The Radish Party

Adapted from article by Jeff Piotrowski, Tammy Mildenstein, Kathy Dungan, and Carol Brewer • *Science & Children* • Vol. 45 • Issue 2

Time	Grade Level	Content Area (s)
Several weeks	Grades 3–5	Life Science

Materials

- 3-4 packs of radish seeds
- 1 medium bag of potting soil
- 1 medium bag of sand
- 1 small bag of granular fertilizer
- 6 popsicle sticks per group
- 1 six-pack of seedling pots per group
- 2-3 seedling trays
- Fluorescent grow lights (optional)
- 2-3 measuring cups (mL)
- Rulers (one per group)

Objective

Students learn that stem strength and color, in addition to growth, are indicative of a healthy plant and healthy soil.

Activity Outline

1. Prepare the three types of soil (sand, sand plus nutrients, and potting soil) for the investigations. Put half the sand in a bucket labeled 'sand.' Next, place the potting soil in a bucket labeled 'soil.' Finally, thoroughly mix a dry granular fertilizer with the remaining half bag of sand in a bucket labeled 'sand + nutrients.'

2. To get students excited about the investigation, discuss what students know about soil as each type is passed around. Explain to students that they are about to become both farmers and scientists, and that they are going to test which of these three soil types is best for growing radishes.

3. Once students have seen the soils and some radishes and understand the investigation, ask them to predict which soil will grow the biggest radish by drawing a picture of the radishes growing in each soil type. Have students draw a big radish in the soil they think will grow the best and a small radish in the soil in which they think it will grow the least. If they

think soil type will not make a difference, they should draw all radishes the same size. Have students carefully label their drawings with the type of soil each radish is growing in and include in the drawings the basic parts of the radish: stem, leaves, roots, radish tuber.

4. Next, gather the students in a circle and have students describe their pictures, predictions, and rationales for predictions. Students should write the reasons for their predictions on their pictures. After students have made their predictions, pass out the supplies so students can plant their own radishes.

5. Start with a supply box containing one six-chambered seed-starting pot, six Popsicle sticks, a spoon, and 20 radish seeds. Fill two chambers of the seedling tray with each of the three soil types, for a total of six filled chambers. Label Popsicle sticks with the soil types and the date of planting. Each chamber should have one clearly labeled stick. Plant three radish seeds in each chamber, leaving a little space between the seeds to avoid crowding. Plant the seeds at least 1.25 cm deep, and make sure they are covered. Place all the pots in a large garden tray that does not leak, and put the tray under grow lights or in a sunny window. Water each pot carefully with an agreed-upon volume of water between 50mL and 100 mL. Allow the plants to grow for several weeks to a month, watering every two or three days with the same amount of water. Have students make observations every week: *When do seedlings first emerge? Which ones are growing faster, taller, slower?*

Differentiation

Depending on the grade level, assessing plant growth and health can be done in several ways. For the youngest of students, simply looking at how tall the seedlings are and gently counting the number of leaves can be a good measure. Older students should be encouraged to measure plant height, stem thickness, and number of leaves. Advanced students may be able to graph plant height, stem thickness, and leaf number through time to determine quantitatively which plants are growing fastest.

Formative Assessment

When the set investigation time is up, bring students together to compare their earlier predictions to the actual plants grown. Ask the students to make observations and look for differences (advanced students may even make a few measurements). Sample questions include: *What differences do you see? Which soil yielded the largest plants? The most healthy looking plants? Is the tallest plant always the healthiest? Were your predictions met? Why or why not?*

Post Assessment

The students' drawings should reveal whether or not they learned basic plant form, understand why plants may differ in growth, and what the reasons for differences in growth are. Follow-up class discussions help clear up any misconceptions that were evident in their predictions.

Safety

"When conducting soil investigations with students, follow appropriate soil safety guidelines."

