USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Soil Quality Fact Sheet

Soil Water

Main Concept

When water touches the soil, it either enters the soil (infiltration) or it runs off over the soil surface. Less disturbed soils generally have more continuous pore space for better infiltration and less runoff than those that are heavily disturbed by tillage or construction activities. Water that infiltrates into the soil can be used by plants, while runoff leads to soil erosion and flooding. Eroded soil particles with adsorbed nutrients and chemicals can be carried by runoff into streams which flow into rivers and eventually into the ocean.

Educational Goals

- Demonstrate that more water infiltrates into less disturbed soil; and more water runs off of soil that is disturbed
- Understand the importance of infiltration to provide water for crop growth
- Understand how water that infiltrates into the soil can be used by plants, transpired, and then fall again as rain
- Understand how undisturbed soils can help reduce flooding and the amount of sediment, nutrients and chemicals that get into streams, rivers, lakes, and eventually the ocean

Background

Water from rainfall or irrigation readily enters soil that has large, continuous pores and channels from the surface into the soil profile. Earthworms and other soil creatures create channels in the soil as they search for food and shelter. Fungi produce organic substances (glomalin) that glue soil particles together into aggregates, thus creating pore space and providing stability to help keep earthworm channels open. Undisturbed soils consisting of leaf litter, dead plant matter, and other organic components provide food for soil organisms, thereby increasing their productivity.

If soil is disturbed by tillage or construction, continuous pore space and channels are destroyed and infiltration is reduced. Additionally, disturbed or exposed subsurface soils generally lack the biological activity and soil glues necessary to hold soil particles together as stable aggregates when water touches or enters the soil. As a result, soil particles fall apart into a mud when it rains or irrigation is applied. The soil particles become suspended in the water and then settle and seal the surface pores as a crust. Water does not infiltrate as easily through the crust, so additional rainfall or irrigation water with suspended sediment runs off.

Explanation

Soil from a lawn, an orchard, or a field that has not been tilled for several years has many large pores for water infiltration compared to a disturbed soil. Undisturbed and disturbed soils can be collected in bottomless pans, and the pans fitted with a screen and rack system so as to sit on top of glass containers that can capture water that infiltrates through the soil. The amount of water collected in the glass containers for the different soils can be compared. If there is any runoff from the less disturbed soils, it will generally be clear.

As simulated rainfall is added to the soil collected from a continuously tilled field, a construction site, or from several inches below the surface, the soil will generally fall apart into individual soil particles and form a mud slurry. This mud will seal the surface of the soil and most of the water will run off of its surface. The soil particles in the runoff water will make the water cloudy. When these particles settle out of the water, a layer of mud will form on the bottom of the containers used to catch runoff.

How to Set Up the Soil Water Demonstration *(Instructor Preparation)*

Have the following materials available for the students to prepare the demonstration.

Materials & Preparation

- √ 2 pans of soil from two different management areas (conservation tillage, conventional tillage, sod, forest, construction site)
- √ 2 glass pans to capture water that infiltrates through the soil
- √ 2 metal racks or stiff screens to separate the soil pans from the glass pans
- √ 2 containers to capture runoff from the soil pans
- √ 2 racks to hold the plastic cups above the soil pans
- √ 2 plastic cups with holes to simulate rainfall
- √ 2 plastic cups
- √ 2 pieces of screen
- √ 1 thumb tack
- √ 1 measuring cup to measure the amount of water that passes through the soil

Gather the soil samples with a set of metal cutters about 3.5" W x 8" L x 3.5" D. These cutters can be pushed into the ground and pulled back out with a clawed hammer. The cutter with the soil sample inside of it is set on a screen and rack that keeps the soil from falling out. Simulated rainfall or irrigation water is applied to the top of the sample using a plastic cup with holes punched in the bottom using a common thumb tack. The soil pans can be tipped slightly by placing them on a board that is elevated with bottle caps.

Answers to Student Exercise

1. Answers will vary. More water should infiltrate into soil collected from areas with less disturbance; more water should run off of soil collected from areas with more disturbance.

2. Answers will vary. The runoff water should be clearer from soils that have a protective cover over them (plant parts) or where disturbed less and contain more soil glues.

3. Answers will vary. A soil that is both disturbed and has more silt and clay in it will generally result in cloudy water that will take a time to clear.

4. The less disturbed the soil, the more stable it will be. The more stable soil will have more pores in it because the particles will not fall apart easily or fill the pores.

5. The soil that holds together the best is the soil that can resist erosion the best.

Further Investigations

- √ Compare samples from several different management areas.
- √ Allow the soils to dry for several days and run the experiment again. Do you get the same results?
- √ Take the soils out of the pans, mix them up and put them in the pans again. Do the soils act the same after they have been disturbed?
- √ Add residue (plant parts) to the surface of each pan. Does the presence of plant parts help the infiltration?

Name:_____

1. Ask your instructor about the source of the soil samples and record the information here.

What type of soil is in each pan?	
Pan 1	Pan 2

2. Add water to each soil using the rainfall simulator. Add about 1/3 cup at a time to each of the two soils.
3. Record your observations after each addition of water.
4. Use the measuring cup to measure how much runoff came from each pan.
5. Likewise, measure how much water was collected in the glass pans underneath the soil samples.

Observations after the rain or irrigation water was added to each pan.	
Pan 1	Pan 2

Questions:

1. Did both soil samples react the same way to the addition of water?

_____
_____

2. Was the runoff water more clear in one jar or the other?

_____
_____

3. If the water became cloudy, did it become clear again? How long did it take to become clear again?

_____
_____

4. Which soil would have more pores in it after a rain storm?

_____
_____

5. Which soil is more apt to resist erosion during a rain storm?

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Illinois NRCS contributed to this fact sheet.

Helping People Help the Land.

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