**Soil Quality Lab**

**Purpose:** To test and compare different soil types from around your community.

**Background:** Unless you are a farmer or gardener, you probably think of soil as “dirt,” or something you do not want on your hands, clothes, or carpet. Yet, your life and the lives of most other organisms depend on the soil. Soil is not only the basis of agricultural food production, it is also essential for the production of many other plant products, such as wood, paper, cotton, and medicines. In addition, soil helps purify the water we drink and is important for decomposing and recycling biodegradable wastes.

Nations, including the United States, have been built on the riches of their soils. Yet, since the beginning of agriculture, people have abused this vital, potentially renewable resource. In fact, entire civilizations have collapsed because of mismanagement of the topsoil that supported their civilizations. Today, we are not only facing loss of soil from erosion, we are also depleting nutrients in some soils and adding toxins to others.

**Prior to completing this lab you will need a sandwich bag full of soil! Use a soil corer from your teacher or dig down at least 6 inches into the soil.**

Where is your soil from? \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**Hypothesis:** Rate the quality of your soil on a scale from 1 to 5, with 5 being excellent for growing plants. What made you rate the soil that number?

**Procedure:** For this lab, you will perform the following tests on your soil to determine its plant-growing capacity. You will then rate the quality of your soil on a scale from 1 to 5 and compare it to your hypothesis. Please complete the experiments in the order in which they are listed to ensure you complete all of them in the time provided.

* Soil temperature - measured when soil sample was collected
* Microorganism survey
* Desiccation and Moisture Content (Day 1 put sample in oven - Day 2 record data)
* pH
* Nitrogen
* Phosphorus
* Potash (potassium)
* Permeability
* Density
* Texture (10-min setup on Day 1; get results on Day 2)

**Soil Temperature**

Procedure:

1. Before digging up your soil, use a thermometer (borrow one from class if you don’t have one at home) to record the temp of the soil
2. Gently push the thermometer about an inch into the soil.
3. Wait until a couple of minutes for the thermometer to reach a final temp.
4. Describe the surroundings - your soil might be in the sun when you take the temperature, but it might be in the shade later in the day.

| **Time of Day** | **Soil Temp** | **Description of Surroundings** |
| --- | --- | --- |
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**Soil Microorganism Survey**

Procedure:

Separating out the nematodes from the soil:

1. Collect ~0.5 kg of soil from various locations in a plastic bag (e.g., gallon-sized Ziploc)
	1. Note: Clay soils are harder to separate and extract from! Sandy or organic soils work much better for this.
	2. Should get to moist soil – normally at least an inch deep into the soil
2. Pour the dirt into a large amount of tap water in a container (3000-mL plastic beaker)
3. Mix the solution by hand to break up large dirt clods
4. Using a sieve (#40) or a medium mesh screen, separate the large particles from the solution by pouring the solution through the strainer into a 2nd container
5. Using a very fine mesh screen or Sieve (#500), separate the finer particles from the nematodes. The nematodes will be caught in the Sieve with very fine particles.
6. With a minimal amount of tap water, rinse what was caught in the very fine mesh into a beaker.

Extraction apparatus:

1. Cut out aluminum window screen that will fit in the top of a funnel, with edges folded up.
2. Place coffee filters in the window screen and use tap water to moisten against the screen. Make sure there are no air bubbles. Preferably, the filter covers the entire area of the screen.
3. Place funnels, with rubber tubes and clamps attached, onto a ring stand.
4. Place the screen/filter combo into the top of the ring stand.

Extraction of nematodes and other small invertebrates:

1. Pour the concentrated soil-animal “slurry” onto the top of the filter apparatus. Pinch the clamp to get rid of the dirty water. For now, most of the nematodes will be caught in the filter.
2. Once all of the solution has been poured into the filter and the water has been drained out, put the clamp back on and pour clean tap water below the filter into the funnel.
	1. The tap water should come up to the very tip of where the screen/filter sits. You want to filter paper to touch the water, but not be submerged.
3. Let sit overnight and the nematodes will sink through the filter paper to the bottom of the water column where the clamp is.
4. The next day, pinch the clamp open, briefly, to drop the concentrated nematode solution into a small beaker.
5. Pipette a couple ml of nematode water onto a depression microscope slide
6. Observe under a microscope and record observations

| **Observations: How many different types of organisms did you find?**  |
| --- |
|  |

**Desiccation & Moisture Content**

Procedure:

1. Desiccation is the process of drying your soil sample. This must be done in a high temperature oven. Realize that any organisms in your soil will be killed thus your soil will be disinfected. Also, the high temperature will ensure that all the water is evaporated off.
2. Weigh and empty evaporating dish
3. Fill evaporating dish with about 40 grams of soil and mass again - label/identify your dish
4. Place your dish in the desiccating oven for 24 hours
5. Remass your dry dish and determine the quantity of water that WAS in the sample. Calculate the % of the sample that was wasted.
6. SAVE you dry sample for **Soil Permeability**

| **Mass of Evaporating Dish** | **Evap Dish + Soil Sample** **Before** | **Evap Dish + Soil Sample****After** | **Water evaporated** | **% of your soil sample that was water** |
| --- | --- | --- | --- | --- |
|  |  |  |  |  |