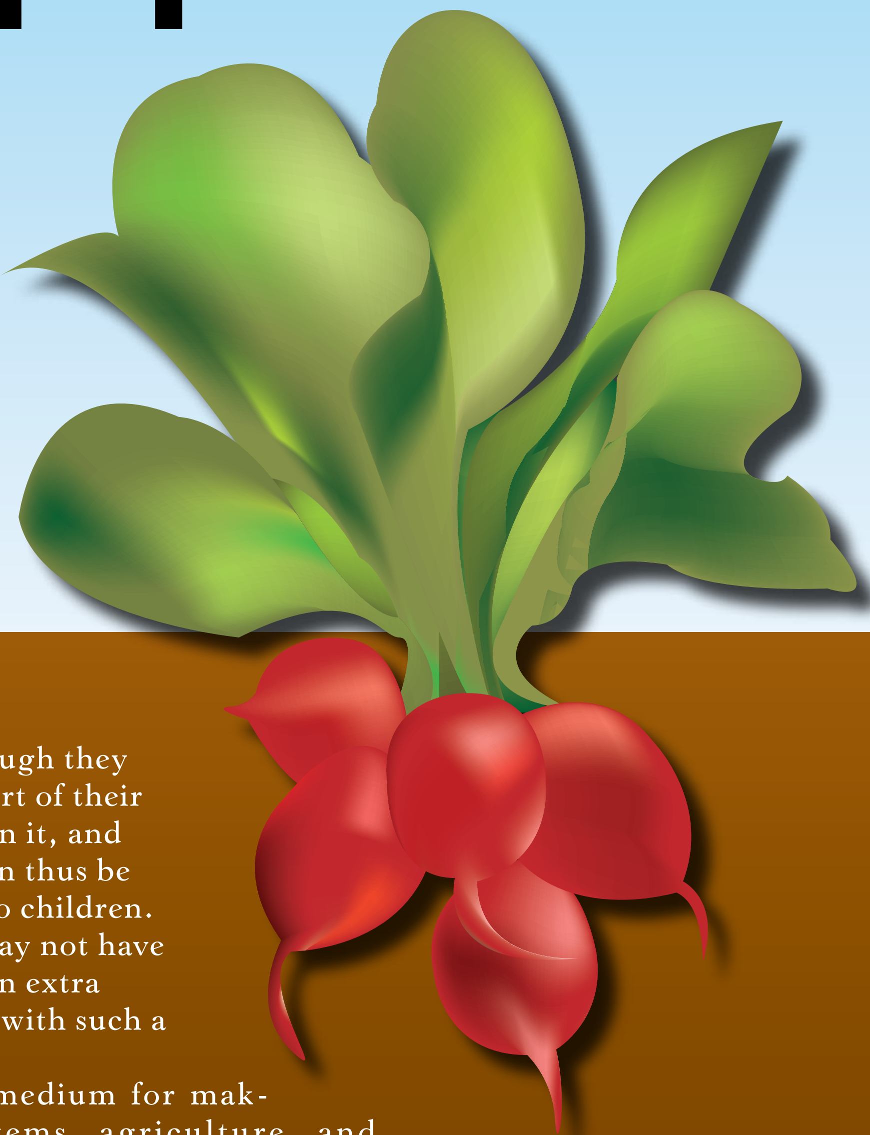
"Remind students never to taste any of the soils and to wash their hands and desk areas with soap and water after working with soil."

1. Send a letter home to parents/guardians of students informing them about soil activities in the classroom to obtain permission before having students working in soil. Include information about possible allergens (mold/spores) etc., which might affect students with compromised immune systems, allergies, or asthma.
2. Remind students to never eat soil, sand, etc. Some soil samples could be contaminated.
3. Always know the source of your soil samples.
4. Have students wear plastic gloves when working with soil. Make sure all open cuts or scratches are covered minimally with a protective barrier to prevent infection.
5. Always wash hands with soap and water after working with soil. Use antiseptics on cuts or scrapes.
6. Don't store wet soil more than a day or two. Mold and bacteria spores will grow in it.
7. Be sure to use good housekeeping standards—wash desktops with mild soap and water where soil activities took place. Do not allow snacks or other food products during soil activities.
8. Do not flush sand, silt, clay, rocks, and other earth materials down the drain. These materials are not soluble in water and may clog the drain. Dispose of them in a trash can or other suitable receptacle.

