INVESTIGATION

9

Soil Analysis

Lab

PURPOSE

- Analyze a soil sample and remediate soil based on analysis
- Compare growth rate, taste, and other factors in crop samples from remediated and non-remediated soils

INTRODUCTION

Collect a soil sample by digging a small hole at least 12 inches deep. Remove any stones, roots, grass, or thatch from the sample and place in a one-gallon plastic sealable bag. Make notes on the surroundings where you collected your sample. Factors such as plant life, buildings, walkways, and paved areas may influence some of your tests and give clues about why you got the results you measured.

Materials

- local soil sample
- lettuce seeds
- hand lens
- 100-mL graduated cylinder
- 250-mL beaker
- centimeter ruler
- aluminum foil
- porcelain crucible
- drying oven
- ring stand and burner
- filter paper
- plastic bottles
- ethanol
- soil test kit (or CBL2)
- sample of clay
- sample of sand

Preliminary Investigation Two weeks prior to the start of this lab, put your name on a paper cup, and poke three holes in the bottom. Fill it with a sample of your soil and plant 5 to 10 lettuce seeds in it. Place the cup in warm sunlight and water it. Over the next two weeks care for your lettuce seeds as well as possible, recording your observations in a daily journal about how many seeds germinated and when, their growth rates, and appearance. Then begin the analysis of your sample using the following procedures.

PART ONE: GENERAL OBSERVATIONS

ur sample and carefully place it on a tray or large piece of ly at your soil sample. What do you see? Record the forms of uch as worms, insects, plant roots, etc. Observe and comment ˙cle sizes. Do any sizes dominate? Use a hand lens and draw

2. Abiotic components of your sample:

3. Biotic components of your sample:

PART TWO: SOIL TEXTURE

Soil is made of mineral particles belonging to three size categories: clay, silt, and sand. The size of soil particles is important. Large particles of sand allow empty space for air and water to enter the soil. Smaller silt and clay particles help hold the water in a soil so that it does not drain away too quickly to be of use to plants. The ratios of these materials, or **texture**, can be determined qualitatively and quantitatively.

Qualitative Test Take a small moist wad of your sample and squeeze it between your thumb and forefinger. If it feels gritty, then you have mostly sand. If it feels sticky, then you have mostly clay. If it feels neither gritty nor sticky, then you have mostly silt.

If you can squeeze out a long, unbroken ribbon of soil from your fingers, you have clay. If you can squeeze out a short ribbon, you have silt or loam. If you cannot form a ribbon, then you have sand or sandy loam.

