Name ____ **Date** __________

APES Soil Study

Purpose: To test and compare soil from an HPA agricultural field terrace.

Background: http://www2.hawaii.edu/~nvhue/acid.html

http://soils.usda.gov/survey/online_surveys/hawaii/#island1973

Hypothesis: Describe where your soil came from. Rate the fertility of your soil on a scale of 1 to 5 with 5 being excellent for growing plants. What made you rate the soil the number that you did?

Procedure: You will perform the lab tests listed below on your soil to determine the plant growing capacity of your soil. You will then rate the soil on a scale of 1 to 5 and compare it to your hypothesis.

Test 1: Soil pH

The acidity of soil determines the nutrient status of the soil. In general, more acidic soils (Lower pH) have a lower fertility than the more basic soils because the Hydrogen ions in acids displace the positively charged nutrient ions on the soil micelle. These nutrients can then be leached from the soil.

Follow the directions in the soil test kit to test the pH and record the pH.

Data: pH______________

Questions:

1. Was your soil acidic, basic or neutral?
2. What did the pH tell you about the fertility of the soil?
3. How does pH influence the fertility of soil?

Test 2: Water Infiltration (percolation rate).

The infiltration and retention of water in soil are also important to plant growing capacity of soil. Soils with low infiltration are more likely to have high runoff after rain and the potential for flooding. On the other hand, these soils can retain a good deal of water. Soils with high infiltration rates cannot retain much water, resulting in leaching and loss of nutrients. These soils are more likely to be infertile and the leachate can have high concentrations of nutrients and pesticides, polluting both the water table and adjacent rivers and lakes. The level of clay in the soil helps to determine the infiltration rate and water retention rate. High clay soils make it difficult for plant roots to get oxygen. Soils that allow for quick infiltration and drainage contain pore spaces that provide air for gas exchange.

Procedure: Water Infiltration

1. Take two plastic cups that have the bottom removed.
2. Place a piece of screen over the bottom of the cup and secure with a rubber band.
3. Fill the cup up halfway with soil.
4. Place the clay triangle over a beaker and put the cup in the triangle.
5. Quickly pour 100ml of water into the cup.

6. Record the time required for all the water to drip through the soil by starting the timer when you pour and ending when most of the water has percolated through the soil. Record.
7. Repeat the procedure with pure sand and record the data.

Data: Time/Soil: ____________
Time/Sand: ____________

Questions:

1. How do the percolation times compare in the soil and the sand?
2. What does this tell you about your soil?
3. What type of soil has the fastest infiltration rate? Sand, silt or clay?

Test 3: Water Retention

The spaces that exist between soil particles, called pores, provide for the passage and/or retention of gasses and moisture within the soil profile. The soil's ability to retain water is strongly related to particle size; water molecules hold more tightly to the fine particles of a clay soil than to coarser particles of a sandy soil, so clays generally retain more water (Leeper and Uren, 1993). Conversely, sands provide easier passage or transmission of water through the profile. Clay type, organic content and soil structure also influence soil water retention (Charman & Murphy 1977). The maximum amount of water that a given soil can retain is called field capacity, whereas a soil so dry that plants cannot liberate the remaining moisture from the soil particles is said to be at wilting point (Leeper & Uren 1993). Available water is that which the plants can utilize from the soil within the range of field capacity and wilting point.

1. Take a flowerpot and place a piece of filter paper at the bottom, mass the flowerpot and the filter paper. Record.
2. Fill halfway with soil.
3. Place the flowerpot in a pan of water for 30 minutes and allow the water to soak in. Mass the flowerpot again and subtract out the mass of the empty flowerpot to the get mass of the wet soil.
4. Place in the drying oven overnight. Remove and mass again, subtract the mass of the pot.
5. Use the formula below to calculate the % of water that remained or water holding capacity.

$$\frac{\text{Wet} - \text{Dry}}{\text{Wet}} \times 100\% =$$

Mass flowerpot	Mass of wet soil	Mass Dry Soil	Water Holding Capacity

Questions:

1. What soil texture will result in the most oxygen for roots? Sand, Silt or Clay.
2. Rate your soil as poor, medium or good in terms of water retention. The higher the percentage, the greater the water loss and the lower the water holding capacity.

Test 4: Soil Texture

Soil texture is a soil property used to describe the relative proportion of different grain sizes of mineral particles in a soil. Particles are grouped according to their size into what are called soil separates. These separates are typically named clay, silt, and sand. Soil texture classification is based on the fractions of soil separates present in a soil. The soil texture triangle is a diagram often used to figure out soil textures.