THE RADISH PARTY

By Jeff Piotrowski, Tammy Mildenstein, Kathy Dungan, and Carol Brewer

Success takes root in an exploration of soil organic matter.



Young children like soil (even though they may refer to it as dirt)—it is a part of their daily lives. They play on it, dig in it, and are often covered with it. Soil can thus be a highly visible and relevant ecosystem to children. For students in dense urban areas who may not have daily access to soil, these inquiries take on extra significance by helping familiarize them with such a fundamentally important substance.

In addition to being an appealing medium for making mud pies, soil sustains ecosystems, agriculture, and human societies. One crucial element of healthy soil is soil organic matter. Soil organic matter consists of decomposed and decomposing remains of organisms, which give soil a dark color and spongy texture. In addition to having greater nutrient

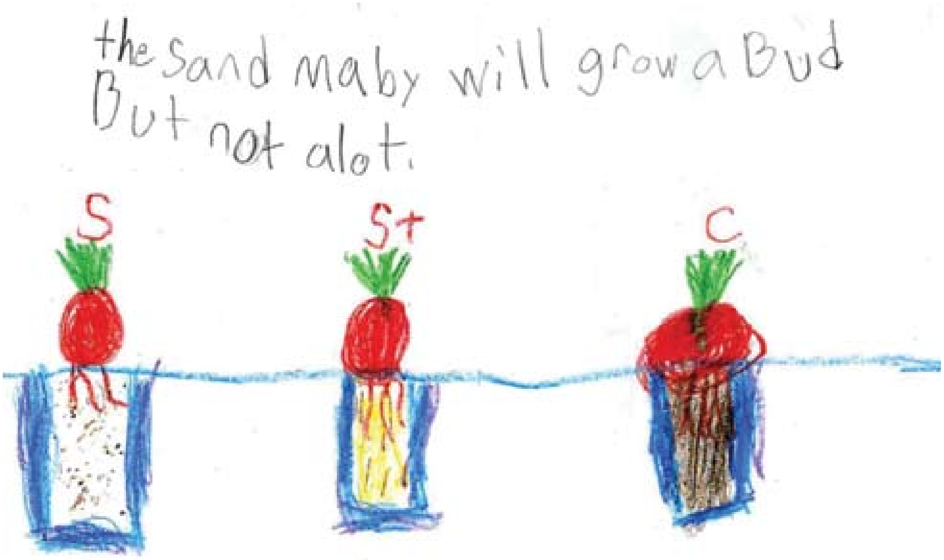
Students made predictions of how their radish plants would grow in different soils.

content, soil rich in organic matter forms water-stable soil aggregates, which are more resistant to the forces of erosion (Six et al. 2002). Water-stable aggregates are secondary soil particles (larger than sand, silt, or clay) composed of organic materials and inorganic mineral particles. These aggregations are more resistant to the forces of erosion because the particles are tightly bound together, primarily by the organic materials that form "bridges" between inorganic particles.

Our activity, The Radish Party inquiry, is designed to teach the importance and relevance of soil organic matter to young students. In this investigation, students grow radishes in three different kinds of soils: sand, sand plus nutrients, and potting soil (soil that includes organic matter). We chose radishes because they germinate and grow quickly, and the materials used in the investigation are readily available and inexpensive (see Figure 1). The experience we share here was conducted with first- and second-grade students, but the investigation can be adapted for students at other grade levels as well.

