Can We Have Too Much of a Good Thing?

Grade Levels

6 - 8

Purpose

In this lesson students will understand that plants require nutrients in the proper concentrations. Students will discover that plants can be damaged or killed by either too many or too few nutrients.

Estimated Time

One 50 Minute Class, Five 15-Minute Observations, One 50-Minute Class for analyzing results

Materials Needed

For the teacher:

- Six, 6 packs of one type of vegetable or flower seedling from a nursery
- Sand or perlite for potting seedlings
- Plastic or wax lined paper cups with a hold in the bottom for planting seedlings
- Liquid fertilizer
- Distilled water
- Jars or beakers that can hold 300 ml of liquid
- 500 ml graduated cylinder or other measuring device
- Wax marking pencil or masking tape

For each student:

- Can You Have Too Much of a Good Thing? lab sheet, 1 copy per student

For each group of four students:

- Four seedlings potted in sand (per group of 4 students)
- Prepared fertilizer concentrations (per group of 4 students)
- Grow or fluorescent light for plant area (optional) or a sunny area for plant growth

Essential File (map, chart, picture, or document)

- "Can You Have Too Much of a Good Thing?" Lab Sheets (https://cdn.agclassroom.org/media/uploads/2015/02/02/Too_Much_of_a_Good_Thing_Lab_Sheets.pdf)

Vocabulary Words

essential element: a chemical element required by an organism for healthy growth

fertilizer: material of natural or synthetic origin that is applied to soils or plants to supply one or more nutrients essential for plant growth

macronutrient: a substance required in relatively large amounts by a living organism such as nitrogen, phosphorus, and potassium in plants

micronutrient: a substance required in relatively small amounts by a living organism such as iron in plants

Background Agricultural Connections

This lesson is part of a series called, *Too Much? Too Little?* created to introduce middle school students to the connection between soil nutrients and the food they eat. The lessons consist of a series of demonstrations and hands-on experiments that show that plants require nutrients in certain quantities. The lesson series allows students to investigate soil properties, learn h to properly prepare fertilizer nutrient solutions, identify deficiencies in plant nutrients using a key, and much more. Other relat lessons include:

- Plant Parts and Functions (https://agclassroom.org/matrix/lesson/343/):Anatomy and physiology of a plant.
- Digging Into Nutrients (https://agclassroom.org/matrix/lesson/123/): How plants obtain nutrients from the soil.
- The Right Solution (https://agclassroom.org/matrix/lesson/344/): How fertilizer solution is properly calculated and applied.
- *Can We Have Too Much of a Good Thing?*: The effects of applying too much or too little fertilizer.
- The Right Diet for Your Plants (https://agclassroom.org/matrix/lesson/346/): Read fertilizer labels and choose the best fertilizer.
- Let's Vote On It (https://agclassroom.org/matrix/lesson/127/): How soil nutrients effect local communities and economies.
- It's a Dirty Job (https://agclassroom.org/matrix/lesson/345/): How earthworms benefit soil.

Plants require 17 different **essential elements** for successful growth and reproduction. Carbon, oxygen, hydrogen, nitrogen, phosphorus, and potassium are required in relatively large quantities and are classified as macronutrients. These elemental nutrients are obtained from the air and from water in the soil. **Macronutrients** are needed in relatively large quantities for healthy plant growth. Nitrogen (N) is known as the builder. Nitrogen is needed to make proteins and to carry out photosynthes Phosphorus (P) is known as the energy supplier and is needed for energy transfer in photosynthesis and is important for seed germination and efficient water use. Potassium (K) is known as the regulator because it plays an important role in catalyzing chemical reactions involved in plant growth and protection from stress.

Eleven other elements are also important to plants but are classified as **micronutrients** because they are needed in smaller quantities than macronutrients. It is important that plants receive the correct amount of nutrients for proper growth and reproduction. There are many different types of **fertilizers** that can provide needed nutrients to plants. Farmers have been fertilizing their crops for thousands of years. As the human population continues to grow, farmers must produce more, from th same amount of land. In order to sustain soil health, nutrients must be replaced after they are removed from the soil with harvested crops. A variety of different fertilizers are available for farmers and home gardeners. Organic fertilizers, such as manures, undergo very little processing before being applied to a crop. Commercial fertilizers are made from natural ingredien that undergo chemical processing in order to increase their nutrient content and ensure that they deliver a guaranteed amoun nutrients. Many farmers use both types and make their selections based upon the needs of their crop, the characteristics of th soil, climate, topography, and many other factors.

Many liquid plant "foods" are purchased in concentrated forms. Before they are used they must be diluted with the proper amount of water. Fertilizers in solid form also have a specific amount that should be applied in order to provide only what will b taken up by the crop. Just as a person can become sick after taking more vitamins than the recommended dosage, plants can harmed if a gardener or farmer applies more fertilizer nutrients than recommended. In addition, farmers and home gardeners must follow fertilizer application instructions to protect the environment by making sure that the nutrients applied are the amount that will be taken up by plants and will not run off into waterways and other fields. The fertilizer manufacturer, throug extensive research and testing, provides instructions on the proper application of the fertilizer, including concentrations, prope dilution, frequency of application, and storage. This research guides farmers and gardeners to use the 4-Rs when managing fertilizer application: Right Rate, Right Time, Right Place, Right Product.

