

**FROM THE GROUND UP**  
**FAMILY ACTIVITY GUIDE:**

# TESTING AND EXPLORING SOILS AND NUTRIENTS

## PART 1 – GET DOWN AND DIRTY! TESTING GARDEN SOILS

### Why test soils?

Soil seems like humble stuff. Yet, regular garden soil is the basis for almost everything we eat. Everyday foods such as grains, vegetables and fruits are grown in soil. Meat production depends on grazing or on plant-based feeds from crops grown in soil. Given soil's importance, soil scientists aim to understand its complex chemistry and biology. The starting point for researchers is to establish the basic chemistry of a soil. Scientists first measure soil acidity and the presence of the three main nutrients that plants need. These nutrients are the elements nitrogen (N), phosphorus (P) and potassium (K). Balanced soils with correct nutrient levels are essential to growing healthy plants.

### Why do this activity?

Did you know that outside activities are beneficial to your overall health, physical development, and even academic achievement? In this activity, you will work on a fun experiment to test garden soils. You not only spend time outside, but you get the reward of learning how to grow healthy green plants! In this activity, you will work with a family member to measure basic soil chemistry of soil from your backyard or garden. (If you don't have access to a yard or garden, you can conduct this activity using soil from potted plants or a nearby park.)

## DID YOU KNOW?

### Soil Fun Facts

- Soil is a nutrient-filled substance in which plants can grow – a complex mixture of living and non-living matter, including living and dead organisms, minerals, and nutrients.
- Most biological activity and plant nutrients are in the topsoil, which is the top layer of soil.
- Soil texture depends on the amounts of different-sized mineral particles, whether sand, silt or clay.
- Fungi and microbes break down soil mineral matter.
- Plant roots loosen soils, break up rocks and help prevent erosion.
- Earthworms and other animals digest mineral matter, helping to recycle nutrients, aerate the soil and make the surface soil richer.

### By the numbers

- 1,000,000,000 – Number of bacteria (one billion) in a teaspoon of productive soil
- 70,000 – Number of kinds of soil identified in the United States
- 500 – Length of time in years to form one inch of topsoil
- 2.5 – Tons of soil needed to cover one acre in a layer as thick as a smartphone
- 10 – Tons of animal life that can be found in one acre of soil
- 45 – Percentage of soil that is comprised of minerals
- 25 – Percentage of soil that is comprised of water
- 25 – Percentage of soil that is comprised of air
- 5 – Percentage of soil that is mineral matter

## HOW TO TEST SOILS

*\*\*Disclaimer – Due to the chemicals used in simple soil kits, we strongly advise students use appropriate safety gear such as gloves and only test soils under the supervision of an adult.*

Most garden centers or hardware stores sell simple soil test kits. Alternatively, they can be purchased online. Usually, each kit can test for the three macronutrients nitrogen (N), phosphorus (P) and potassium (K) and can also test for soil acidity and alkalinity (pH). Most kits can do multiple tests for each of these. The test kits are designed for home use and include straightforward instructions. For a more detailed and precise analysis, contact your local cooperative extension office. In most at-home kits, the first step is to make a soil-water mixture. Next, add a chemical or a test strip to the mixture. The chemical causes a color change that matches a color scale. The matching color gives an estimate of soil nutrient levels in the sample. Follow these steps to test the soil samples:

1. Obtain a soil test kit and any additional materials, such as a spoon and plastic bags for collecting soil samples.
2. Working with an adult, create a simple plan to collect samples, including one or more locations. (If needed, get permission to collect samples.)
3. Keep a notebook to record all observations.
4. Create a method for collecting samples and testing the soil. The method ensures that the test is consistent (see below for example method).
5. Be sure to sample several different areas to compare nutrient levels. In a garden, test the garden beds, surrounding lawn, and natural areas. You can also sample nearby soils, such as neighbors' yards or public areas.
6. If plants are growing in the test area, write in your notebook a hypothesis to predict which nutrients may be lacking based on your observations in plant growth.
7. Conduct the test according to the method you developed in Step 4.
8. Evaluate whether or not the test results support the hypothesis in Step 6.
9. If you are testing soil in your garden, consider applying fertilizer to remedy any soil deficiencies (see Activity Part 2).
10. Continue the activity for other nutrients.

## EXAMPLE METHOD

Here is an example testing method based on a simple soil nitrogen test. You may need to modify this protocol depending on the specific tests' instructions.

1. Select the sample area.
2. Dig down 2 to 6 inches depth in the soil.
3. Use the spoon to scrape up some soil. Place the soil in the bag.
4. Collect four or five sub-samples from this area, about one tablespoon per sub-sample.
5. Label the bag, with a unique number, location, and date.
6. Back at home, ask an adult to provide a space that you clean easily, such as in the kitchen or garage.
7. Mix the sub-samples from the sample area.
8. Remove plant debris and rocks. Break up soil clods.
9. Spread the soil on a piece of paper (newspaper is fine) and allow the sample to air dry, preferably overnight. Do NOT oven dry the sample!