Teacher Preparation

In advance of the activity, prepare the three types of soils for the investigations (the teacher should do this step to avoid having students working with fertilizers). Put half the sand in a bucket labeled "sand." Next, place the potting soil in a bucket labeled "soil." Finally, thoroughly mix an organic dry granular fertilizer (such as greensand) with the remaining half bag of sand in a bucket labeled "sand + nutrients." You just need to add enough so that it is visible to students in the mixture. When conducting soil investigations with students, follow appropriate soil safety guidelines (see Soil Safety, page 44). CAUTION Once the soils are prepared, refresh your background knowledge of soil ecology (see Internet Resources), and let the investigations begin.



At the start of the unit, some students knew what a radish looked like but not a radish *plant*.

Getting to Know Soil

To get students excited about the investigation, discuss what students know about soil. Young students will certainly know what soil is and have some ideas that plants need it to survive, but asking a few thought-provoking questions can help introduce the topic:

- What is soil made of? (Students may reply "dirt," "mud," "rocks," "sand," "dead leaves," etc.)

- Where does soil come from? ("crushed up rocks")
- Why do plants need soil to grow? ("for their roots," "to get water," "for nutrients or food")
- What are roots for? ("to hold the plant in place," "to get water and food")
- What are the differences between a good soil for plants and a bad soil? ("dry," "rocky," and "sandy" soil were common responses.)

One key idea for students to gain from this discussion is that soil comes from both the weathering of rocks (an inorganic portion) and the decomposition of plants and animals (an organic portion). Students may know soil is composed of sand, silt, and clay, but few students, if any, will be familiar with the concept of soil organic matter. When questioned, however, some students may suggest that soil contains bits of dead plants and animals.

Another key idea is for students to understand that plants get their nutrients and water from the soil.

After the introductory discussion, show students the three prepared types of soil: sandy soil, sandy soil plus nutrients, and potting soil with organic matter, which we called "compost." Pass them around. Remind students never to taste any of the soils and to wash their hands and desk areas with soap and water after working with soil.

As the different soils are passed around, explain to students that they are about to become both farmers and scientists. "Healthy soil is important to farmers and food production. We want to grow radishes for our food, but are not sure which soil is best. We are going to test which of these three soil types is best for growing radishes." (Be sure to have a few radishes or pictures of radishes for the children to see and/or touch.)

After students have seen the soils and some radishes and understand the investigation, ask them to predict which soil will grow the biggest radish by drawing a picture of the radishes growing in each soil type.

Have students draw a big radish in the soil they think will grow the best and a small radish in the soil in which they think it will grow the least. If they think soil type will not make a difference, they should draw all radishes the same size. Have students carefully label their drawings with the type of soil each radish is growing in and include in the drawings the basic parts of the radish: stem, leaves, roots, radish tuber. (It is helpful for the teacher to draw a diagram of a basic radish plant and describe the parts on the board so that all students are aware of the plant's form.) This typically takes 10 to 15 minutes.

Next, gather the students in a circle and have students describe their pictures, predictions, and rationales for predictions. Students should write the reasons for their predictions on their pictures. Many of our students suggested that the plants would grow better in the compost because it was "healthier," though a handful of students predicted that the soil comprised of sand plus nutrients would provide more nutrients than the other treatments. Some predicted that the sand would not have enough water.

Growing Radishes

After students made their predictions, we passed out the supplies so students could plant the radishes. Students worked in pairs and followed the procedures below.

1. Obtain a supply box containing one six-chambered seed-starting pot, six Popsicle sticks, a spoon,

Figure 1.

The Radish Party supply list.

Almost every item is available year-round at hardware or garden supply stores, with the exception of radish seeds, which are seasonally available in some areas.

Supply	Quantity
Radish seeds	3–4 packs
Potting soil	1 medium bag
Sand	1 medium bag
Granular organic fertilizer	1 small bag
Popsicle sticks	6 per group
Seedling pots (6 packs)	1 6-pack per group
Seedling trays that don't leak	2–3
Fluorescent grow lights*	Enough to cover the seedlings
Measuring cups (mL)	2–3
Rulers	1 per group

* If fluorescent grow lights are unavailable, a warm, sunny window could be an alternative. Be aware though that the effects of too little light could outweigh the effects of the soil types, leading to different results.

