Plant Nutrients in Soil and Soil pH

Introduction

The texture and chemical composition of soils are extremely important in determining the types of plants that will be able to grow in a particular area. Soil texture will be analyzed in the next lab. In this lab, we will look at the chemical composition and pH of three soils. In a separate, concurrent lab, we will observe the ability of plants to grow in these soils.

Plants require a number of **essential elements** in order for them to function properly. Some essential elements are considered **non-mineral** and include oxygen, hydrogen, carbon, and nitrogen. Other essential elements are considered **mineral** and include phosphorous, potassium, sulfur, calcium and magnesium, to name a few. All of the essential elements, except oxygen and carbon, are available to plants almost exclusively through the soil or the soil/water solution. For some essential elements, their availability in the soil does not guarantee that plants will be able to absorb them. The ability of a plant to absorb some essential elements is directly affected by the pH of soil. Most plants, especially food crops, do well in soils with a pH range of 5 to 8.

The essential elements can be divided into two categories based on the quantity of the element that is required by plants. **Macronutrients** are required by plant tissues in a concentration of at least 1 mg/g of dry weight. **Micronutrients** are required by plant tissues in a concentration of at least 100 µg/g of dry weight.

Three major plant macronutrients are nitrogen (N), phosphorous (P) and potassium (K). Nitrogen gives plants their green color and is essential for protein synthesis and growth. Phosphorous is important in cell division, root development, flowering and fruiting. Potassium is involved in photosynthesis, disease resistance and seed development. Because of the importance of these macronutrients, they are standard components of commercial fertilizer mixtures. So that fertilizer applications can be tailored based on the specific needs of the target plant and the specific deficiencies of the target soils, fertilizer mixtures are marked with a "N-P-K value". The N-P-K value is a series of three numbers which represent the

percentage of each nutrient in the mixture

In a series of three "companion" labs, we will determine the plant nutrient content and pH of three soils, the ability of those three soils to support plant growth and we will analyze the texture of those soils.

In this lab, we will determine the N, P, and K content and the pH of three soils; nutritionally-enhanced commercial potting soil, fill soil, and waste composting facility compost.

Hypotheses

The pH and the N, P and K content of the three types of soil will differ.

The pH and N, P, and K content of the nutritionally-enhanced commercial potting soil will be at levels optimal for plant growth.

Materials

- Soil from three different sources (nutritionally-enhanced commercial potting soil, fill soil, and waste composting facility compost)
- Permanent markers
- Rapitest° Soil Test Kits
- Hach pH test kits
- Plastic spoons
- 50mL plastic beakers
- 100mL plastic beakers
- 100mL beaker
- Plastic droppers
- Distilled water
- 250mL flask
- Parafilm
- Mortar and pestle

Procedures

Preparing the Soil Samples

1. Work in groups by lab table.
2. Prepare a sample of each of the three types of soil
   a. avoid handling the soil with your bare hands, wear gloves while handling
   b. select plastic spoonfuls of soil from 5 different areas of the soil and place the spoonfuls of soil into a labeled 50mL plastic beaker until you have a volume of approximately 30mL of soil
   c. use a mortar and pestle to break any larger clumps of the soil into small pieces and thoroughly mix each soil sample
   d. remove any stones or other debris

Preparing Liquid Extracts from the Soil

1. Work in groups by lab table.
2. Add the 30mL of the mixed soil sample you prepared above to a labeled 250mL flask.
3. Add 100mL of distilled water to the flask containing the soil.

4. Cover the flask opening with parafilm and thoroughly shake and swirl flask for at least one minute.
5. Allow the mixture to stand undisturbed for at least 30 minutes (to allow the fine particulates in the soil to settle out). (NOTE: you should conduct the set-up or maintenance portions of other exercises while waiting for the soil to settle). The clarity of the solution will vary, the clearer the better.
6. Repeat steps 2-5 until you have a flask with a liquid extract for each soil sample.