10. Take a quarter cup of the soil and mix with a quarter cup of water (1 to 1 by volume).
11. Shake thoroughly in a sealed container.
12. Allow the shaken mixture to settle for at least 2 to 3 minutes.
13. Apply the test according to manufacturer's instructions.
14. Note down the results including the sample details and the nutrient measurement.
15. Repeat from step 1 for another sample area or different test. Create a table with each location sampled and the results of soil tests for N, P, K, and pH.

## PART 2 – IT'S IN THE BAG! CHOOSING THE RIGHT FERTILIZER

### Why add fertilizer?

Over time, plants use up soil nutrients. Using energy from the sun, the chemical factories in plants transform water, carbon dioxide, and soil nutrients into leaves, stems, roots, and flowers or crops. When plants deplete soil nutrients, we can restore them by adding fertilizer, enabling the plants to grow strong and healthy.

### Why do this activity?

In this activity, you will evaluate a fertilizer to meet a need for a particular nutrient, as indicated in the soil tests. For example, if the soil tests show that the samples were low in nitrogen, then you should apply a fertilizer that is relatively high in nitrogen. Applying another type of fertilizer would waste money and potentially harm the environment. Visit a local garden center or hardware store to look at the variety of fertilizers available. Use information about the fertilizers to evaluate which would be the most appropriate for amending the deficiencies observed from the soil test.

## DID YOU KNOW?

### Fertilizer Fun Facts

- Synthetic fertilizer was the driving force behind the "Green Revolution"
- 50 percent of world food production is attributable to fertilizers.
- Half of U.S. fertilizer use is for corn production alone.
- Between 1980 and 2014, fertilizer use efficiency in U.S. corn production increased by 105%.
- Total global consumption of plant nutrients is around 200 million tons.
- Fertilizers are compounds that contain the elements needed by plants.
- Plants cannot use nitrogen gas in the atmosphere.
- China is the world's leading producer of nitrogen and phosphate-based fertilizers.
- China is the world's leading consumer of nitrogen, phosphate and potash fertilizer nutrients.
- 90 percent of fertilizers are applied in solid form.
- Most fertilizers are added to soils, but some fertilizers can be applied to plants, plant leaves, and trees through methods like fertigation.
- Excess fertilizer application can be detrimental to the environment.
- Production of ammonia accounts for around 2% of global energy use.
- It is important to apply the correct amount of fertilizer based on your soil tests to avoid wasting money or harming plants.

## EXAMPLE STORE VISIT

During this visit, you will examine different kinds of fertilizer and evaluate them for use on the soils that you tested in Part 1.

1. Go to your local garden center or hardware store with an adult family member.
2. Take your notebook or clipboard containing the results of the soil tests.
3. Meet with a staff member at the store and tell him or her what you are doing. Ask for assistance to locate the fertilizers.
4. If you have gloves, wear them. Otherwise, avoid touching the fertilizer bags.
5. Create a table with the name of the fertilizer, its NPK values and its main use (e.g., for lawns, flowers or vegetables?) and relevant information.
6. Check the table and indicate whether the fertilizer will be useful to amend nutrient deficiencies in your soil samples.

## FAMILY CHALLENGE

How much do you and your family already know about soil and plant nutrients? Try to answer these questions based on what you already know or can find on the Internet. You can compete against each other or work as a team. Give yourself one point for every correct answer!

1. What is the role of earthworms in soil fertility?  
A. digest mineral matter    B. recycle nutrients    C. enrich surface soil    D. A, B and C
2. How much soil passes through an earthworm in a year?  
A. 25 pounds    B. 500 pounds    C. two tons    D. 15 tons
3. Moles are bad for soil. True or false?
4. How deep are soils?  
A. Up to 2 feet    B. Up to 50 feet    C. Up to 500 feet    D. Thousands of feet or more
5. Synthetic fertilizers are made from natural sources. True or false?
6. What is a major source of synthetic phosphate fertilizers?  
A. Haber-Bosch process  
B. Cow manure  
C. Ancient bones from sea animals  
D. Seawater
7. How much nitrogen in human beings comes from synthetic nitrogen fertilizer?  
A. a tenth    B. a quarter    C. a third    D. a half
8. What is the United States' place in global consumption of nitrogen fertilizer?  
A. first    B. second    C. third    D. fourth
9. After corn, the crop using the most synthetic fertilizer is \_\_\_\_\_.  
A. cotton    B. wheat    C. soybeans    D. peanuts
10. The action of fertilizer draining out of soil is called \_\_\_\_\_.  
A. leaching    B. seeping    C. dissolving    D. filtering

Family Challenge Answer Key

1. **D** 2. **D** 3. **False** (moles help aerate soil)  
4. **B** 5. **True** 6. **C** 7. **D** 8. **C** 9. **B** 10. **A**

## ADDITIONAL RESOURCES

Nutrients for Life Foundation

[www.nutrientsforlife.org](http://www.nutrientsforlife.org)

U.S. Department of Agriculture Soil Education Page

<http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/edu/>

U.S. Department of Agriculture Agricultural Library Kids' Page

<http://www.nal.usda.gov/educational-resources-children-parents-and-teachers>