Soil Safety

CAUTION

Follow these guidelines when conducting soil investigations in the classroom.

1. Send a letter home to parents/guardians of students informing them about soil activities in the classroom to obtain permission before having students working in soil. Include information about possible allergens (mold/spores) etc., which might affect students with compromised immune systems, allergies, or asthma.
2. Remind students to never eat soil, sand, etc. Some soils could potentially contain lead, pesticides, or other toxic substance and should not be consumed.
3. Always know the source of your soil samples! Some soils are contaminated by animal waste, pesticides, etc.
4. Have students wear plastic gloves when working with soil. Make sure all open cuts or scratches are covered minimally with a protective barrier to prevent infection.
5. Always wash hands with soap and water after working with soil. Use antiseptics on cuts or scrapes.
6. Don't store wet soil more than a day or two. Mold and bacteria spores will grow in it.
7. Be sure to use good housekeeping standards—wash desktops with mild soap and water where soil activities took place. Do not allow snacks or other food products during soil activities.
8. Do not flush sand, silt, clay, rocks, and other earth materials down the drain. These materials are not soluble in water and may clog the drain. Dispose of them in a trash can or other suitable receptacle.

and 20 radish seeds.

2. Fill two chambers of the seedling tray with each of the three soil types, for a total of six filled chambers.
3. Label Popsicle sticks with the soil types and the date of planting. Each chamber should have one clearly labeled stick.
4. Plant three radish seeds in each chamber, leaving a little space between the seeds to avoid crowding. Plant the seeds at least 1.25 cm deep, and make sure they are covered. (We sowed three to allow for less than 100% germination—that would ensure that at least one radish will emerge per pot. Ideally, if no seeds are lost, each team would have two extra plants.)
5. Place all the pots in a large garden tray that does not leak, and put the tray under grow lights or in a sunny window.
6. Water each pot carefully with an agreed-upon volume of water between 50 mL and 100 mL. (To aid measuring, students can use a cup with a "fill to" mark on the side or a graduated cylinder if available. Having all students water each pot with the same amount of water helps ensure a fair test.)

Allow the plants to grow for several weeks to a month (if you want to harvest a mature radish), watering every two or three days with the same amount of water. Have students make observations every week: *When do seedlings first emerge? Which ones are growing faster, taller, slower?*

Depending on the grade level, assessing plant growth and health can be done in several ways. For the youngest of students, simply looking at how tall the seedlings are and gently counting the number of leaves can be a good measure. Older students should be encouraged to measure plant height, stem thickness, and number of leaves. Advanced students may be able to graph plant height, stem thickness, and leaf number through time to determine quantitatively which plants are growing fastest. Students should realize that overall plant health, including stem strength and color—in addition to growth—are indicative in part of a healthy plant and healthy soil.

Assessment Time

When the set investigation time is up, bring students together to analyze their data and compare the results with the students' earlier predictions. Gather all the plants together on a table in front of the students. Ask the students to carefully remove all plants from their pots and place them in a pile on the table in three separate, labeled piles (sand, sand plus nutrients, compost). Ask the students to make observations and look for differences (advanced students may even make a few measurements). The following questions can be used for discussion and can also form the basis of an assessment of student learning from the inquiry:

SCILINKS
THE WORLD'S A CLICK AWAY
Keywords: Explore Soil
at *www.scilinks.org*
Enter code: SC100701

- *What differences do you see?*
  Our students saw that plants grown in sand were very small and dried out. The plants grown in sand plus nutrients were similar. Plants grown

in the compost were green, strong, and healthy.

- *Which soil yielded the largest plants? The most healthy looking plants?* The compost had the healthiest plants.
- *Is the tallest plant always the healthiest?* Our students usually answered "no," because they saw that even though a plant was taller, it had a weak stem or was pale.
- *Were your predictions met? Why or why not?* A few students had predicted that the plants given nutrients (sand plus nutrients) would grow best, so they were surprised at the results. However, most of the students had predicted that the soil with organic matter (compost) would grow the healthiest plants, but they were unsure if it was because of water or nutrients.

