What is soil erosion by water and how can it be prevented?

PROJECT PUMPKIN (gr 3-5)

Soil: Its Components

(ILS 7, 10, 12E)

Overview

This curriculum explores the relationship between people and the food they eat. By growing pumpkins in a garden plot, the curriculum takes teachers and students through six features of sustainable agriculture that separate it from conventional farming. If the entire curriculum is completed, students will gain an understanding of sustainability and people's place in the food chain.

Sustainable Agriculture, for the purpose of this curriculum, shall be defined as "a system of food production, supported by consumers, where farming operations, practices and technologies work in harmony with the natural systems that sustain life on earth."

Suggested Grade Level

This curriculum is designed for 3rd through 5th grade levels. The topics covered can be built upon in complexity throughout that age range.

Approximate Time

Session 1 requires about 45 minutes; session 2 requires about 35 minutes.

Objectives

1. The students will learn that various kinds of soil components affect the flow of water.
2. The students will learn the general components that make up soil.

Activity Abstract

The students will learn about the general components of soil. They will participate in a hands-on activity to qualitatively determine the rate of water flow through the various soil types.

Background Information

The structure of soil is the mix of sand, silt and clay in the various proportions to produce good tilth (workability), porosity, and texture. According to researchers, by definition, healthy soil functions to sustain plant and animal productivity, stabilize water flow through the environment, and buffer environmental changes in air quality and water quality. People describe soil types in all kinds of ways such as heavy, light, sandy, clay, loam, poor or good.

Sand is the largest particle in the soil. When you rub it, it feels rough. This is because it has sharp edges. Sand doesn't hold many nutrients. Water tends to drain

quickly through sandy soils (made up of large particles).If the water drains too quickly from the soil, plants will wilt.

Silt is a soil particle whose size is between sand and clay. Silt feels smooth and powdery. When wet it feels smooth but not sticky.

Clay is the smallest of particles. Clay is smooth when dry and sticky when wet. Soils high in clay content are called heavy soils. Clay also can hold a lot of nutrients, but doesn't let air and water through it well. Water drains slowly through clay (composed of small particles). If drainage is poor, the soil spaces will have limited oxygen that plants and soil organisms need to survive.

Soil quality has three categories: physical, chemical, and biological. The physical has to do with texture (mix of sand, silt and clay). It is possible to change the texture by adding different things. Changing texture can help in providing the right conditions needed for plant growth. Some other factors are tilth (physical condition of cultivated soil in relation to plant growth, and porosity. The chemical component has to do with the nutrient and mineral content, organic matter, pH, and salinity. The biological component is composed of microorganisms, fungi, soil-living animals such as worms and ants, and many other microscopic living organisms.

A healthy soil has a number of features: be well drained, have a deep rooting zone, be easily penetrated by air, water, and roots, have a good water-holding capacity, have a balanced nutrient supply, and resist erosion. Different-sized soil particles (clay, silt, loam, and sand) create air spaces that can hold air or water. When rain falls, water and dissolved nutrients fill the soil spaces and become available to plant roots. Soil and water have a dynamic and important relationship. Water tends to drain quickly through sandy soils (made up of large particles), and slowly through clay (composed of small particles) and compacted soils. If the water drains too quickly from the soil, plants will be able to process it quickly enough to be healthy. On the other hand, if drainage is poor, such as a clay soil, the soil spaces will have limited oxygen that the plants and soil organisms need to survive. If soil is compacted or packed very tightly, excess water can collect on the surface, then run off and take priceless soil away. Plant roots help protect the soil from being washed or blown away. Organic matter (decaying plant and animal materials) improves how both clay and sandy soils absorb and hold water.

Materials

- Three differently-sized balls, such as a basketball, baseball and golf ball
- Soil samples – at least one cup – of various types including sand and clay, possibly gravel. Be sure to use soil that includes organic components. (Purchase bags at the hardware store or dig from locations outside that have different soil structures.)
- For each team of 3-4 students, 1 plastic 2-liter bottle with top part cut off to make a funnel to be inverted into bottom of bottle. See http://www.bottlebiology.org/basics/buildingblocks.html for lost of details on preparing your bottles.
- 1 coffee filter for each funnel
- Water for pouring (about 2 cups per group)
- Measuring cups (1 per group)

Teacher note: Appendix A contains a picture of how the bottle should be assembled.

