WISCONSIN FAST PLANTS

Soil Meditations

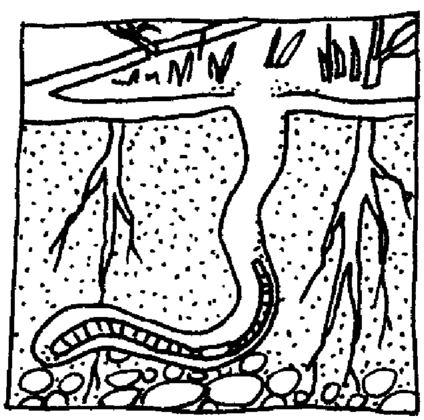
Exploring the World Under Your Feet

The following activities were excerpted from the Bottle Biology manual, published by Kendall/ Hunt Publishers.

Are you walking on air? The ground under your feet seems solid. You can jump on it and nothing appears to collapse under you.

But if the earth is so solid, where do trees, grass, and other plants put their roots? How do earth-worms breathe? And why does rain water soak into the ground?

Take a close look at a handful of soil. Soil comes from solid rock that has been broken down into very tiny particles, and from decomposed plant and animal tissues. These bits of rock and organic matter contain many minute spaces.



These open spaces between soil particles are "living spaces," filled with air, water, and life. While soils vary greatly, a typical soil is 25 percent water (unless it has been dried), 50 percent minerals (5 percent of which is organic matter), and 25 percent air.

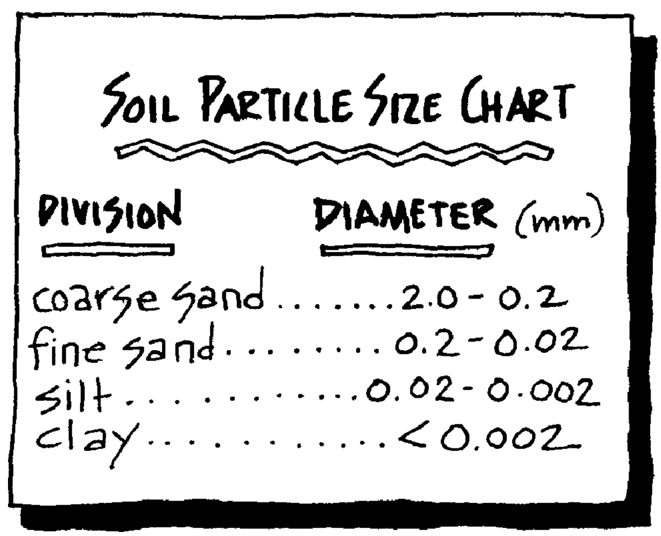
Millions of bacteria, protozoa, fungi, and algae can exist in just a handful of soil. Some larger soil residents include springtails, earthworms, roots, seeds, moles, badgers, and insect larvae.

In the following activities you will look at soil texture and density, and then "cook" with soils to find out what sorts of recipes plants prefer.

Texture Test: Soils are made up of variously sized particles, which fall into three basic textures: *sand, silt,* and *clay*. If we could multiply the diameter of a typical sand, silt, and clay particle by a thousand, the clay particle would be about as thick as this page, the silt would be about 2.5 cm thick, and the sand about a meter thick! Soils are not usually just sand, silt, or clay, but contain all three.

You might identify a soil's general texture by rubbing a slightly dampened bit of a sample between your fingers. If the soil feels gritty and you can see grains, your soil is sandy.

If the soil feels slippery but not really sticky, it is a silty soil. If your sample is very sticky, and you can squeeze it out between your thumb and forefinger into a kind of ribbon, your soil has a high percentage of clay.



We invite you and your students to explore the soil beneath your feet in the following three activities.

- Film Can Mysteries
- The Sedimentation Bottle
- Cooking with Soils

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Film Can Mysteries

How dense is dirt?

In this exploration, you fill film cans with several different soil types and compare their densities. *Soil density* refers to how loosely or tightly soil particles are packed. We will estimate the densities of different types of soil by comparing their weights.

Materials

For this exploration you'll need to collect several different samples of soil from nearby yards, parks, construction sites, woods or fields. You'll also need several soil components such as gravel, sand, silt, clay, and organic matter or peat moss. Next, you will need lots of black film cans.

Make a set of mystery film cans by placing five to eight different samples of soil in different black film cans. Fill another can with water and leave one empty. Use a marker and randomly number all the can tops. Keep a list indicating which number corresponds to which type of soil, and the water and air.

Make several identical sets of the mystery film cans and divide your class into five or six cooperative groups. Group members can take turns weighing, balancing, recording answers, and writing their results on the board.

Procedure

Pick up the mystery film cans. Weigh them in your hands. How heavy are they? Shake them next to your ear. What do you hear?