Rapitest Kit: Soil Nitrogen (N), Phosphorous (P), Potassium (K) and pH

1. Work in groups by lab table.
2. Select the appropriate "comparator" for either the N, P, K or pH test.
3. Remove the cap from the "comparator".
4. Make sure the color chart (film) is in place.
5. Using a plastic dropper, fill the test and reference chambers up to the fill mark on the chart with the solution from the flask with your soil sample/water mixture. Avoid disturbing the sediment. Transfer liquid only.
6. Obtain an appropriately colored capsule for this test (color coded to match lid on "comparator").
7. Holding the capsule horizontally over the test chamber, carefully separate the two halves and pour the powder into the test chamber.
8. Fit the cap onto the "comparator", making sure it is sealed properly and snaps shut tightly.
9. Shake thoroughly
10. Allow color to develop in the test chamber for 10 minutes.
11. Compare color of solution in the test chamber to the color chart on the front of the "comparator". For best results, allow daylight (not direct sunlight) to illuminate the solution when "reading" the results.
12. Record results in Table 1 and on the transparency (or blackboard).
13. Repeat steps 2 through 12 for each of the remaining three tests.
14. Repeat steps 1 through 13 for the other two soil samples.

Hach Test Kit pH

1. Work in groups by lab table.
2. Use the liquid extract prepared from each soil sample to test the pH of each soil sample by

following the instructions contained in the test kit.

3. Record the results in Table 1 and on the transparency (or blackboard).

Data Analysis

1. Calculate the mean pH for each soil type as determined by each test kit and record in Table 1 and on the transparency (or blackboard).
2. Complete Figure 1 by preparing a bar graph illustrating the results of the nitrogen content tests for each lab group for each soil type. The data for this graph will come from Table 1.
3. Complete Figure 2 by preparing a bar graph illustrating the results of the phosphorus content tests for each lab group for each soil type. The data for this graph will come from Table 1.
4. Complete Figure 3 by preparing a bar graph illustrating the results of the potassium content tests for each lab group for each soil type. The data for this graph will come from Table 1.
5. Complete Figure 4 by preparing a bar graph illustrating the class-wide mean pH value obtained for each soil type by each test kit. The data for this graph will come from Table 1.

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Student Name: _____ Lab Date: _____

Lab Instructor: _____ Lab Section: _____

Table 1. Nitrogen, phosphorus and potassium content and pH using Rapitest kit, pH using Hach kit, and mean pH for three soil types by lab group.

		Rapitest Kit				Hach Kit
Lab Table	**Soil Type**	**Nitrogen (N)**	**Phosphorous (P)**	**Potassium (K)**	**pH**	**pH**
1	Potting					
2	Potting					
3	Potting					
4	Potting					
5	Potting					
6	Potting					
				Mean=		
1	Fill					
2	Fill					
3	Fill					
4	Fill					
5	Fill					
6	Fill					
				Mean=		
1	Compost					
2	Compost					
3	Compost					
4	Compost					
5	Compost					
6	Compost					
				Mean=		

Figure 1. Nitrogen (N) content for three soil types by lab group.