After discussing which soil type produced the "best" plants, students naturally wondered why the plants with added nutrients did not grow better than the plants in the soil, so we talked about conducting more investigations in the future. (The answer is likely to be that the plants in sand dry out more quickly than plants in soil that holds more water.)

The students' drawings (see examples on p. 42) revealed whether or not they learned basic plant form, understood why the plants may differ in growth, and what the reasons were; the follow-up class discussions helped clear up any misconceptions that were evident from their predictions.

Radish Party Success

The Radish Party inquiry proved to be an exciting opportunity for students. The students loved "being farmers" and growing vegetables and watching the stages of growth. They were excited to see how their predictions would turn out, kept an ever vigilant eye on their crops, and created detailed pictures of their predictions and lucid explanations of why they made their predictions. Students were engaged in the concluding discussions and gave evidence of a greater understanding of soil organic matter. More importantly, the activity had planted a seed for inquiry. At the end of the radish exploration, students were eager to continue investigating and apply what they learned to their home gardens. ■

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Connecting to the Standards

This article relates to the following *National Science Education Standards* (NRC 1996):

Content Standards

Grades K–4

Standard A: Science as Inquiry

- Abilities necessary to do scientific inquiry
- Understandings about scientific inquiry

Standard C: Life Science

- The characteristics of organisms

Resources

Hillel, D. 1991. *Out of the Earth*. New York: Free Press.

National Research Council (NRC). 1996. *National science education standards*. Washington, DC: National Academy Press.

Pimentel, D., C. Harvey, P. Resosudarmo, K. Sinclair, D. Kurz, M. McNair, S. Crist, L. Shpritz, L. Fitton, R. Saffouri, and R. Blair 1995. Environmental and economic costs of soil erosion and conservation benefits. *Science* 267: 1117–1123.

Six , J., R.T. Conant, E.A. Paul, and K. Paustian. 2002. Stabilization methods of soil organic matter: Implications of C-saturation of soils. *Plant and Soil* 241: 155–176.

Internet

Ecologists, Educators, and Schools
www.bioed.org/ecos/about.htm

K–12 Teaching Resources and Activities by Dr. Dirt
www.wtamu.edu/~crobinson/DrDirt.htm

Soil Education
http://soils.usda.gov/education

Soil Science Education Home Page
http://soil.gsfc.nasa.gov

NSTA Connection

For additional soil ecology lessons, visit *www.nsta.org/sc0710.*

Soil ecology lessons for K–2 students.

These lessons are available at *www.bioed.org/ecos/inquiries.aspx.*

A Tour of Soils

This simple and fun outdoor activity is a perfect introduction to soils and is especially good to use before The Radish Party investigation. Children go on a scavenger hunt to find and describe five different soils from around the schoolyard. With only the help of a shovel, magnifying glasses, and their senses, the students explore the diversity of soil types and organic matter content. Teachers and students alike will be surprised at the diversity of soil characters in even the most homogenous schoolyard.

Composting 101: It's the Microbes

In this long-term experiment, students actually create soil organic matter from fallen leaves they collect in the fall. The influence of soil microbes on decomposition takes center stage as students test if "living soil" speeds up decomposition compared to "dead soil." Students can even use some of the compost they make in this experiment in The Radish Party investigation for an integration of concepts.

Soil Erosion: Causes and Cures

Here students learn how soil organic matter and litter help prevent soil erosion. This is an advanced experiment that takes a little setup and time but is very informative, dramatic, and relevant to students' daily lives. Students help the teacher create an erosion machine, and then the students test how different soil types with varying organic matter or the presence or absence of a litter layer respond to the erosive force of water. Students can see how organic matter and litter mulch can greatly reduce soil loss from erosion. They are encouraged to think of ways to prevent erosion in their gardens at home.