Too Much of a Good Thing? Study the Effect of Fertilizers on Algal Growth

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You might not know it, but a lake without algae would be a very dull place. If there were no algae, there would be no small animals feeding on the algae, and there wouldn't be any fish eating the small animals that eat the algae. You might conclude that since some algae is good, more algae is even better, but algae growth has a down side. If there is too much algae, they can deplete the oxygen in the water, killing off other species in the water. What is one culprit that leads to algal growth? Fertilizer. In this environmental science fair project, you will experiment with the effect of different concentrations of fertilizers on algal growth.

TIME REQUIRED

2 - 5 Days

We depend on fresh water from lakes, rivers, and reservoirs for drinking, as well as for recreational activities, such as swimming, boating, and fishing. It is obviously of critical importance to keep sources of fresh water as clean and unpolluted as possible. But many activities leave these water sources polluted and unfit for personal consumption. Nitrogen and phosphorus compounds from fertilizers are among the most common pollutants. They contribute to pollution by causing algae and bacteria in the water to reproduce rapidly. When these organisms die, the decomposition process then depletes oxygen in the water, killing fish and other aquatic life.

Nitrogen is supplied in fertilizers because it is necessary for plant growth, but is often in short supply in soils. Nitrogen makes up the majority of our atmosphere, but plants are not able to use the form of nitrogen found in the atmosphere, called diataomic nitrogen (N2.) Plants require a form of nitrogen that they can readily absorb and use to promote growth and reproduction. Nitrogen in the form of nitrates works very well as a plant fertilizer and is produced in large quantities for this purpose. Phosphorus is also often present in fertilizers in the form of phosphate. Phosphate-containing chemicals deliver the essential element phosphorus to plants in a readily absorbable form.

Some of the nitrates and phosphates in fertilizer wash off lawns, golf courses, and agricultural fields into freshwater sources. When these chemicals are introduced into a natural water source, such as a pond, they can upset the ecological balance that exists, causing some organisms to flourish (such as algae) at the expense of others (such as fish). Therefore, it is important to consider means to prevent or reduce the amount of fertilizer that finds its way into natural bodies of fresh water when considering ways to deliver fertilizer to crops and lawns. In this environmental science fair project, you will investigate the effect of varying concentrations of fertilizers on the growth of freshwater algae.

TERMS AND CONCEPTS

- **Nitrogen**
- **Phosphorus**
- **Pollutant**
- **Reproduction**
- **Diatomic nitrogen**
- **Nitrate**
- **Phosphate**
- **Nitrogen cycle**
- **Algae cultures**

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QUESTIONS

• What are sources of nitrogen and phosphorus pollution in freshwater?

• What is the chemical formula for nitrate? For phosphate?

• Why is light needed for algal growth?

• Why might excess nitrates in the water not cause excessive algal growth? Hint: Is increased nitrate concentration sufficient for algal growth, or does growth require other factors?

• Based on your research, what organisms produce nitrates as part of

MATERIALS AND EQUIPMENT

- Pond or lake water
- Adult helper
- Plastic container, with lid, 4-liter (L) capacity (2) Note: You will be performing a total of three trials of this experiment, so you might want to collect all the water at once, meaning you will need four containers (3 for collection and 1 for use during the experiment).
- Lab notebook
- Styrofoam cups, 12-ounce (oz.) size (18)
- Permanent marker
- Graduated cylinder, 100-milliliter (mL)
- Fertilizer, 8-ounce size - available at local garden stores
- Tablespoon
- Distilled water
- Plastic spoons
- Graph paper

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EXPERIMENTAL PROCEDURE

Collecting and Setting Up the Pond/Lake Water Samples

1. Collect 2 L of pond water from a local pond using the 4-L plastic container. Have an adult come along to help. Note: You will need to perform this procedure two more times to collect fresh pond water.

- **a.** Collect water that appears relatively clear, without sediment or large amounts of algae.
- **b.** Record the appearance of the pond water in your lab notebook.

2. Label six Styrofoam cups, as follows:

a. 1X
b. 0.5X
c. 0.25X
d. 0.12X
e. 0.06X
f. No fertilizer: control

3. Using your graduated cylinder, place 400 mL of pond water into the cup labeled 1X.

4. Place 200 mL of pond water into the remaining cups.

5. Now dissolve 15 mL (1 tablespoon) of fertilizer in 4 liters of distilled water in your second plastic container. Call this the 10X (ten times concentrated) fertilizer solution.

Performing a Dilution Series

1. You will now perform a series of 2X dilutions so that you can test a range of fertilizer concentrations. Each cup will have 1/2 the concentration of fertilizer as the previous cup, but the algae will stay the same. Note: It is important to always use clean containers, as a small amount of carry-over liquid can cause large errors, so be sure you wash and dry your graduated cylinder after each use within this section.

2. Pour 40 mL of the 10X fertilizer solution into the 400 mL of pond water in the cup labeled 1X. Mix the contents in the cup with a clean plastic spoon.

3. Transfer 200 mL from the cup labeled 1X to the cup labeled 0.5X. Mix the contents of the 0.5X cup with a clean plastic spoon.

4. Transfer 200 mL from the cup labeled 0.5X to the cup labeled 0.25X. Mix the contents of the 0.25X cup with a clean plastic spoon.

5. Transfer 200 mL from the cup labeled 0.25X to the cup labeled 0.125X. Mix the contents of the 0.125X cup with a clean plastic spoon.

6. Transfer 200 mL from the cup labeled 0.125X to the cup labeled 0.06X. Mix the contents of the 0.06X cup with a clean plastic spoon.

7. Transfer 200 mL from the cup labeled 0.06X to a sink or other disposal area.

8. The remaining “control” cup should not have any fertilizer.

Observing the Growth of the Algae

1. Place the algae cultures in a spot indoors that is well-lit during daylight hours.

2. Make a data table in your lab notebook listing the concentrations of fertilizer in each cup and the amount of algae growth. Make a scale from 1 to 5 for the relative amount of algae growth.

3. In your lab notebook, describe the appearance of the algae cultures each day for 10 days.

4. Record the value, 1 to 5, for the amount of growth each day for each culture.

5. Graph you results, with the growth on the y-axis and the time on the x-axis.

Running Several Trials

1. Repeat the above procedure two more times. Performing the procedure several times shows that your results are repeatable.

2. Based on your observations, you may think of ways to improve on the procedure.
Feel free to alter the steps or materials in the procedure, just make sure you keep good notes.

VARIATIONS

- **Design a procedure using a single species of algae and precise amounts of nitrates and phosphates.**
- **Determine the concentration of the fertilizer chemicals in your dilutions based on label information. Add this information to your data table.**
- **Measure the actual concentration of nitrates and phosphates present in your samples using water testing kits.**

Authors/Source
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