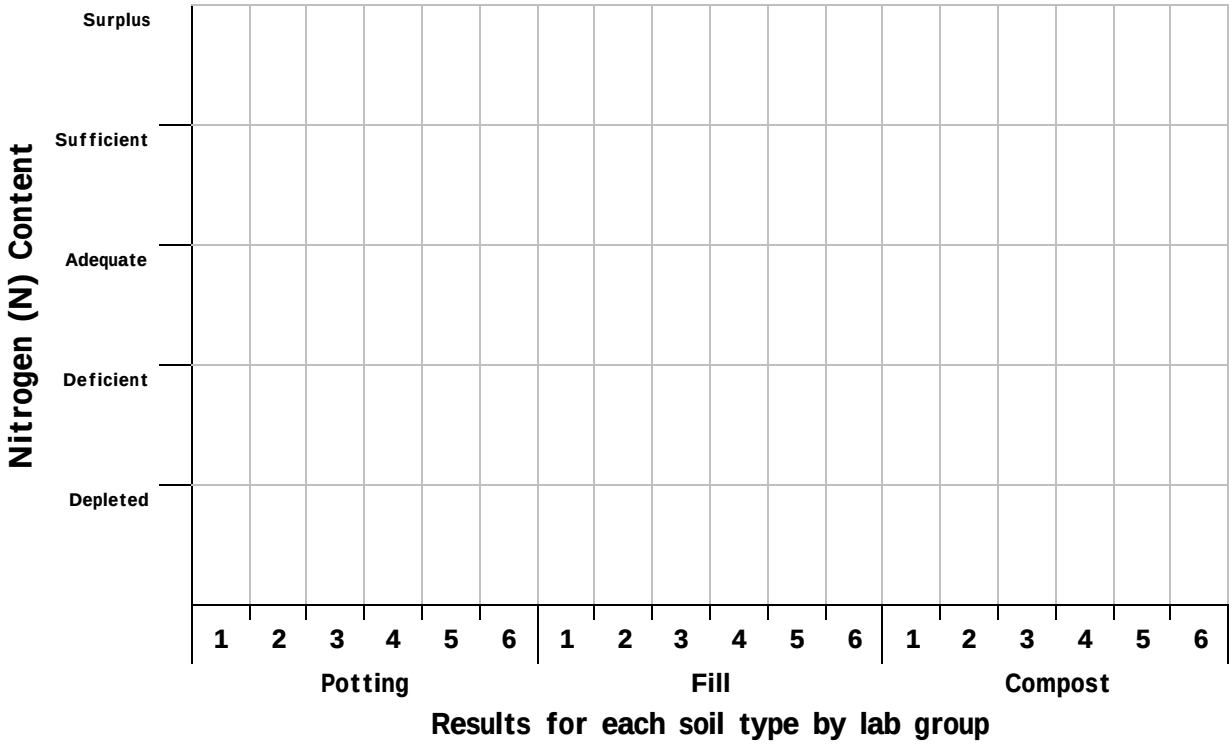


Figure 2. Phosphorus (P) content for three soil types by lab group.