1. What type of soil do you think you have? Why?

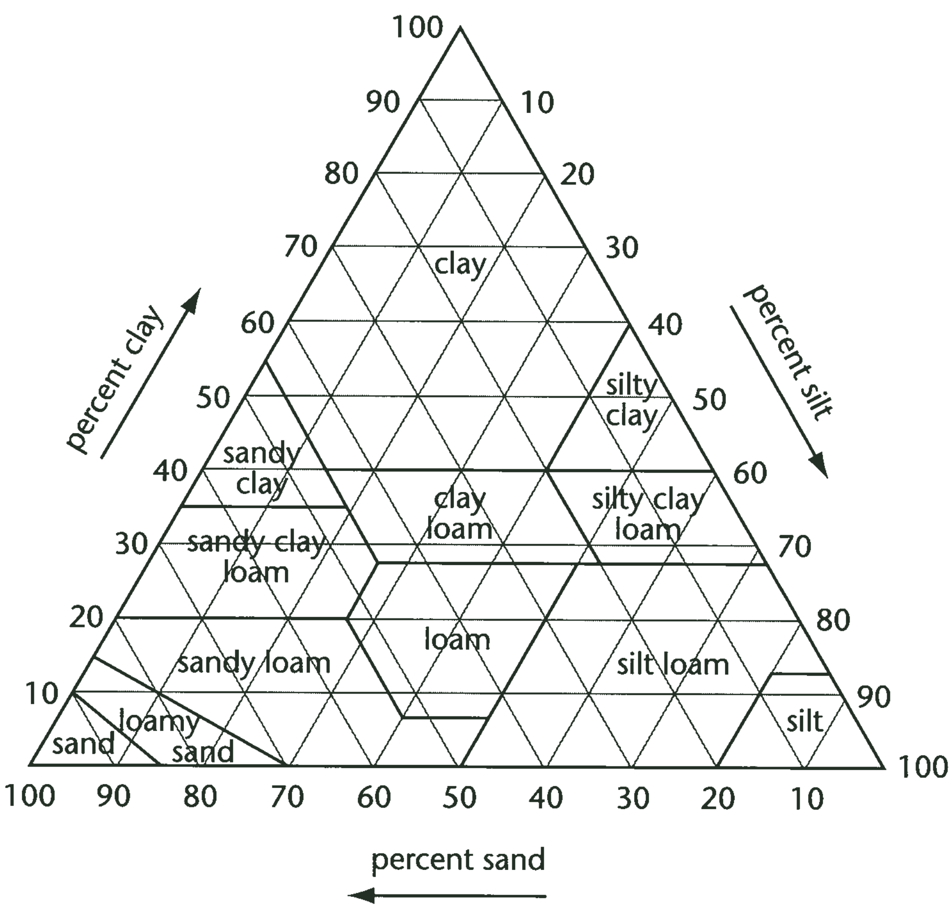

Fig. 9-1: Soil Triangle

Quantitative Test In a 100-mL graduated cylinder, place about 60–70 mL of your soil sample. Add enough water to saturate the soil completely and then keep adding water until the level gets to about the 100-mL mark. Now place your hand tightly over the open end of the graduated cylinder to seal it and shake the whole apparatus until the soil and water completely mix to make a free-moving slurry. Be sure to break up any lumps in the soil. Do this for at least one minute. Now place the graduated cylinder in a safe place for 24 hours, to let the soils settle out. The denser, large sand particles will settle out first and be on the bottom of the cylinder. A layer of silt will settle out on top of the sand and finally, after 12 to 24 hours, the tiny clay particles will settle out on top of the silt.

For calculations, show all setups with proper units.

2. With a centimeter ruler, measure the height of each layer and the total height of the sample. Calculate the percent of sand, silt, and clay in the sample.

   Total height: ______ cm, ______ % Silt: ______ cm, ______ %

   Sand: ______ cm, ______ % Clay: ______ cm, ______ %

3. What type of soil do you have? Use the Soil Triangle, **Fig. 9-1**.

   ____

4. How does your answer compare to the qualitative method?

   ____

5. Is your soil type consistent with your percolation test results from Part Six? How so?

   ____

   ____

   ____

6. Compare your soil texture to the results others in the class have measured. Which sites were the most sandy, silty, or claylike?

   ____

   ____

7. Hypothesize why the soils are the way they are. How were they formed?

   ____

   ____

   ____

   ____

8. Look for patterns in the class data. On separate paper, draw a map of the area and plot the soil types of the class.

9. If there were plants growing naturally in the area where you took your samples, do they prefer a particular soil type?

____

____

PART THREE: SOIL MOISTURE

You will now measure the amount of water in your soil sample. Make a small tray of aluminum foil and record the mass. Then put several spoonfuls of soil on the tray and again record its mass. Now put the tray with your sample into a drying oven for 24 hours, at a temperature of 90–95°. After heating the soil to dryness, let the sample cool and again record its mass. Any mass loss will most likely be water.

1. Determine the percent water, by mass, in your sample. Show your work.

   Mass of aluminum tray empty: ______ g

   Mass of tray + soil sample before heating: ______ g

   Mass of tray + soil sample after heating: ______ g

   Mass loss due to heating: ______ g ______ % mass loss

2. Compare the soil moisture of your sample to your soil texture results in Part Two.

____

____

____

3. Is there a pattern or correlation between soil moisture and texture, based on results by other members of the class? Describe it.

____

____

____

PART FOUR: PERCENT ORGANIC MATTER

To measure the organic matter, you will have to burn the soil at high temperature to convert as much of it as possible into CO_2 and H_2O. Since the general procedure involves measuring mass loss, you must first ensure the dryness of the sample.

Record the mass of a clean, dry porcelain crucible and fill it about ¾ full of your soil sample. Place it in the drying oven overnight at a temperature of 90–95° C to drive off the water. When that has been accomplished, record the mass of the soil and crucible.

In a fume hood, place the crucible on a ring stand, using an iron ring and pipe-stem triangle. Heat it gently for a few minutes and then heat it as hot as you can for about 30 minutes. Shut off the burner and allow the crucible to cool. Now record the mass of the crucible and soil again.

1. Calculate the organic matter in the sample (the loss of mass). Show your work.

Mass of empty crucible: ______ g

Mass of crucible + dry soil: ______ g

Mass of crucible + soil after heating: ______ g

Percent organics in sample: ______ %

2. Why is it not necessary to measure the mass of the soil alone?

____

____

3. Give at least three reasons why it is important to have organic material in soil.

____

____

PART FIVE: SOIL POROSITY

Porosity is the amount of air space in a soil sample. Porosity is important because it determines the ease with which water, oxygen, and nitrogen can work their way down to the root zones of plants. The creation of aquifers also depends on pore spaces between soil particles.

To determine the porosity of your soil, fill a 250-mL beaker to the 200 mL mark with dried soil and tamp down gently. Fill a 100-mL graduated cylinder to the 100 mL mark with water. Gently pour the water onto the surface of the soil until the soil is completely saturated and water just starts to pool up on the surface. Measure the amount of water left in the graduated cylinder. The amount used is the amount of pore space in your sample.

