Soil Lab

Purpose:
How are soils classified?

Objectives:

- Compare soil texture based on physical characteristics of soil particles. Physical characteristics to be observed and tested include size, texture, air space, water availability and permeability.

Background:

Soil differs in its texture and characteristics, soil texture determines water availability and permeability, land use and management are influenced by soil texture. Texture refers to the proportion and size of soil particles. Texture can be determined very accurately in the lab. However, it can also be judged or estimated by the feel of the soil.

The outstanding physical characteristics of the important textural grades, as determined by the "feel" of the soil, are as follows:

Course-textured (sandy) soils: loose and single-grained. The individual grains can be seen readily or felt. Squeezed, when dry in the hand, it will fall apart when the pressure is released. Squeezed, when moist, it will form a cast, but will crumble when touched.

Medium-textured (loamy) soils: has a relatively even mixture of sand, silt, and clay. However, the clay content is less than 20% (The characteristic properties of clay are more pronounced than those of sand.) A loam is mellow with a somewhat gritty feel, yet fairly smooth and highly plastic. Squeezed when moist, it will form a cast which can be handled quite freely without breaking.

Fine-textured (clay) soils: usually form very hard lumps or clods when dry and is quite plastic. It is usually very sticky when wet. When the moist soil is pinched between the thumb and fingers it will form a long, flexible "ribbon." A clay soil leaves a "slick" surface on the thumb and fingers when rubbed together with a long stroke and a firm pressure. The clay tends to hold the thumb and fingers together with its stickiness.

Sand is the largest and coarsest of the particles and creates fewer but larger air spaces in the soil. Due to these air spaces, sandy soils usually percolate quickly, drain quickly and hold very little water. They have low fertility due to the low availability of water and their low nutrient levels. Sandy soils feel and sound gritty. Sand particles can easily be seen by the naked eye.

Silt can barely be seen with the naked eye. It feels soft and smooth with a flour-like texture. Silt is a medium sized particle with more but smaller air spaces than sand. These air spaces allow for good water availability and fertility.

Clay is the smallest of the particles and cannot be seen even when using an ordinary microscope. The particles are multilayered and contain many elements. Clay soils are sticky in nature and make a ribbon when rubbed between two fingers. There are many tiny air spaces between the clay particles. The smallness of the spaces causes clay soils to percolate slowly or not at all. Over saturated clay soils will not percolate at all. While the pore spaces in clay soils are tiny, the total amount of pores space is greater than in any of the other particle types. Clay soils can hold a large quantity of water. Because clay soils can hold water quite well, allow only slow water movement and contain many elements necessary for plant growth, they are high in fertility. Soils can be comprised of any one, two, or three of these soil particle types in any combination to give it texture. Soils are classified by texture.

Texture can be done by textural analysis. The procedure for textural analysis is easy. Once this procedure is complete, the Soil Texture Triangle can be used to determine the texture type of the soil sample.

Soil texture is directly related to the percolation rate of a soil in the size of air spaces and surface area of the soil particles. For example, sand is the largest of the soil particles; therefore it has the largest surface area of the soil particles. Percolation is usually quick in sandy soils. The faster the percolation rate, the more permeable the soil will be (generally.) Rate of percolation determines how land can be used. Soils with slow percolation rates would be difficult to drain causing problems with a septic system. Alterations in a septic system or actual land use would be required.

Soil structure refers to the tendency of soil particles to cluster together and function as soil units called aggregates. Aggregates or crumbs contain mostly clay, silt, and sand particles held together by a gel-type substance formed by organic matter. Aggregates absorb and hold water better than individual particles. They also hold plant nutrients and influence chemical reactions in the soil.

Another major benefit of a well-aggregated soil or a soil with good structure is its resistance to damage by falling raindrops. When hit by falling rain, the aggregate stays together as a water-absorbing unit, rather than separating into individual particles. When aggregates on the surface of soil dry out, they remain in a crumbly form and permit good air movement. However, dispersed soil particles run together when dry and form a crust on the surface. The crust prevents air exchange between the soil and atmosphere and decreases plant growth. The process and benefits of aggregation is applicable mostly to fine- and medium-textured soils.

