ahead of the session.

Assembling the Support Structure for the Growing Plant

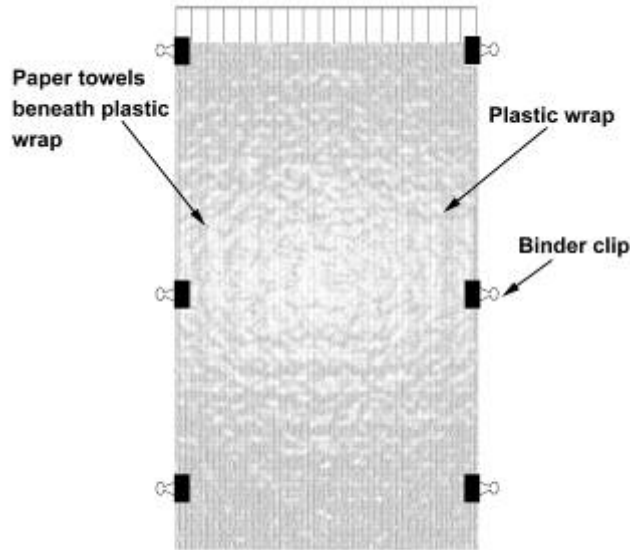
1. Cut the plastic cardboard so that it is 20 inches tall and 10 inches wide (shown below). Make sure that the corrugation is traveling up and down, as shown below.



Plastic cardboard with vertical corrugation

NOTE: An alternative to the plastic cardboard is regular cardboard. Place a layer of plastic wrap on top of the cardboard before placing the paper towels on the cardboard (discussed in step 2).

2. Lay the cardboard on a table and place three layers of paper towels over the whole surface. Smooth out the paper towels so they lie flat.
3. Place pieces of plastic wrap over these paper towels so that the paper is covered and there is a slight overlap at both edges. Then use the binder clips to hold the plastic wrap and paper towels in place. The complete setup is shown below.



Complete setup, before seeds are added.

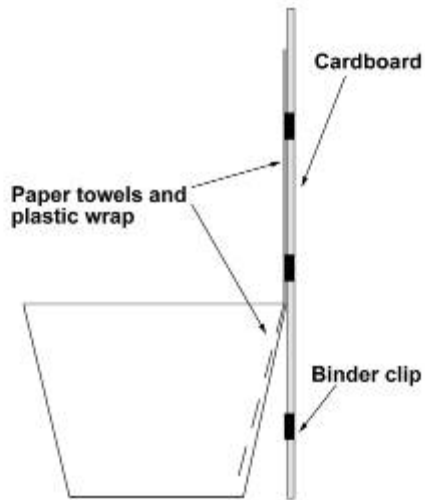
4. Place this arrangement vertically in a wallpaper tray filled with several inches of water, as shown below. (You will have to lean the cardboard against a wall.) Pour water into the top of this arrangement so that all of the paper towels become wet.



Photo courtesy Bernie Zubrowski

The set-up placed in the wallpaper tray.

NOTE: If you are using regular cardboard, don't place the bottom portion of the sandwiched arrangement in the tray with water. Instead, place the cardboard part outside of the tray. Then, take several inches of the sandwiched arrangement of plastic and paper towels and place this into the tray. The idea is to have the paper towels, but not the cardboard, under the water to act as a wick.



Alternative setup if using paper cardboard. Note that the cardboard is outside the wallpaper tray but the paper towels and plastic wrap are inside the wallpaper tray.

5. Place a pre-soaked seed between the plastic wrap and paper towels near the top. Use T-pins to hold the seed in place (see figure below).



Photo courtesy Bernie Zubrowski

Secure the seeds with T-pins.

6. Place a 3/8-inch-diameter dowel into one of the corrugations (columns) of the plastic just above where the seed has been anchored. The dowel is added to support the stem and leaves of the plant as it grows.



Photo courtesy Bernie Zubrowski

Place the dowel into the corrugation to help support the stem of the plant as it gets taller.

Space and Storage

You need to plan ahead in deciding where youth will keep these devices. Find an area in the room where you sessions occur, and place them next to a sunny window and where other youth will not disturb the growing plants. If you cannot place them near a window, you may need to set up a stand with a grow light, placing the groups' support structures beneath the same light as best as you can.

NOTE: At one field test site there was limited growth in a room without windows and without a grow light. It seems the fluorescent lights in the room provided the right part of the spectrum and a sufficient amount of light.

Introducing the Activity

Ask the youth if they have grown any kind of plant from seeds before. If they have, ask them to describe what they observed.

- What kind of plant was it?
- How big did it get?
- Did you get to see the root system?

Tell the youth that they will make a special arrangement for growing a plant where they can view both the growth of the top part of the plant and the bottom part—the root system. The arrangement will allow them to see how the root system grows in relation to the top part.

Show them the arrangement you constructed before the session. Have the youth form groups of two or three. Lead them through the steps for the construction as outlined in the Preparation section.

Once the structures have been assembled and the seeds added, have the youth place their trays and structures in the area you have selected for ongoing observation.

Tell the youth that they will check on the growth of the plant over the next few weeks. They will mark the growth of the shoot on the dowel with pieces of tape showing the date and mark the growth of the roots with T-pins. The T-pins should also have a piece of tape attached with the date.

NOTES:

- To make useful comparisons of the youths' photos, explain the need to establish a set distance and height from the device from which they will take their photos. They should record this distance in their journals. For instance, they may decide to always take their photos from 2 feet away from their plants. Also, they might want to take two kinds of photos of the growing plant. One is a close up of the roots of the plants; the other is a photo of the whole plant—stem and root. They can also take photos of the plant as it grows. In this recording, remind the youth to establish a distance and height from which they will take the photo. The idea is to generate a group of photos that can be compared easily.
- Care should be taken in the placement of the seeds between the plastic and the paper towels. Seeds should be placed at the very top so that they have access to air. If totally covered, mold can start to grow on them, halting their growth.