1. Calculate porosity as the percent of pore space compared to the volume of dry soil. Show your work.

Volume of soil: ______ mL Volume of water used: ______ mL

Porosity: ______ %

PART SIX: SOIL DRY PERCOLATION RATE

The **dry percolation rate** is a measure of how fast water flows through dry soil. This measure is particularly important in the design of leaching fields for septic systems in areas without sewer systems. The excess fluids from the septic tank must disperse quickly over a wide area.

Preparation Place a small piece of filter paper in the neck of a 16-oz water bottle that has been cut off to act as a funnel. You will fill the funneled section with soil samples to 1 cm of the top. Set the funnel section into the remaining, bottom part of the water bottle so that it collects the water as it drains through the soil sample. Set up three of these apparatuses, one for a sample of sand, one for a sample of clay, and one for your soil sample.

Percolation rate is measured in cubic centimeters of water per surface area of sample per second. Calculate the cross-sectional area of the funnel and give this area in square centimeters, a value that should be the same for all three set-ups. Pour water onto the surface of each sample and record from the time the water hits the surface to the time a measurable amount of water collects on the bottom of the bottle. Measure the water volume and record the elapsed time.

1. Record your measurements in **Table 9-1**.

	Sand	Clay	Your Sample
Sample Area			
Time Elapsed			
Water Volume			

Table 9-1

2. Calculate the percolation rate for all three samples. Show your work including proper units.

3. Discuss the patterns in your values.

PART SEVEN: BERLESE FUNNEL

In this test you will collect and count macroinvertebrates in your soil sample.

Preparation Cut the top off a 2-liter clear soda bottle 2 to 3 cm below where the sides become parallel. This will be the funnel to hold the soil sample. Pour about 20–25 mL of ethanol into the bottom part of the bottle and place the funnel section on top. Place a small section of wire mesh in the neck of the funnel, then fill with your soil and humus sample to about 2 cm from the rim.

Put the apparatus in a warm quiet place so it will not be disturbed. Set a heat lamp about 10 cm above the surface of the soil to speed the drying and help drive the organisms to the bottom of the funnel, where they will fall through the mesh into the ethanol to be identified and counted.

1. After five to six days, pour the ethanol sample into a petri dish. With proper ventilation, use a hand lens to identify, count, and draw the life forms that you have collected.

2. Explain what role these various organisms play in your soil.

3. How do your soil populations compare with those of others in class? Describe any patterns.

PART EIGHT: SOIL FERTILITY ANALYSIS

Four variables are important in determining the fertility of soils. They are: pH and the amounts of nitrogen, phosphorous, and potassium. The values of each of these components can serve as a limiting factor in the growth of plants.

1. Use soil test kits and/or CBL2s to determine the values of each variable for your sample.

   pH: ________ Nitrogen: ________

   Phosphorous: ________ Potassium: ________

2. Based on your results of these tests, which nutrients are low in your soil sample?

3. What is the ideal pH range for the plants that were growing where you collected your sample? Did the plants look healthy there? Compare their general appearance to your results.

FOLLOW-UP INVESTIGATION

From the lab you should have a reasonably complete analysis of your soil, and from your text and class an understanding of what soil characteristics are good for growing plants. Based on your analysis and using the soil in which you grew your first lettuce crop, now remediate your soil to make it better able to support a second lettuce crop. You may need to add more nutrient, balance the pH, adjust the soil texture, add organics, or take other measures.

Once the soil is remediated, add it to another cup and prepare it as you did the first. Plant more lettuce seeds, add water, and set aside in warm sunlight. For two weeks, take care of your crop, keep daily notes as before, and monitor the progress of your lettuce. Aim to have enough lettuce for a taste comparison test, if possible, with the first crop.

CONCLUSIONS

Prepare your lab report. It should contain the following:

1. This lab guide with all the information and questions filled in and complete.
2. Daily journals for your preliminary and final lettuce crops.
3. Summaries of your test results.
   a. Describe the vegetation growing in your soil when you collected it.
   b. What correlations did you find between soil fertility and the organisms you found in your sample?
   c. Give two examples of how the results on one test are related to other tests.
   d. Outline the composition of your original soil and what you did to correct the deficiencies.
   e. Explain the logic of your remediation procedure and the expected outcomes.
4. Discussion: How does the growth of lettuce after remediation compare with lettuce planted before you did these experiments? Compare growth rate, color, number of leaves, and survival rate of the two crop samples.
5. Discussion: Assuming you did the taste test with the lettuce grown in the remediated soil, tell how the lettuces of different students compared.
   a. How did they taste, compared to each other? (They should all be of the same variety of lettuce and from seeds from the same source.)
   b. What could account for the difference in the tastes?