Activity 3-9

The Effect of NO_3 on Plant Growth

Adapted from BTNEP/LSU AgCenter: *Nonpoint Source Water Pollution* & *Bottle Biology*

Focus/Overview

This activity sets up an experimental design to investigate the effect of various concentrations of fertilizer on plant growth.

Learning Objectives

The learner will…

- set up an experimental design to investigate the effects of fertilizer on aquatic plant growth.
- record results after one week and draw conclusions from their data.

Louisiana Grade Level Expectations (Science)

7 INQ: GLE-4	Design, predict outcomes, and conduct experiments to answer guiding questions (SI-M-A2).
7 INQ: GLE-5	Identify independent variables, dependent variables, and variables that should be controlled in designing an experiment (SI-M-A2).
7 INQ: GLE-12	Use data and information gathered to develop an explanation of experimental results (SI-M-A4).
7 INQ: GLE-22	Use evidence and observations to explain and communicate the results of investigations (SI-M-A7).
7: GLE 37	Identify and describe the effects of limiting factors on a given population (SE-M-A2).
7: GLE 39	Analyze the consequences of human activities on ecosystems (SE-M-A4).
HS INQ: GLE-4	Conduct an investigation that includes multiple trials and record, organize, and display data appropriately (SI-H-A2).
HS INQ: GLE-9	Write and defend a conclusion based on logical analysis of experimental data (SI-H-A6) (SI-H-A2).
HS: Biol-26	Analyze the dynamics of a population with and without limiting factors (LS-H-D3).

BTNEP Connection
Water Quality

Grade Level
7, HS Biol

Duration
1-2 class periods

Subject Area
science

Setting
classroom

Vocabulary
limiting factor

Original Source
"Effect of NO_3 on Plant Growth" in BTNEP/LSU AgCenter: Nonpoint Source Water Pollution, Activity 8, and adapted from *Bottle Biology*.

BTNEP Barataria-Terrebonne National Estuary Program
www.btnep.org

Materials List

Students can bring their own 2-liter bottles.

- 3 two-liter soda bottles per group of four students
- 2 potted plants per group (about 4" high)
- Duckweed or other small floating aquatic plant
- Sand
- Soluble plant food such as "Miracle Grow"
- Distilled water
- 100 ml measuring container or graduated cylinder
- Sharp scissors
- Stapler
- Containers to hold fertilizer solution (three containers per workstation)

Background Information

See background information in activities focused on nitrogen and phosphorus cycles (Section 3, Act 7, 8).

Advance Preparation

1. Set up six or more workstations around the room. Each station should have the materials to make three terr-aqua columns. One will be a control, one will receive a dilute fertilizer application and the third will receive a more concentrated fertilizer application.

2. Place sand in a container that will allow water drainage (cheese cloth can be used in a colander). Drain several cups of distilled water through the sand to leach out any existing nutrients. Allow sand to partially dry.
3. Remove labels from two-liter containers – rinse containers thoroughly. (Students can be told to do this prior to bringing in their two-liter containers.
4. Make lines for cutting around the shoulder of the bottles (about 10 cm down from the cap). A good technique is to place the bottle on its side in a shallow box, position the marker horizontally so the point touches the side of the bottle, but is stable, and then slowly rotate the bottle to produce an even line circling the bottle.
5. With sharp, pointed scissors, cut along the lines to make a cylinder and a funnel-shaped piece from each bottle.
6. Cut small holes in the upper portion of the cylinders (5 cm from the top) to allow air circulation.
7. Make small holes in the cap using hot wire heated over a Bunsen burner or stove top. Screw caps onto funnel sections.
8. Prepare fertilizer solutions: One solution according to directions on the container, and the other solution, double strength. Use distilled water to make the solutions.
9. Set up the workstations: Each station has three two-liter bottles cut into two with holes in the lids and in the sides of the bottom parts. Each group has clean sand, three small plants and duckweed in water. Each station also has labeled containers of the two fertilizer solutions and one container of distilled water.

Procedures

1. The experiment we will do this week will simulate the situation where a waterway receives too much nitrate nutrients. We will set up an experimental design that has a control and two levels of our independent variable, concentration of nitrate (or fertilizer).
2. You will work in groups of four. The materials are set out at the workstations around the room. Each group has three two-liter bottles cut into two with holes in the lids and in the sides of the bottom parts. Each group has clean sand, three small plants and duckweed in water.
3. Distribute student worksheets, **Experimental Design** (**Blackline Master #1**). Your worksheet has a diagram showing how to put the experimental apparatus together. Follow the directions on the worksheet. Have students set the columns, labeled with their group name, in an evenly lighted place. Have students record the changes in their columns on their data sheets, **Experimental Design and Data Collection (Blackline Master #2)**, over the next week.
4. At the end of a week, have students complete **Results and Conclusions (Blackline Master #3)**.