**Soil Profile & Type**

Procedure:

1. Take a graduated cylinder (100ml) - fill with about 30ml of soil - Fill the rest of the graduated cylinder with water
2. Cover the mouth of the cylinder with your hand and shake for 3 minutes
3. Set the cylinder aside and allow to set for 24 hours
4. Record the % of Sand, Silt, and/or clay in your sample.
5. Use the triangle on the next page to determine soil type

**Your Soil Texture Data:**

| **Soil Separate** | **Quantity of Component (mL or mm)** | **Percent of Component (mL of component/total mL)** |
| --- | --- | --- |
| Sand (at bottom of diagram) |  |  |
| Silt (in middle of diagram) |  |  |
| Clay (at top of diagram) |  |  |
| Total (sum of all three) |  |  |

**Question:**

1. Using the soil texture triangle below, determine what type of soil you have (see p. 240 in your textbook for color version).

**\_\_\_\_\_\_% Sand \_\_\_\_\_\_% Silt \_\_\_\_\_\_% Clay → Soil Texture \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Soil Permeability**

**Permeability** is a measure of the size and connectedness of the open spaces in a rock or soil. Generally, materials with larger particle sizes (that are well-sorted) are more permeable.

Procedure:

1. Soil permeability (porosity) refers to how close the soil particles are together and is generally related to particle size (ie. So the more CLAY you have the LOWER the porosity. The more SAND you have the HIGHER the porosity) A soil can be very porous, but if the pores are not connected, it will not be permeable.
2. Fold a piece of filter paper, dampen it, and place it in a funnel. Then place a funnel in the top of an Erlenmeyer flask.
3. Place approximately 10 grams of your soil in the filter paper. Then use a beaker or graduated cylinder to measure out approximately 50 ml of water
4. Slowly pour the water in the funnel and over the soil. (NOTE: make sure for an accurate timing that there is ALWAYS a level of water in your funnel until ALL the water has been poured) time from start to finish how long it take for ALL the water to drain OUT of the funnel.
5. Record the time it took to drain
6. Measure the amount of water that has drained through the funnel from the flask. Record that in Ending Water Volume
7. Calculate how much water was retained in the soil sample
8. Calculate the rate of drainage (how many milliliters of water per minute)

**Soil Permeability Data:**

| **Starting Water Volume** | **Ending Water Volume** | **Time to Drain** |
| --- | --- | --- |
| 5050 |  |  |

**Soil Permeability Data:**

| **% Retention** | **Rate of Drainage** |
| --- | --- |
|  |  |

**Questions:**

1. Which soil texture will help produce the most oxygen for roots (sand, silt, or clay)?
2. Rate your soil as poor, medium, or good in terms of water retention. Soils with larger particle sizes have a low water-retention capacity.

**Soil Density**

Soils that are very dense have high strength and low porosity and support plant growth poorly. Soils can become compacted in many ways, such as from overgrazing by livestock or from a high amount of traffic over the soil.

Procedure:

1. Measure out about 10 grams of your dry soil sample
2. Fill a large graduated cylinder with about 50ml of water
3. Drop your soil sample in the water
4. Record the new volume
5. Calculate the density of the soil

**Soil Density Data:**

| **Mass** | **Volume** | **Density (g/mL)** |
| --- | --- | --- |
|  |  |  |

**Soil Nutrients (pH, Nitrogen, Phosphorus, and Potassium)**

Procedure:

1. Obtain a “Rapitest Soil Test Kit”
2. Read the instructions on the inside of the Rapitest booklet
3. Do all FOUR (pH, Nitrogen, Phosphorus, and Potassium) tests and record the results below

**Soil pH**

The acidity of soil determines its nutrient status. In general, more acidic soils (those with a lower pH) are less fertile than 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.

**Soil pH Data:**

**Questions:**

1. Is 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?

**Soil 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.

**Soil** **Nitrogen Data:**

**Questions:**

1. Why do you think you got these results on the nitrogen test?
2. What could you do to increase nitrogen?

**Soil 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.

**Soil Phosphorus Data:**

**Questions:**

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

**Soil Potash (Potassium)**

Potassium acts as a **catalyst**, a chemical agent that facilitates a number of chemical processes, in a 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 their natural mechanisms to resist disease and extreme weather.

**Soil Potassium Data:**

**Question:**

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

**Soil Analysis**

Upon completion of your soil tests, choose a crop that is grown in the Midwest. Research what that crop prefers in terms of soil characteristics and nutrients. Discuss whether your soil is a good fit for this crop and WHY.

1. What is your chosen crop and what are its soil requirements?
2. What TWO things can you do to your soil in order to improve your soil quality for your chosen crop? You must pick a realistic, environmentally healthy solution.