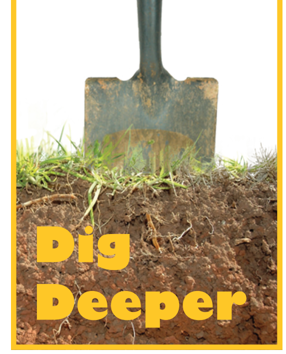
Soil Lessons

Soil Science Society of America

Rain and Soil



Subject Area

Environmental Science
Grade Levels 5-10

Type of Lesson

Hands-on, Outdoor Experiment

Materials Needed

Access to a green space or schoolyard garden

Ring infiltrometers (supplies needed: large metal coffee can or other clean metal can, ruler, marker)

Water

Graduated cylinder

Stopwatch

Tiller or garden spade

Time

Teacher prep time – 20 minutes
Student class time – 45 minutes-1 hour

Student Learning Outcomes

Students will be able to understand:
- How water moves through soil
- How to calculate water movement

Keywords

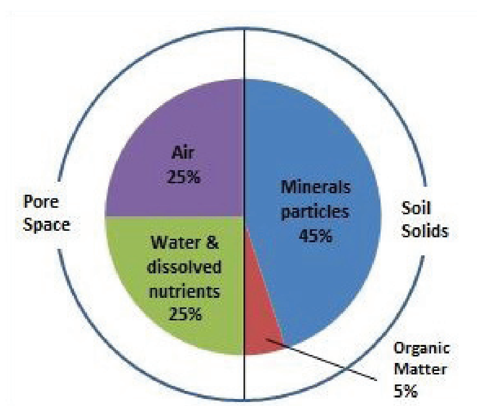
Infiltrometer, infiltration, organic matter, micropore, macropore, compaction

Summary

We all know that when it rains, much of the water drains directly into the ground. But why?

Soil is made up of four main components: minerals, organic matter, water, and air. Ideal percentages of each is shown in the figure below, but in reality the percentages vary from location to location. Water moves through open spaces in soil known as "pores." More and larger pores allow water to move freely, whereas fewer and smaller pores restrict water movement. Restricted flow can cause water to pool at the surface, resulting in big muddy patches. It can also cause water to flow over the land surface, leading to erosion.

Compaction of soil can contribute to the size and numbers of pores. Soil can become compacted many ways, and this can have long-term effects. For example, when American settlers traveled the Oregon Trail in their wagons in the 1800s, soil became so compacted that we can still see wheel ruts today. Try the following experiment and draw your own conclusions about compaction and pore size in soil.