Organic matter plays an important role in soil structure. Soil is a living medium with a great variety of living organisms. Living organisms excrete cell or body wastes which become part of the organic content of soil. Further, the microbes of the soil and the remains of larger plants and animals decompose or decay into soil-building materials and nutrients. People who garden and/or farm generally find it useful to add organic materials to the soil. Popular sources of organic matter for soil amendments are peat moss, leaf mold, compost, livestock manure, sawdust, and others. Some important benefits of organic matter in soil include increasing soil porosity, supplying nitrogen and other nutrients to the plants, holding water to protect against drought, furnishing food for soil organisms, minimize leaching, and stabilizing soil structure.

Procedure:

Complete the following table:

Table 1. Soil Particle Characteristics

Particle (Soil Texture)	Size (mm)	Water Infiltration	Water-Holding Capacity	Nutrient-Holding Capacity (Fertility)	Aeration	Workability	Feel
Sand							
Silt							
Clay							

Sample: ____

1. Describe the soil.
   a. Color: ____________________________________
   b. Odor: ____________________________________
   c. Feel: ____________________________________
      i. Make a stiff mud ball.
      ii. Rub the mud ball between the thumb and forefinger.
      iii. Note the degree of coarseness and grittiness due to the sand particles.
      iv. Note the degree of stickiness due to the clay particles.
      v. Make the soil slightly more moist and note that the clay leaves a "slick" surface on the thumb and fingers.
   d. Place a small sample on a microscope slide and examine the soil particles under magnification. Describe and illustrate.
   ____
   ____
   ____
   ____

2. Describe the air space.
   a. How much does 100 ml of the soil weigh? ________________________
   b. Fill the container with water until it reaches the top of the soil. How much does 100 ml of soil and water weight? ___________________________
   c. What is the weight of the water? _______________________________
   d. What is the volume of air in this soil sample? (NOTE: 1 gram of water displaces 1 ml of air) ____________________________________

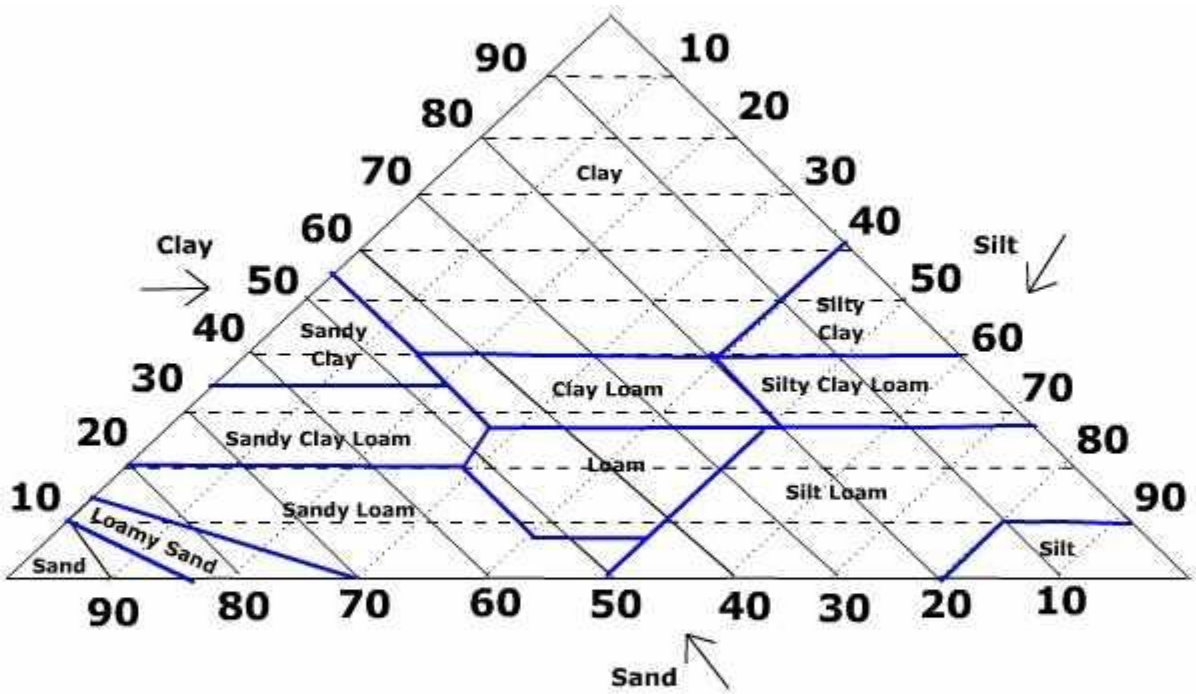
At this point in my analysis of the soil sample, I think that the soil type is
____ .