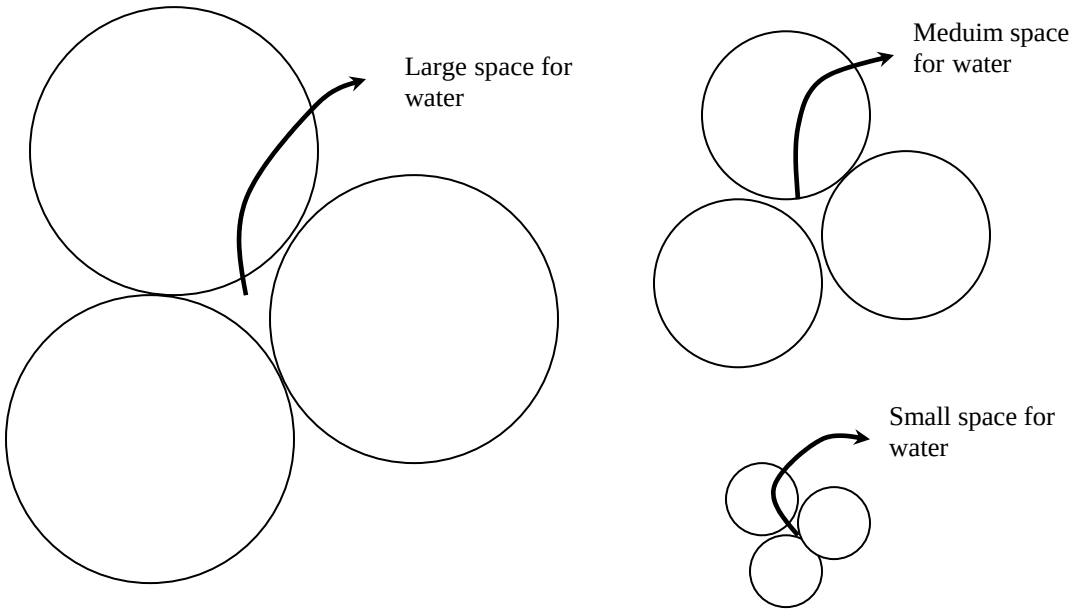
- For each group, stopwatch or watch with second hand
- Soil Seekers Record Sheet (See Appendix B)
- Computer with internet access (optional)

Set-up

Assemble the bottle funnels (see Appendix A). Place the samples of various types of soil out on a table.

Procedure

1. **Tap prior knowledge.** Review with students the main types of particles that comprise soil: sand, silt, and clay along with the organic components such as the various organic materials present (decaying leaves, dead bugs, bits of grass, etc.). How can various soil types affect the way that water drains through or away from soil? Do different types of soil "hold" water differently?
2. Explain that particle size has a lot to do with a soil's drainage and nutrient holding capacity. When soil particles have less air space between them, there is less room for air, water, and nutrients to pass through to the roots. Use the three different ball sizes to visually illustrate the comparative sizes of pore spaces that are created by the balls. This is the sort of variation in pore space size that you will find between sand, loam and clay soils. If a particle of sand were the size of a basketball, then silt would be the size of a baseball, and clay would be the size of a golf ball. Line them all up, and you can see how these particles compare in size.
3. Illustration of varying particle sizes, using different sized balls:



4. Split the class into groups of 3 or 4 students.
5. Explain that they will be testing the soil samples on the table to see which holds the most water.

6. **Share with neighbor.** Have each group come up with a hypothesis about which soil will hold the most water and the least water and write it in their science notebooks or on their data sheet. Allow the students to inspect the soil to make their decision.
7. Distribute funnel-bottles and coffee filters to each group. Have students put the filter in the funnel as though they were going to make coffee. (The funnel should not have a lid on it.
8. Assign each group to collect an agreed-upon amount (i.e., one cup) of one type of soil sample from those available.
9. **Hands-on experience.** Have students place the designated amount of soil in each funnel and pack the soil firmly so that the soil resembles in situ soil. Even the least permeable clay soil will drain rapidly in this experiment if it is not firmly packed into the funnel. (The instructor may want to test out the funnels and soils before class instruction.)
10. Have a student from each group pour an equal amount of water (i.e., 1.5 cups) through the soil while someone else on the team tracks how long it takes for the first drop of water to drip into the bottom of the container.
11. Students can compare how much space is between the particles by the speed of the first drop to emerge.
12. Allow the rest of the water to pass into the container (bottle bottom.) By comparing the water volume before being poured with the volume that drips out, students can also determine how much water each soil is holding.
13. **Relate experience to scientific concept.** Compare guesses with results. Which soil component allowed the water to pass most quickly? Which allowed the most water to pass through? Which "held" the water and allowed the least to drain out? Which had the most sediment in the collection area? Relate to the discussion with the three balls (more space between the particles allows more water through it). Which soil would be most likely to hold the most nutrients? Which soil would be best for growing plants? Why? Which soil most likely had the most clay? Sand? Have students ever seen examples in real life of areas where water has carried away the soil?
14. **Conclusion and Wrap up.** Answer the question at the bottom of the Soil Seekers Data sheet. Discuss answers as a class.
15. Follow up with the Soil Conservation: Erosion Activity, shortly after this activity.