Follow-Up Observations

At each subsequent session with these youth, have them spend some time observing their plants, paying particular attention to the growth of the roots. Remind them to add a piece of tape to the dowel where the tip of the plant is and a T-pin where the tip of the roots is.

Youth also should be reminded to add some water at the top of the structure every very time they meet, because the paper towel surrounding the seed can dry out quickly. This means opening the space between the plastic wrap and the seed slightly and pouring in the water. Then they should make sure to once again secure the plastic wrap around the seed to reduce evaporation of the water while still allowing air to circulate slightly to reduce the formation of mold.

NOTE: If you are meeting with the youth only once a week, you will need to make some arrangement so that the plants are watered in this manner every two to three days.

As the plant grows, direct the youth's attention to the way the root system is growing (shown below).

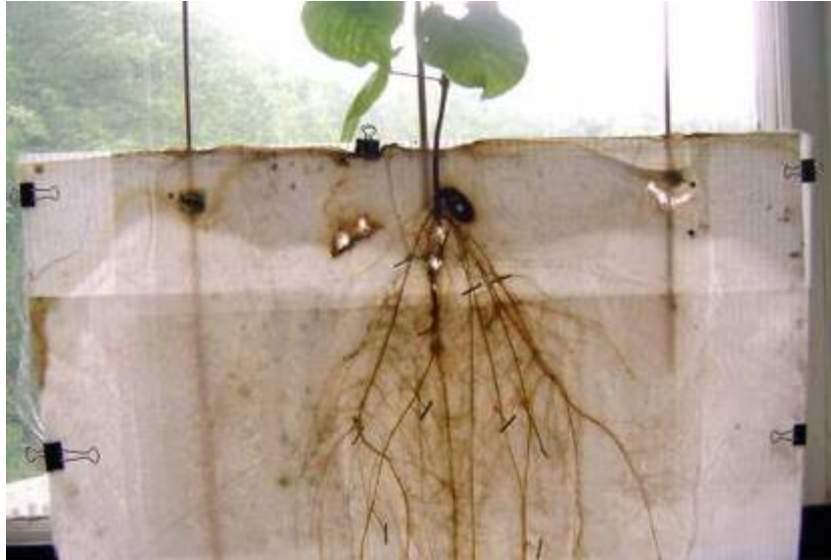


Photo courtesy Bernie Zubrowski

A seedling showing the root system.

Point out the smaller root hairs of the roots and the way they are growing, as shown below.



Photo courtesy Bernie Zubrowski

A closer look at the smaller root hairs.

Follow-Up Discussions

The growth of the seeds may vary depending on the exposure to sunlight or a grow light. Take some time during each session to have the youth comment on what they are observing. After the plants have been growing for several weeks, have a discussion about what a plant needs to grow. Point out that every living thing needs some kind of food to survive. Since a plant is a living thing, how is it surviving? What does it need to survive?

The role of light and water may be readily apparent to the youth. However, there are some misunderstandings about the role of the water and whether or not a plant makes its own food. Have a discussion with them about the fact that no dirt is involved in this growing arrangement, so the plants are not obtaining any nutrients from soil. Point out to them the difference between nutrients and food. There are some essential nutrients (minerals) in the water that are needed for the plant to grow, but at the same time the plant is making its own food in the leaves of the plant. Water and a gas in the air (carbon dioxide) combine in the cells of the leaves to make a substance that is then used by the plant for its survival.

Observing Behavior

The particular arrangement suggested for this activity allows youth to see the growth of roots and how they grow in relation to the shoot. Note to what extent the youth give attention to this relationship. Note also to what extent they give attention to the number of roots and the emergence of root hairs.

- Do they make drawings and take photos of the root system?
- Do they make spontaneous comments about how the roots are growing?

Background

Plants take in carbon dioxide through a special arrangement in their leaves' cells and converts the carbon dioxide and water into a carbohydrate called *glucose* through a chemical reaction called *photosynthesis*. The roots supply water and nutrients, including some minerals and nitrogen, to the plant. This is a highly simplified summary of a very complicated process. The essential point is that the plant is making its own food, and the water and the nutrients assist in the production of that food.

Since the roots of the bean plant are so readily visible, this is a good opportunity to probe youth about where the roots are located with different kinds of trees. A common perception is that the largest roots extend deep into the ground. Recent research involving excavations indicates that some trees have tap roots (one long root extending vertically downward) and others do not; lateral roots may extend far beyond the tree; and fine roots appear mainly near the surface. How the tree was started and where it grows can determine whether it will grow a tap root. For instance, oaks will more often grow tap roots but maples will not. In highly compacted soil, roots will grow nearer the surface.

Source: Gilman, E. (n.d.) *Where are tree roots?* University of Florida IFAS Extension, retrieved July 12, 2010 from <http://edis.ifas.ufl.edu/wo017>.

Point out to the youth that roots can serve more than the function of collecting water for the rest of the tree or plant. They can also be the site of food storage. A number of vegetables found in the supermarket—carrots, parsnips, and beets—are some examples of when roots function as food storage. Some roots, such as the beet, accumulate sugar while others accumulate starch, such as orchid roots. One advantage to having roots store the plant's food is that the plant is more protected from the grazing of animals and from the danger of drought.

Source: Coulter, J., Barnes, C., & Cowles, H. (1911). *Ecology, Vol II*. Woodstock, GA: American Book Company.

For more activities like this, or for more information on how to carry out *this* activity, please go to <http://treesandponds.edc.org>.

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