Interest Approach - Engagement

1. Ask the students how their body obtains energy to live and be healthy? Guide the students to the answer that they consum food for energy.
2. Next, ask students if they can have too much food and what the effects would be?
3. Ask students if plants need energy to live and be healthy? How do plants obtain "food?"
4. Explain that in this lesson they will be learning about the nutrients that plants require and how to provide the correct balance.

Procedures

It may be helpful to try this experiment ahead of time, especially preparing the solutions and determining how far away the lig source should be from the plants for optimal outcome. Consider how often, and with how much, the plants will need to be watered in the classroom environment. Evaluate how many of your students can participate in set-up.

1. Designate a well-lit area of the classroom for the plants. An optional grow light or a fluorescent fixture can improve results. Place sand or perlite in cups and plant one seedling in each cup.
2. Prepare the fertilizer mixtures ahead of time for each student group.
3. Label sets of four jars or beakers for each group with a wax marking pencil or piece of tape at the 300 ml mark. Label one container in each set with the fertilizer concentrations: 0%, 0.5%, 1%, and 2%. Use the following directions to prepare the concentrations of fertilizers:
   - **0% solution:** Fill jars or beakers, labeled 0%, with distilled water. No fertilizer is to be added to these jars.
   - **0.5% solution:** Put 1.5 ml liquid plant fertilizer in a 500 ml graduated cylinder and add distilled water to the 300 ml mark. Do this for each of the jars or beakers labeled 0.5%.
   - **1% solution:** Put 3 ml liquid plant fertilizer in a 500 ml graduated cylinder and add distilled water to the 300 ml mark. D this for each of the jars or beakers labeled 1%.

- **2% solution:** Put 6 ml liquid plant fertilizer in a 500 ml graduated cylinder and add distilled water to the 300 ml mark. D this for each of the jars or beakers labeled 2%.
- When time permits, make a reserve stock of each of the same solutions to use during the experiment to replenish the solutions. Keep the solution jars covered and away from heat and possible contamination.

4. Divide the students into groups of four. Each group will carry out the experiment using the scientific method. At the completion of the experiment each individual student will write a lab report.
5. Review the Scientific Method and the components of a properly written lab report with the students. Give students a reference for lab report expectations by providing examples that range from high to low quality.
6. Guide the students in the proper set up of their experiment. Check each student's hypothesis prior to beginning the lab experiment. Monitor their process and reinforce the concept of having only one variable. Have the student's take detailed notes and use them to write their final reports. They should include their notes as an attachment to the final report.
7. Complete the following activity with your students. Give as much or as little instruction as appropriate for the class. You car give your students detailed instructions or this experiment can be done as a Design-Your-Own-Experiment.
8. Discuss the results of the experiment as a class. What did your students learn about fertilizers? What are some examples o fertilizers? Why are fertilizers important to farmers? Why are they important to the students? What should a farmer or hom gardener know before applying fertilizers?

Concept Elaboration and Evaluation:

After conducting these activities, review and summarize the following key concepts:

- Plants are an important element in our food supply. Plants grow in soil and require specific levels of nutrients for healthy growth.
- Fertilizer can be used to supplement needed nutrients, however, it must be applied at the proper time, place, and rate.
- Over or under fertilizing can have negative impacts.

Variations

- Do the experiment as a class with just one set of plants.
- Have each group produce one lab report and put it on a poster board for display.
- Have the students follow directions to mix the various fertilizer solutions for their own group.
- Grow plants from seeds as a class project.

ELL Adaptations

- Employ group work and cooperative learning. These activities provide opportunities for students to exchange, write, and present ideas. Students use a variety of skills that work together to increase understanding and retention.

We welcome your feedback (https://usu.co1.qualtrics.com/jfe/form/SV_4HhIVpN4L8IC2lT)! Please take a minut to tell us how to make this lesson better or to give us a few gold stars!

Enriching Activities

- Set up two class experiments: one on how fertilizer in various concentrations affects the germination of seeds, and one on how the fertilizer dosage affects the growth of seedlings. This can also be done in student groups.

Sources

This lesson was updated in 2013 with funding from California Foundation for Agriculture in the Classroom and a grant from the California Department of Food and Agriculture's Fertilizer Research and Education Program. The Fertilizer Research and Educat Program (FREP) funds and facilitates research to advance the environmentally safe and agronomically sound use and handling fertilizer materials. FREP serves growers, agricultural supply and service professionals, extension personnel, public agencies, consultants, and other interested parties. FREP is a part of the California Department of Food and Agriculture (CDFA), Division Inspections Services.

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Suggested Companion Resources

- Troubled Waters (https://www.agclassroom.org/matrix/resource/270/)
- Feeding the World and Protecting the Environment (https://www.agclassroom.org/matrix/resource/462/)
- Phosphate Mining Video (https://www.agclassroom.org/matrix/resource/756/)
- Potash Mining Video (https://www.agclassroom.org/matrix/resource/757/)
- Soil Science Videos (https://www.agclassroom.org/matrix/resource/470/)
- Dig In: Hands-On Soil Investigations (https://www.agclassroom.org/matrix/resource/677/)
- How a New Evolutionary Map Could Help Farmers Eliminate Fertilizer (https://www.agclassroom.org/matrix/resource/584/)

- Nitrogen & Agriculture (https://www.agclassroom.org/matrix/resource/892/)

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