3. Describe the contents.
   a. Transfer the soil and water to a jar. SLOWLY add 2 ml of Calgon dispersing solution to the jar until the soil is covered with approximately 5 cm of water.
   b. Allow the soils to settle overnight. Measure the height of the soil in the jar in mm.
   c. Height of the soil: ____________________________________
   d. Put the lid on the jar tightly and shake vigorously for approximately 2 minutes. Allow to settle for at least 24 hours.
   e. Measure the height of each layer in mm.
   f. Height of sand: ____________________________________
   g. Height of silt: ____________________________________
   h. Height of clay: ____________________________________

i. Use the following formula to calculate the percentage of the soil sample and use the soil texture triangle to determine your soil sample's type.

$$\frac{\textit{Height of Settled Layer}}{\textit{Height of Soil Originally}} \times 100\%$$

j. % Sand: ___________________________________
k. % Silt: ____________________________________
l. % Clay: ___________________________________



To use the triangle, locate the percentage of each particle. Draw a straight line through each point. Where the three lines intersect is the name of your soil type.

Based on my analysis, the soil type is a ____.

4. pH is a measure of how acidic or basic things are. We assign a number scale from 0 to 14 to things to tell us how acidic or basic they are. A pH of 7 is neutral, less than 7 is acidic like vinegar with a pH of 3.5, and more than 7 is basic like ammonia with a pH of 10. (When soil pH is basic, it is usually called "alkaline.")
   a. Use the top layer of water in your jar. Fill a test bag to line C. Add one pH wide range Testab and shake for 20 seconds (or until the tablet dissolves.) Compare the color of the soil solution to the Color Chart Poster.
   b. The pH of your sample: ___________________________________

5. Each nutrient has specific roles in producing healthy plants. When not enough of an essential nutrient is present, or if too much is present, plants may show symptoms. When soil nutrients are used up the nutrients must be replaced in the soil by adding manure, compost, or fertilizers. Commercial fertilizers contain plant nutrients in forms available to plants. They use a 3-number notation indicating the percentage of nitrogen, phosphorus, and potassium in the fertilizer. For example, "15-10-5" fertilizer is 15% N, 10% P, and 5% K.

a. Prepare the nutrient extract.
    i. Pour1/2 cup of distilled water into a ziplock bag.
    ii. Add one soil extraction tablet and dissolve.
    iii. Add 5 teaspoons of soil to the bag.
    iv. Close the bag, shake briskly for 1 minute.
    v. Let settle for 2 minutes so the soil particles can settle.
    vi. Filter
b. Nitrogen Test (N)
    i. Fill test bag to line C with extract. Add one Nitrate #1 Testab.
    ii. Shake for 1 minute until tablet is dissolved. Add Nitrate #2 CTA Testab.
    iii. Shake for 2 minutes until tablet dissolves.
    iv. Wait 5 minutes and compare color to the chart.
    v. The Nitrogen Test resulted in a ____________ level of Nitrogen in the sample.
c. Potassium (K)
    i. Fill test bag to line C with extract. Add one Potassium Testab.
    ii. Shake for 2 minutes.
    iii. Compare "cloudiness" to chart. Place over salamander and see how fuzzy it looks.
    iv. The Potassium Test resulted in a __________ level of Potassium in the sample.
d. Phosphorus (P)
    i. Put 7 teaspoons of distilled water in a cup and add 1 teaspoon of soil extract. Stir.
    ii. Fill test bag to line C with the diluted extract. Add one Phosphorus Testab.
    iii. Shake for 3 minutes. Wait 5 minutes.
    iv. Compare the color to the Color Chart.
    v. The Phosphorus Test resulted in a _________ level of Phosphorus.