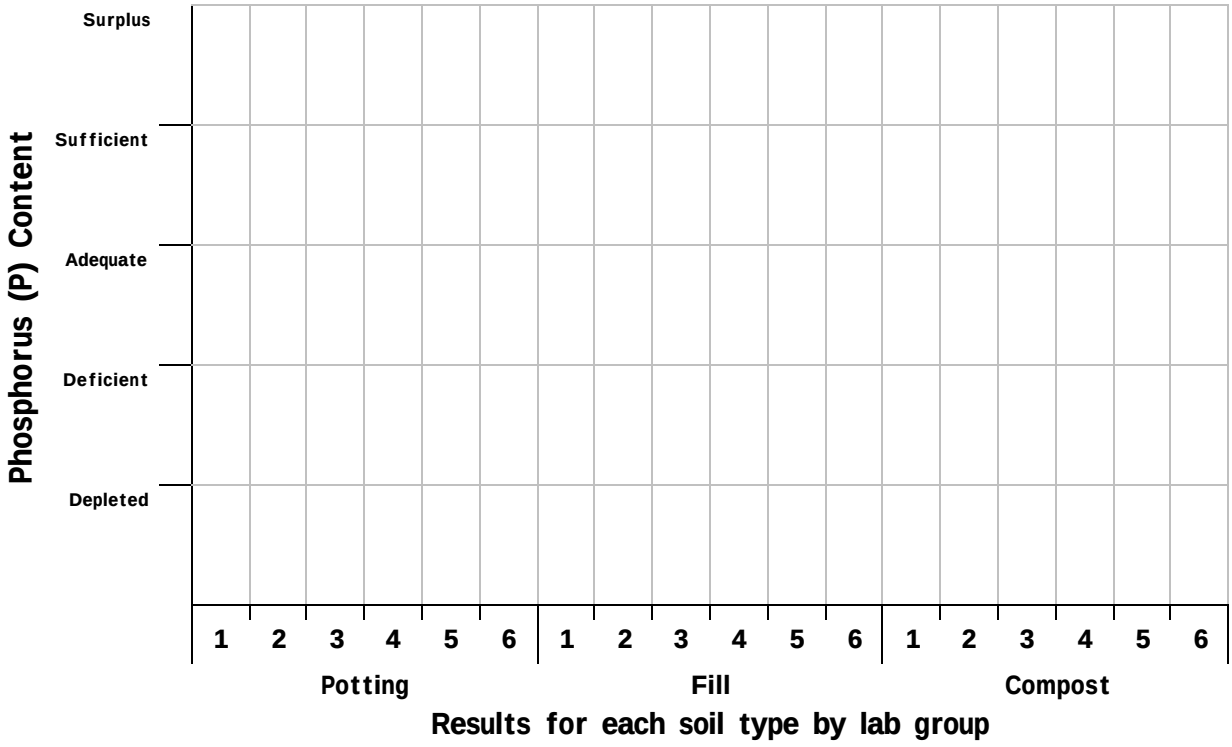


Figure 3. Potassium (K) content for three soil types by lab group.