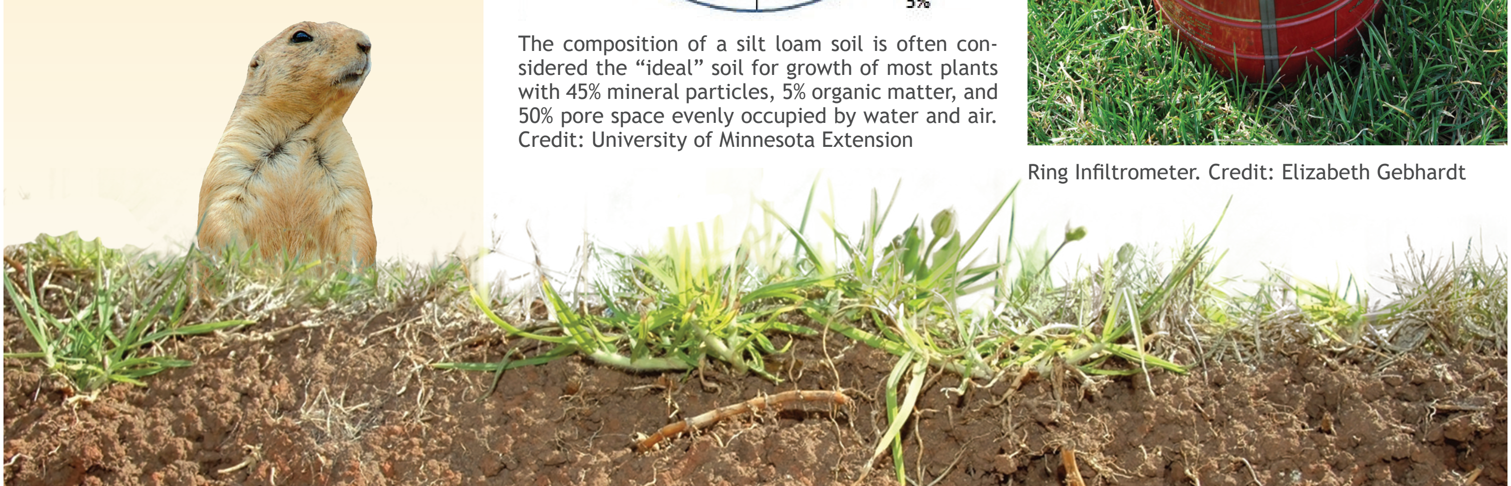


The composition of a silt loam soil is often considered the "ideal" soil for growth of most plants with 45% mineral particles, 5% organic matter, and 50% pore space evenly occupied by water and air. Credit: University of Minnesota Extension

Procedure

1. Create your own ring infiltrometer using the instructions found below.
2. Locate two patches of soil or grass near (but not directly next to) each other: one people have walked on quite a bit, and one mostly undisturbed.
3. Sink your infiltrometers about a third of the way into the soil in each patch to the mark you made. (Try to not break up the soil or grass.)
4. At the first patch, fill the infiltrometer with water to your pre-marked line and start the stopwatch. Continue adding water to the line and measuring the amount added as you go. After two minutes, stop the stop watch and note the time and total volume of water added.
5. Repeat the experiment at the other patch (or run the experiments simultaneously with two teams).
6. Calculate the infiltration rate (see below) by dividing the depth of water that ran through in the time elapsed.

Ring Infiltrometer. Credit: Elizabeth Gebhardt



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Procedure

Calculations:

To compute infiltration rates from your experiment, you will need to convert the volume of water to a water depth, then divide by the elapsed time. Follow these steps to reduce your data and compute infiltration rates for each experiment.

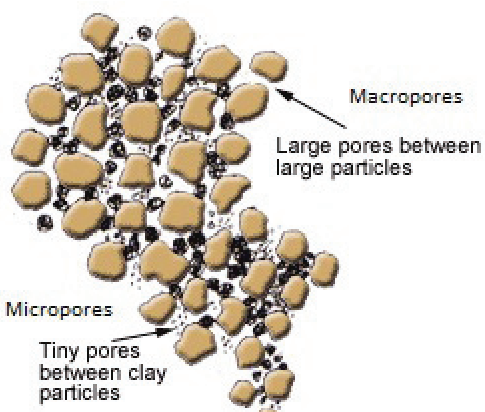
1. Use the table below to calculate the surface area (A) of the infiltrometer from the radius (r) of the ring $A = \pi r^2$ where r = ½ ring diameter
2. Compute depth of water infiltrated (H) as the volume1 of water (V) divided by the surface area (A) of the infiltrometer, e.g. $H = V/A$
3. Convert the elapsed time (t) in minutes and seconds to time in seconds.
4. Compute infiltration rate (I) by dividing water depth (H) by elapsed time (t), e.g. $I = H / t$
5. Record any relevant observations about the site conditions, including amount and density of vegetation, evidence of soil compaction, etc.

Extension: Repeat the experiment by locating a third area that can be tilled. Till an area of soil uniformly using a tiller or garden spades without destroying medium-sized soil clods. Once the soil has been tilled to a "fluffy" consistency, stomp down on half of the tilled area to compact it.

Discussion

View image of macropores and micropores below and discuss:

- What factors affect water infiltration, storage, and runoff in soils?
- How do surface soil aggregation, compaction, and porosity affect infiltration, storage, and runoff?
- Based on what you've learned, what practices would you implement or avoid at your home or school?



Credit: sielearning.tafensw.edu.au

Make your own Ring Infiltrometer

A **ring infiltrometer** (in-fill-trah-met-urh) is a device scientists use to measure how fast water infiltrates (runs into) soil. Our version will be a little simpler, but not by much.

Materials:

Coffee Can
Can opener
Ruler
Permanent Marker

1. Cut the bottom off of the coffee can so that you have a tube that's open on both sides. A can opener should do the trick.

2. Next, mark two lines all around the inside of the coffee can. Each line should be about 1/3 of the way from each end of the can (about 2.5 inches). Make sure you use the ruler to measure all the way around to ensure your line is straight.

Credit: Emily Fuger

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