The soil nutrient tests are based on the Morgan Extraction Method. The results of the nutrient tests are reported as relative test amounts. The following approximate quantitative values may be assigned to the relative amounts determined in the previous experiments.

Result	**Nitrate** (lb A/6in)	**Potassium** (lb A/6in)	**Phosphorus** (lb A/6in)
Low	40	40	8
Medium	160	80	20
High	320	160	64

The unit "lb A/6in" equals: pounds per acre of nutrient in 6 inches of soil.

<u>Prepare a Soil Sample Report</u>

Based on the test results from your soil sample, prepare a type-written report that states:

a. the soil texture and characteristics of that soil texture;
b. nitrogen, phosphorous, and potassium level, an explanation of why each of those elements are important in soil, and if needed, ways to increase the levels for optimum plant growth;
c. pH of the soil and its implications;
d. an explanation of what those results mean for the quality of the soil and what type of native plant life will thrive or struggle in those soil conditions.

The report should exhibit professional quality and be easily understood by the reader.

Example - Soil Sample Report

Soil Sample location in the school forest: A1 test spot
Test results supplied by: Sue Smith

SOIL TEXTURE – The soil is a **sandy loam**. It should be a well-draining soil made up of light to medium course soil comprised of crumbling and alluvial debris. The sandy loam is a result of your being in an outwash plain – the area where the rock and debris carried by the melting glaciers were deposited.

NITROGEN (DEPLETED) – Nitrogen forms new cells and is essential to total plant development. A shortage of nitrogen halts plant growth and cell production. Symptoms of nitrogen deficiency are a yellowish brown color along the veins and tips of leaves, stunted growth of the plant or paleness in color on older leaves. Too much nitrogen can cause tall, spindly plants that easily topple over and nitrate poisoning (look for a strong red tint to the leaves). Nitrogen is also essential to the compost pile, as it aids in the breaking down of old plant residues. Good sources of nitrogen include: blood meal, cottonseed meal, fish meal, soybean meal, rabbit manure and tea grinds. You can also grow a cover crop of legumes in the fall to raise the nitrogen level for the next spring's crop.

PHOSPHORUS (DEFICIENT) – Phosphorus produces vigorous seed and root development. A shortage of phosphorus slows cell division and results in stunting of growth and late maturity of the plant. A symptom of phosphorus deficiency is spindly plants with purple streaks in the stems. Since phosphorus moves very slowly in the soil, it is essential to have it available during early plant development. Good sources for phosphorus include: bone meal, rock phosphate and colloidal phosphate. Incorporating organic matter (compost) into the soil makes the phosphorus present more readily available to the plants.

POTASSIUM (ADEQUATE) – Also called Potash, this nutrient helps produce strong and sturdy stems. It advances root growth and helps plants resist disease and cold weather. Shortages of this nutrient cause stunting and stem weakness. Symptoms include a yellowing of leaf edges and yellowing of the leaves veins. This nutrient must be available during early plant development. Good sources of potash are: cow manure, compost, granite meal and wood ashes.

pH (6.5/slightly acidic) - pH is a measure of acidity or alkalinity on a scale of 0 to 14, with 7 being neutral. The pH of the soil affects many elements, including nutrient availability, plant nutrient uptake, and microorganism activity. Because soil pH affects many factors, it is important to maintain proper pH throughout the growing season. *Considering the complexity of factors involved, the recommended soil pH for each individual variety of plant is very important.* Regular pH testing will allow you to make informed decisions if soil pH adjustment is necessary. In general, your pH should not need to be altered as the majority of plants manage well on a pH around 6.5.