Methods:

1. Fill a square sided glass jar with soil about 1/3 of the way up.
2. Add water almost to the top of the jar.
3. Shake the mixture really well for about 2 minutes.
4. Allow the jar to sit overnight and settle out.
5. Use a ruler to measure the height of the column of soil, then measure the height of the column of sand, silt and clay. Divide the height of the sand by the height of the total soil column and multiply by 100%. This will tell you the % of sand. Repeat with silt and clay.
6. Use the "Soil Triangle" to determine the texture of the sample.

	Total soil column	Sand	Silt	Clay
Height of column (mm)				
% of Total	*100%*			

Questions:

1. What type of soil do you have?
2. What is the best type of soil for plant growth?

Test 5: Nitrogen

Nitrogen is a part of every living cell. As a component of amino acids, the building blocks of proteins, nitrogen is a vital link in the world's food supply. Nitrogen is directly involved in photosynthesis. It stimulates above ground growth and produces the rich green color characteristics of healthy plants. Nitrates, the available form of soil nitrogen, are produced through the decomposition of organic matter, the application of nitrogen fertilizers, and the fixation of atmospheric nitrogen by microorganisms in the roots of legumes. Soil nitrogen is depleted through harvesting crops, leaching by rainwater and denitrification.

Methods: Follow the procedure in the soil test kit.

Data: Nitrogen level:___________________

Questions:

1. Why do you think you got the results you did on the nitrogen test?
2. What could you do to fix it?

Test 6: Phosphorus

Young plants absorb large amounts of phosphorus, which speeds seedling development and promotes early root formation. Rapid, early growth means hardier, stronger plants. In mature plants phosphorus is vital to the development of healthy seeds and fruit which contain large amounts of this essential nutrient. Only a small percentage of soil phosphorus is in available form and these phosphates move more slowly through the soil than other nutrients.

Methods: Follow the instructions in the soil test kit.

Data: Phosphorus Level:______________________

Questions:

1. What does mean to say that the phosphorus is not in an "available" form?
2. Why is phosphorus often a limiting factor in ecosystems?

Test 7: Potash (Potassium)

Potassium acts as a catalyst, a chemical agent that facilitates a number of chemical processes in the plant. Potassium promotes various aspects of plant metabolism – photosynthesis, efficient use of water and the formation of strong roots and stems. Well described as a "tonic" for plants, potassium strengthens natural mechanisms for the resistance of disease and extreme weather.

Methods: Follow the instructions in the soil test kit.

Data: Potash Level:____________________

Questions:

1. Besides fertilizer, how does potassium get into the soil.

Conclusion

Follow the lab write-up format. Include purpose, hypothesis, was your hypothesis correct, include data to support hypothesis.

In the second paragraph discuss accuracy and error and suggestions for improvement

In the final paragraph relate the lab to what we learned in class. Include information about what can be done to remediate poor soil to make it good for plant growth.

Volcanic Ash Soils (Andisol)

Typical Characteristics:

1. **Parent Material**: Volcanic soils, also known as Andisols, are formed from volcanic ash and cinder deposits. While most of the world's volcanic soils are not highly weathered, there are notable exceptions on the Big Island.
2. **Mineralogy:** Volcanic soils largely consist of non-crystalline (amorphous) minerals, such as allophone and imogolite. These minerals form strong bonds with organic matter. As a result, organic matter generally accumulates in the surface horizon. In addition to organic matter, volcanic soils may also contain high amounts of volcanic glass material with the possibility of amorphous iron and aluminum minerals.
3. **Physical Traits:** Andisols are usually light and fluffy and are easily tilled. Like a sponge, these soils also hold a lot of water.
4. **Fertility:** When not highly weathered, volcanic soils are typically very fertile soils. However, volcanic soils form strong complexes with phosphorus. When poorly managed, phosphorus can be limiting. Additionally, the amorphous minerals that dominate volcanic soil can generate an anion exchange capacity (AEC) when under acidic conditions and depleted in organic matter. Fertility problems may be corrected with additions of organic matter, lime and/or fertilizer amendments.

Thanks to Sophia for the research!

http://en.wikipedia.org/wiki/Kohala_(mountain)#Ecology

Kohala is buffeted by strong winds, which are directly correlated to soil erosion; ancient farmers utilized a series of earthen embarkments and stone walls to protect their crops. This technique has been shown to reduce wind by at least 20–30 percent.[17]

