Soil Analysis Lab
APES
Lindemulder

Overview
Soil is one of the earth's most important, yet least appreciated, resources. It performs a crucial role in land ecosystems. In order for an advanced community of producers and consumers to become established on land, soil must be present. Because of this need, soil quality is often a limiting factor for population growth. Soil is a complex mixture of inorganic materials, organic materials, microorganisms, macroorganisms, water, and air.

The formation of soil starts with the weathering of bedrock, usually by water, or the transport of sediments from another area, again usually by water.
These small grains of rock accumulate in various layers, known as horizons, on the surface of the earth. There they become mixed with organic matter called humus, which results from the decomposition of the waste products and dead tissue of living organisms. This process is very slow and can take hundreds or thousands of years, but soil structure can be destroyed in a matter of seconds or minutes if not properly managed. Thus, it is detrimental to a community if the soil is lost through erosion or its quality degraded in any way. Soil contains important primary plant nutrients such as nitrogen, potassium and phosphorus. Also necessary for plant growth, water and air are trapped in its pore spaces.

Purpose
In this lab activity you will determine textural and compositional characteristics of a soil sample as well as chemical characteristics of your soil sample.

Required Reading (from LaMotte Soil Handbook)
Soil texture - pages 4-9
Macronutrients - pages 10-17
Micronutrients and Trace Nutrients - pages 21-26
pH - pages 27-29

Timeline
Day One - Physical Properties of Soil
Texture and Composition Analysis - measurement of the proportions of sand, silt, and clay in the soil. This will be measured by shaking a soil and water mixture in a graduated cylinder and allowing the sand, silt and clay to settle out in separate layers.

Day Two - Chemical Properties of Soil
Chemical Properties and Nutrient Analysis
Determination of pH - The pH is a very important factor in the fertility of a soil. Plants have defined pH ranges they can tolerate.
Nutrient Testing - Using soil test kits, you will examine nitrogen, potassium, and phosphorus concentrations. These are three primary nutrients needed by plants and are what are most commonly added in an attempt to improve soil fertility. They become depleted from human activities (farming, excess irrigation, runoff caused by unsustainable farming techniques).

Finally, you will determine the overall health of the soil.

Materials Needed

Soil test kit
Graduated cylinder
Soil sample
Plastic wrap
Rubber band
Paper towel

Procedures

Hints to make this lab successful:

Plan time wisely - There will be times a sample has to sit for up to thirty minutes. Begin a new activity while you wait.
Read instructions on the soil test kit very carefully.
Do not put soil down the drains and be sure to clean up carefully.

Prepare the soil sample:

1. Remove about 40-50mL of the soil sample and set it aside for determination of soil texture.
2. Spread out the rest of the soil onto a sheet of paper to dry for chemical analysis.
3. Remove unwanted foreign material from the soil such as twigs, leaves, and stones.
4. Crush the soil gently to break up any clumps.
5. Dry the soil until it is ready to be used.

Determination of Soil Texture

Soil is composed of particles that are categorized into groups according to their size, as shown in the table below. One method of classifying soils is to measure the relative amounts of sand, silt, and clay in a soil sample, then use a soil triangle to determine the soil type. In this lab, the textural classification of a soil sample will be determined by measuring the relative amounts of sand, silt, and clay particles, then using a soil triangle to determine the soil type. The comparative volumes of sand, silt, and clay will be determined based upon the fact that the different sized particles will settle out of a mixture at different rates.

Particle	Size
Clay	< 0.002 mm
Silt	0.002 - 0.06 mm
Sand	0.06 - 2.0 mm
Gravel	> 2.0 mm

1. Place 40 to 50 mL of soil sample in the graduated cylinder.
2. Add water until the total volume of the soil and water is between 80 and 100 mL.
3. Cover the top of the graduated cylinder with a piece of plastic wrap and secure it with a rubber band.
4. Invert the cylinder several times until the soil is thoroughly suspended in the water. You may have to shake the cylinder to mix the water and soil thoroughly.
5. Place the cylinder on the table and let the soil material settle for at least 30 minutes. The different soil materials will settle to the bottom at different rates depending on their particle size.
6. Estimate and record the volume of sand, silt, and clay layers. There should be at least three reasonably distinct layers in the graduated cylinder representing sand, silt, and clay. There may be a dark humus layer above the clay layer or possibly floating on top of the water. Be sure to record the volumes of the three layers as the total volume of your sample.
7. Calculate the percent composition by volume for each layer.

Determination of soil pH

The pH of soil is an important factor in determining which plants will grow because soil pH controls which nutrients are available for plants to use. The actions of plants, animals, and microbes that inhabit soil, along with physical factors, especially the characteristics of rainfall in the area, affect soil pH. Contrary to popular belief, rainwater does not have a pH of 7.0. As raindrops fall through the troposphere, carbon dioxide (CO_2) is absorbed and dissolves in the rainwater, as a result the raindrops become acidic as CO_2 reacts with water to form carbonic acid (H_2CO_3), as shown ($CO_2 + H_2O \rightarrow H_2CO_3$). Since air has always contained CO_2, rain has always been acidic. Today, the pH of rain can be 5.0 or lower if it is contaminated with oxides of sulfur and nitrogen which can form sulfuric and nitric acids respectively. In this lab activity, the pH of a soil sample will be determined.

Soil pH procedure

1. Use the dried soil you previously placed on the paper.
2. Determine the pH of the soil following the instructions included with the soil test kit. Note: This test requires that you allow the soil to settle for ten minutes.
3. Record you pH data.

Soil nutrients procedure

1. Use the dried soil you set aside previously.
2. Determine the nitrogen, potassium, and phosphorus contents of the soil sample following the procedure provided in the soil test kit. Note: These tests require that you allow the soil to settle for ten minutes.
3. Record your results.

Cleanup Procedure

1. Dump unused soil in the appropriate container.
2. Soil used in tests should be disposed of in a separate container. Do not put soil down the sink.
3. Return all equipment and materials to their appropriate places.

Analysis Questions

Answer the following using complete sentences.

1. Of the three three component particles present in soil (sand, silt, and clay), which gives the most surface area per unit volume? Which gives the least surface area? Explain why.
2. Use the soil triangle to determine the type of soil with the following particle sizes.

	Sand	Silt	Clay
Soil 1	70%	20%	10%
Soil 2	30%	60%	10%
Soil 3	50%	10%	40%
Soil 4	30%	40%	30%
Soil 5	40%	10%	50%

What was the composition of your soil? Use the soil triangle to determine the soil type.

3. Looking at the Soil Texture Triangle, which soil type has the greatest:
   a. water retention?
   b. water percolation?
4. What role does humus play in soil fertility?
5. Why is pH such an important aspect of soil fertility?
6. What are some natural sources of nitrogen, potassium, and phosphorus found in soil?
7. How are the three primary plant nutrients used by living organisms?
8. By what process is atmospheric molecular nitrogen (N_2) converted into a form that plants can absorb through their roots? What for of nitrogen can they absorb?
9. Evaluate the fertility of the soil used in this lab based upon your results.
   a. Explain the results of the physical analysis and explain the qualities of the type of soil you identified your sample as.
   b. Explain the results of the pH test and what types of plants would be best suited. You should give at least three recommendations of farm/garden plants and at least five recommendations of various plants/shrubs. If you know of plants already present in the area determine if they are suited for this environment. If the pH requires adjustment, explain how that could be done.
   c. Explain the results of the inorganic compounds tests (nitrogen, phosphorus, and potassium). Explain what these results show. Are there deficiencies? Are their nutrients in excess? How much fertilizer should be added? What plants would work well in these conditions?

Soil Texture Triangle