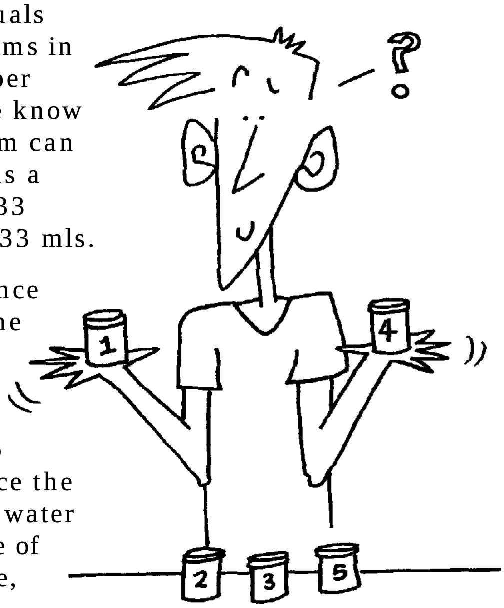
Weigh the film cans in your hands and **rank** the film cans from lightest to heaviest. Use the numbers on the lids to identify them, and write a series on the blackboard like this:

$$2 < 1 < 3 < 6 < 5 < 4$$

Now you have an idea of how the film cans compare to each other in weight. How do the series on the blackboard compare to each other? Now, how can you figure out the exact density of each film can?

We can do this by always comparing the same amount, or volume of different soils. In this case we are using one film can. (Since density equals weight per volume, and we will be using *one* film can, the density of the soil will be equal to its weight. What weighs more, a pound of feathers or a pound of lead?)

Using a standard : In order to measure something, you need a universal standard with which to compare it. In this case you have the convenient standard of water, which has a known density of one. We also know that one film can holds 33 mls of water. Since density equals weight (grams in this case) per volume, we know that the film can of water has a density of 33 grams per 33 mls.



Use a balance to determine how your mystery film cans compare to water. Place the film can of water on one side of the balance, and a mystery soil can on the other side. Does the soil weigh more or less than the water?

Next, balance the scale. Place two empty film cans on either side of the balance and add water to the lighter side. You can determine the difference between the weights of the water and the soil by adding water to the lighter side to balance the scale. Measure exactly how much water you added.

Figuring soil densities: Say you have a soil that is heavier than water. To balance the scale you added 33 mls, or one film can, of water. So your soil is equal to two film cans of water. In other words, your soil is twice as dense as water, and has a density of 2.

To think about this numerically, remember that water has a density of 33 grams per 33 mls, and you had to add 33 grams worth of water to balance the scale. So your mystery film can is equal to 33 grams plus 33 grams, or 66 grams per 33 mls. A quick calculation will tell you that this equals 2.

Continue this exercise with the other mystery film cans in your collection. Afterwards, open the cans and examine the contents. How does the density of clay compare to sand? To water?

The Sedimentation Bottle

How many shapes and sizes can you see?

This project allows you to observe the diversity of particles that make up a soil. By mixing soil and water in a bottle, and then observing the layering of the soil as it settles, you will see differently shaped, sized, and colored particles.

Procedure

Remove the label from a 1-liter soda bottle using hot water or a hair dryer.

Use a graduated cylinder and a permanent marker to mark off your bottle in 50-milliliter increments. Fill the bottle to about the 700 ml mark with water. Next add film cans of different soils. If you add six film can's worth of soil, will the bottle overflow? Why or why not?

Cap the bottle and shake it vigorously. Set it someplace where you can watch it settle. Some particles will settle immediately, others will continue to float for days. Why?

What happens?

How many different layers can you identify? After everything has settled, re-shake the bottle and time the sedimentation rates of the various particles. Can you graph your results?

Some soils may have many fine clay particles that remain suspended in the water for a long time. You may also observe a layer of decomposing plant material, or organic matter, floating on the surface of the water. You will see some of these particles fall slowly as they soak up enough water to sink.

Let the bottle sit for a day or two and then tap the sides. Does anything happen?

Photosynthesis and respiration by algae and soil bacteria may have produced many tiny gas bubbles, which will rise to the surface when you tap the bottle.

You may also see crumbs of soil rising to the surface, buoyed up by gas bubbles produced by soil microbes. What happens if you make two identical soil columns and keep one in a dark place?

Cooking with Soils

What do plants like best?

If you were a plant root you would have a very different perspective on dirt. The soil around you would be your shelter and source of nutrients. It would provide you with air to breathe, water to drink, and shelter from storms and errant footsteps.

In your soil surroundings you would see a diverse world of differently shaped and sized particles. You would see how these particles affect the way water flows, how much water and nutrients are available to you, and what sorts of microorganisms and other soil life you have for company.

Explore the relationships between plants and soils by growing several different plants of the same species under the same conditions but with different soil recipes.

You can create your own soils by mixing the contents of your mystery film cans. You can also compare different brands of commercial potting soils.

How do plants grown in a very sandy soil compare to plants grown in a clayey soil, for example? What happens if you add peat moss?

Procedure

Begin by preparing planters of several different soil components, such as pure sand, pure peat moss, and pure silt. Record the properties of each soil component, including color, feel, and density.

Next create and record a soil recipe of, for example, one part sand, one part peat moss and one part clay. Mix your components well, and then record the properties of your new soil as you did for the components.

In order to test your recipe, plant several seeds of a fast-growing plant (such as turnip, lettuce, or Wisconsin Fast Plants) in the planters of each soil component and in your new soil. Make sure your seeds sprout under exactly the same conditions of light, water, and temperature.

Over the next several weeks, observe your planters closely in order to record factors such as the speed of seed germination, rate of plant growth, and the general appearance of the plant, including height, and the color, size and number of leaves.

How do the plants respond to the different soils? Do all plant species like the same recipes? Experiment and find out. You are