The soil at Kohala is nitrogen-rich, facilitating root growth

http://pubs.usgs.gov/wri/wri02-4006/pdf/wri02-4006.pdf

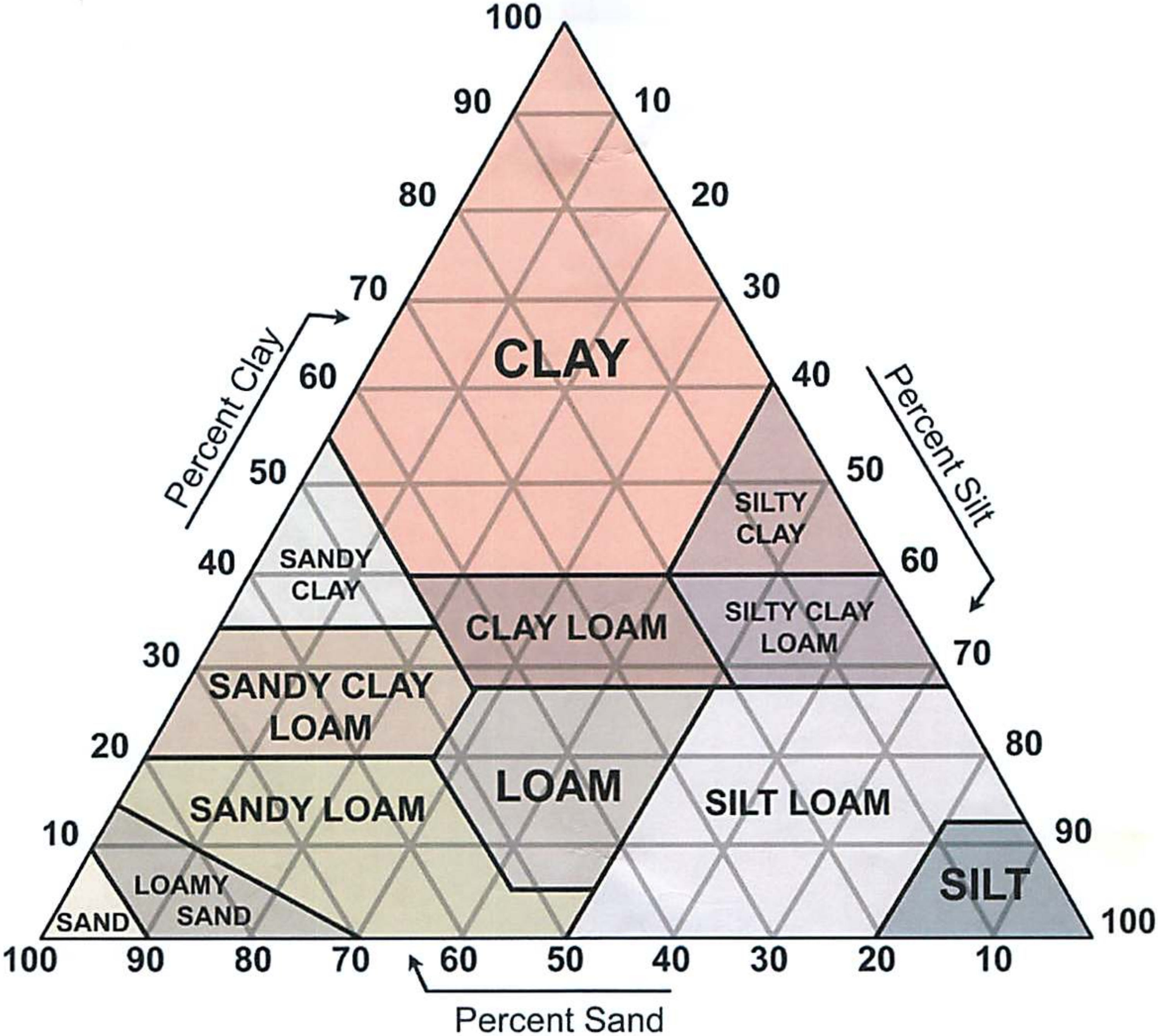
Soil series	Available water capacity, in inches per inch of soil
Kohala	0.14

Soil-moisture storage capacity is computed from the product of available water capacity and root depth.

http://www.sciencemag.org/content/304/5677/1665.abstract

Before European contact, Hawai`i supported large human populations in complex societies that were based on multiple pathways of intensive agriculture. We show that soils within a long-abandoned 60-square-kilometer dryland agricultural complex are substantially richer in bases and phosphorus than are those just outside it, and that this enrichment predated the establishment of intensive agriculture. Climate and soil fertility combined to constrain large dryland agricultural systems and the societies they supported to well-defined portions of just the younger islands within the Hawaiian archipelago; societies on the older islands were based on irrigated wetland agriculture. Similar processes may have influenced the dynamics of agricultural intensification across the tropics.

http://news.stanford.edu/news/2004/june16/hawaii-616.html


100
90
80
70
60
50
40
30
20
10
Percent Clay
Percent Silt
Percent Sand
CLAY
SILTY CLAY
SANDY CLAY
CLAY LOAM
SILTY CLAY LOAM
SANDY CLAY LOAM
LOAM
SILT LOAM
SANDY LOAM
LOAMY SAND
SAND
SILT