References

"A Day at the Races," Jaffe, R. and Appel, G. 1990 The Growing Classroom: Garden Based Science. Addison-Wesley Publishing Company, Menlo Park, CA

http://www.cals.ncsu.edu/sustainable/peet/cover/cover.html

View a slide show illustrating the various types of conservation tillage. Go to http://www.uvm.edu/~nesare/slides/sld001.htm

www.sfc.ucdavis.edu

http://www.uvm.edu/~nesare/slides/sld001.htm

http://www.kidsgardening.com/Dig/DigDetail.taf?ID=856&Type=Art*

http://www.kidsgardening.com/Dig/DigDetail.taf?Type=Art&ID=845

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http://www.kidsregen.org/educators/curriculum/farmingGlossary.html

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http://anrcatalog.ucdavis.edu/

http://www.kidsgardening.com

http://4hgarden.msu.edu/main.html

http://www.ahs.org/

http://www.sarep.ucdavis.edu

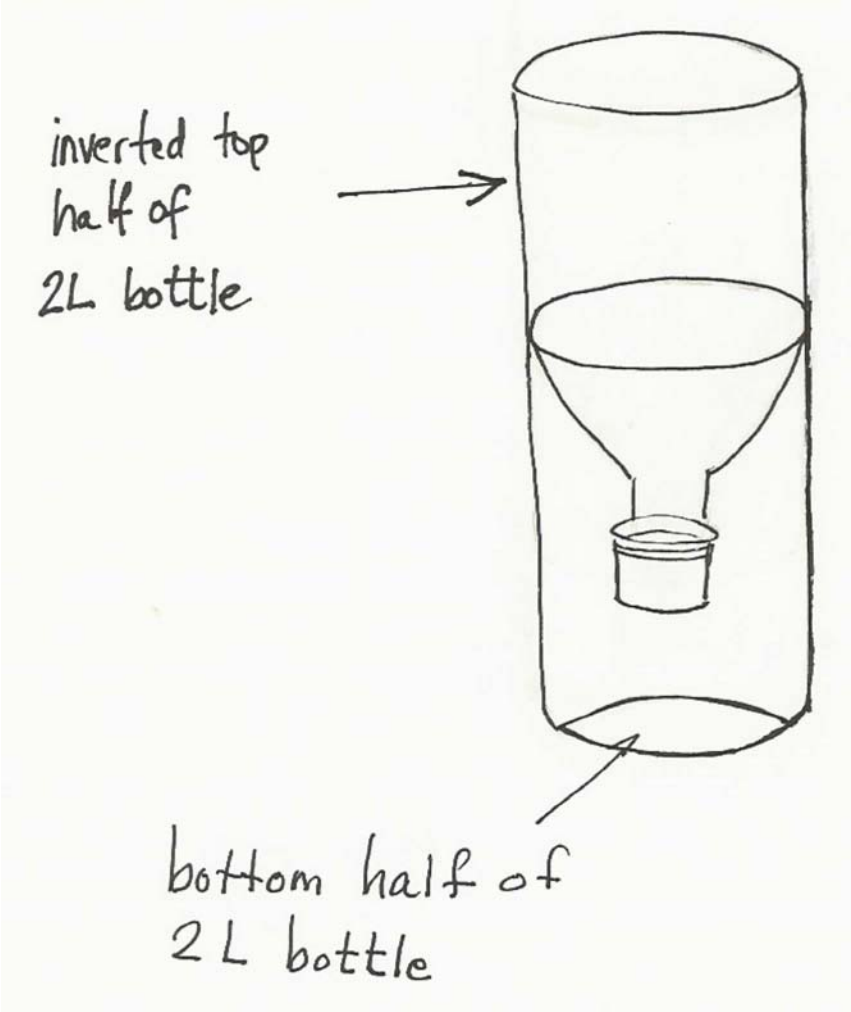
http://www.ces.ncsu.edu/depts/hort/consumer/hortinternet/index.html

http://www.uvm.edu/~nesare/slides/sld001.htm

http://www.bottlebiology.org/basics/buildingblocks.html

Random House Webster's College Dictionary, Random House, New York 1992

Appendix A: Bottle-funnel set-up.



Appendix B: Soil Seekers Data sheet.

Soil Type	Speed Prediction	Actual Speed	Sediment Prediction	Sediment Actual
Garden Soil				
Clay				
Sand				
Gravel				

What does this experiment tell you about the different types of soil?