Blackline Master(s)

1. **Experimental Design**
2. **Experimental Design and Data Collection**
3. **Results and Conclusions**

Assessment

- Assess student's data, results and conclusions drawn from the experiment.

Resources

References

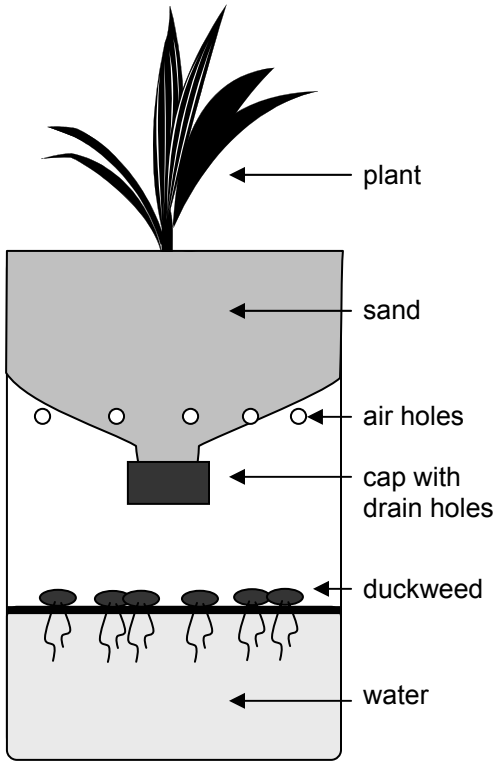
Bottle Biology: See It, Touch It, Smell It, Taste It… accessed January 9, 2006, at http://www.bottlebiology.org/.

Blackline Master #1

Experimental Design: Constructing Terr-Aqua Columns to Investigate the Effects of Fertilizer on Aquatic Ecosystems

Materials Checklist:

- ☐ 3 two-liter bottles, each cut in two
- ☐ 3 caps with holes
- ☐ container of clean sand
- ☐ 3 small plants
- ☐ container of duckweed in water
- ☐ distilled water
- ☐ weak fertilizer solution
- ☐ concentrated fertilizer solution
- ☐ 100 ml graduated cylinder



Directions:

1. Pour 300 ml of distilled water into the bottom of each bottle.
2. Remove an equal amount of duckweed plants (for example, 30 plants) from their containers and place them in the water in each of the three bottles.
3. Screw the caps on the upper (funnel) sections of the bottles.
4. Place the upper (funnel) sections upside down in the bottom sections as shown above. Staple them in place.
5. Remove the plants from their containers and gently wash wash the soil from their roots.
6. Place the cleaned sand in the funnel part of your Terr-Aqua Column.
7. Place the plant in the sand.
8. Mark your Terr-Aqua Column: Control, E1 and E2. Label each bottle with your group name.
9. Water the control plant with 50 ml of distilled water.
10. Water E1 with 50 ml of the weak fertilizer solution.
11. Water E2 with 50 ml of the concentrated fertilizer solution.
12. Place your columns near a window, making sure all receive equal amounts of light.
13. Record your observations on the data sheet each day.
14. If you have a water quality testing kit, conduct nitrate and dissolved oxygen tests on samples of the water in the bottom layer on the first and last days of the experiment. Compare the results.

Blackline Master #2

Experimental Design and Data Collection: The Effects of Fertilizer on Aquatic Ecosystems

In this experiment,
The Independent Variable is _____.
The Levels of the Independent Variable are _____.
Variables held constant are: _____
_____
The Dependent Variables are: _____
_____
_____

A well-written hypothesis that includes both the independent and dependent variables for this experiment would be: _____
_____
_____

Experimental Data

DAY 1

Dependent Variables	Control	E1	E2
Height of plant (mm)			
Appearance of leaves			
No. of duckweed plants			
Appearance of water			

DAY 2

Dependent Variables	Control	E1	E2
Height of plant (mm)			
Appearance of leaves			
No. of duckweed plants			
Appearance of water			

DAY 3

Dependent Variables	Control	E1	E2
Height of plant (mm)			
Appearance of leaves			
No. of duckweed plants			
Appearance of water			

DAY 4

Dependent Variables	Control	E1	E2
Height of plant (mm)			
Appearance of leaves			
No. of duckweed plants			
Appearance of water			

DAY 5

Dependent Variables	Control	E1	E2
Height of plant (mm)			
Appearance of leaves			
No. of duckweed plants			
Appearance of water			

Blackline Master #3

Results and Conclusions:
The Effects of Fertilizer on Aquatic Ecosystems

Results:

Write a paragraph describing the changes you observed in your Terr-Aqua Columns. Use the data from your data sheet.

Conclusions:

What statement can you make, based on your results summarized above, about the effect of fertilizer on the growth of terrestrial and aquatic plants?

How do your observations and conclusions relate to what might happen in the natural environment if too much nitrogen fertilizer is used?