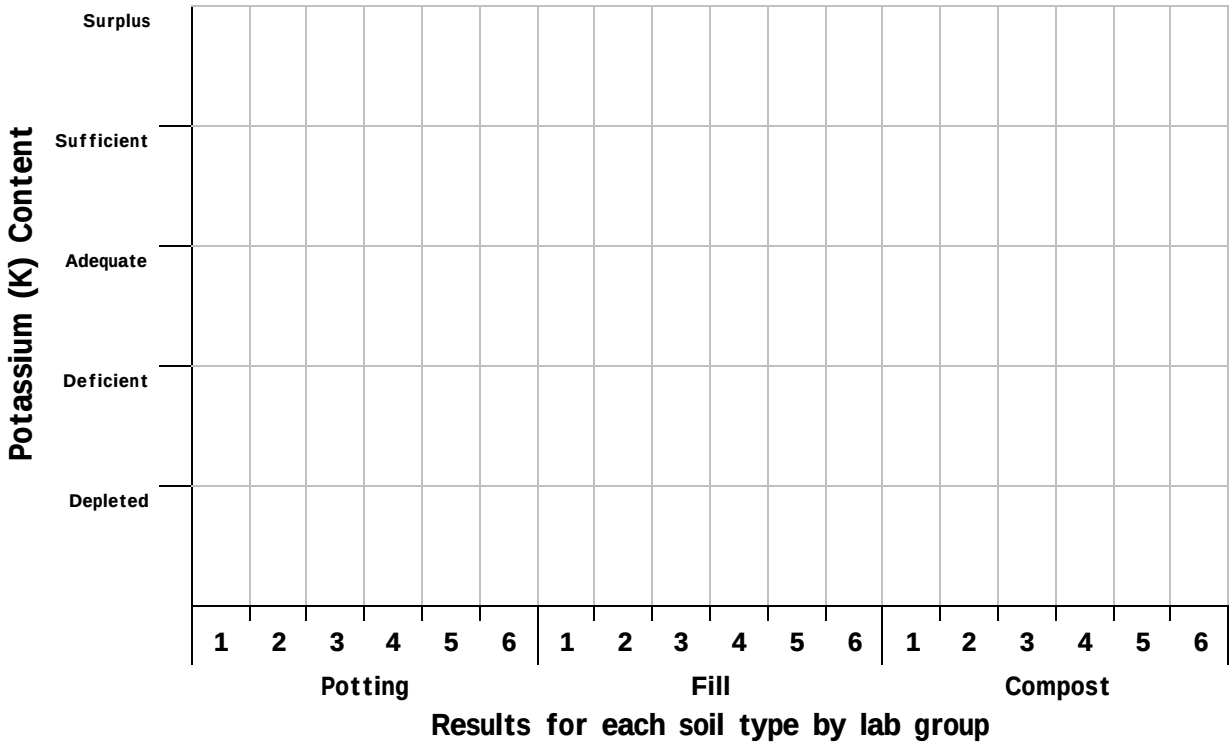
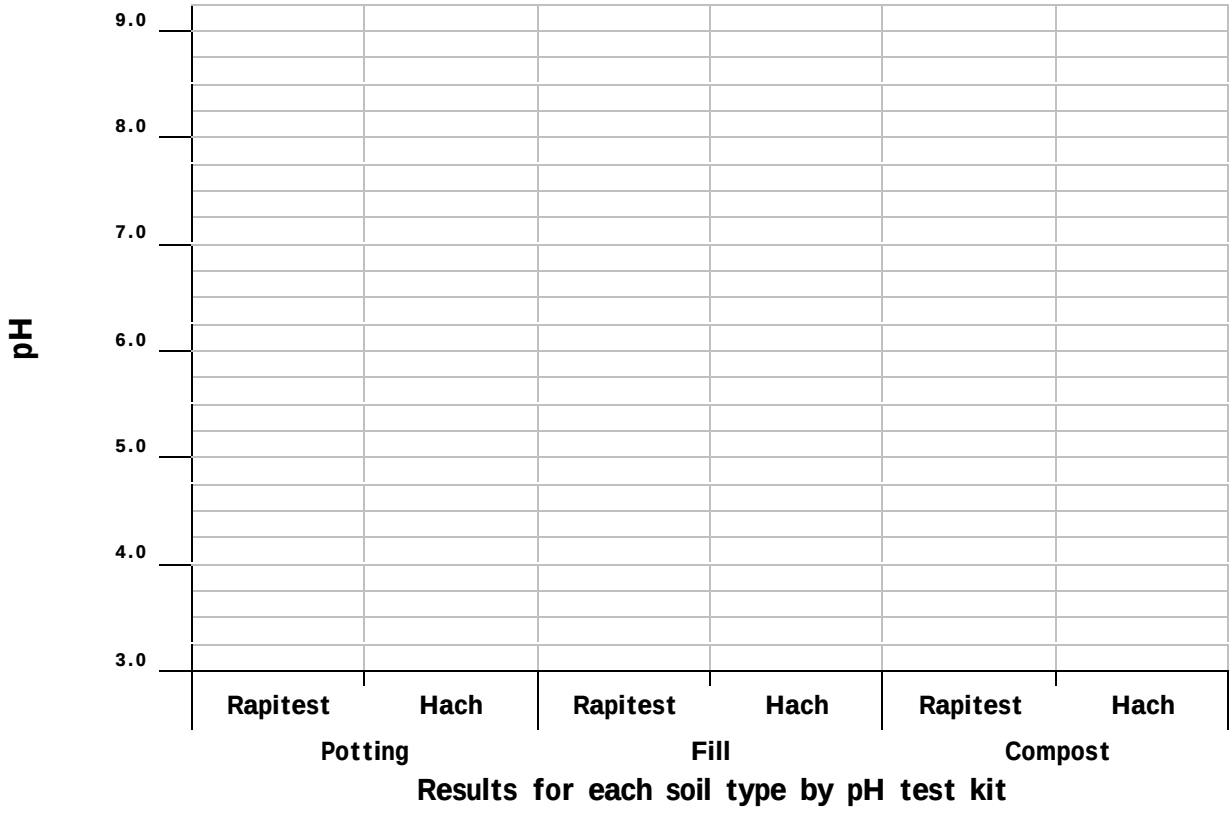


Figure 4. Class-wide mean soil pH for three soil types by test kit.



Conclusions (Questions): *For full credit, these questions should be answered thoroughly, in complete sentences, in legible handwriting.*

1. Describe the comparison of the nitrogen (N) content of the three soil types. Do your results coincide with your expectations?

2. Describe the comparison of the phosphorous (P) content of the three soil types. Do your results coincide with your expectations?

3. Describe the comparison of the potassium (K) content of the three soil types. Do your results coincide with your expectations?

5. Compare all three soil types in terms of their N-P-K content. In which of these three soils do you predict the best plant growth and why? In which of these three soils do you expect the worst plant growth and why?

4. Describe the comparison of the pH of the three soil types. Do your results coincide with your expectations? Discuss the differences, if any, in the pH results produced by the two different kits. In which of these three soils do you predict the best plant growth and why? In which of these three soils do you expect the worst plant growth and why?