Topic 7: Plants – 7e. Fertilizer Strength Lab

Resources:	Campbell et al. *Biology: Exploring Life.* Prentice Hall, p. 463. Campbell et al. *Biology: Concepts and Connections.* Pearson, p. 656. Miller and Levine. *Biology.* Prentice Hall, p. 78.
Building on:	Scientific method Measurement Plant physiology
Links to Chemistry:	Chemical reactions Photosynthesis reactions
Links to Physics:	Conservation of energy
Stories:	Students will try to make a hypothesis for which fertilizer strength grows plants the best. Often they will choose the stronger fertilizer strength and they will be "dead wrong." In fact, because the fertilizer is added to water and the plants treated every day, the diluted fertilizer or even tap water-treated plants will grow far better than the regular strength or double strength plants. This investigation can be framed around a "real-world" question, which is, "Should farmers fertilize their crops in the amounts recommended by the manufacturer or should they dilute or increase its strength?"

Lab Instructions and Materials for the Teacher:

Mix Miracle-Gro fertilizer according to the directions on the box (about 1 tbsp. per gallon of water) as your regular strength dilution. For half strength, put just a small amount, and for double strength, use copious amounts (3-4X); this will make your results more dramatic without giving the students the idea that the fertilizer strengths are too varied.

I use this lab as an introduction to the scientific method, metric measurement and graphing at the start of the year. It also gives me a chance to have the students write up a formal lab report with a detailed conclusion. I will let them write up their own report and then grade it, after which I will show them my sample conclusion to allow them to see an exemplary conclusion. The lab takes about two weeks to complete from start to finish.

Beans Lab Conclusion**: (Share with students AFTER they have written their own conclusion!)**

(In a conclusion, you will attempt to make sense of the experiment: what you did, what you found, and why. It should be written to a reader who is somewhat intelligent but is not familiar with this particular experiment.)

(Summary of procedures – in enough details that another scientist could repeat your experiment)

In this experiment, we grew bean seeds with different strength fertilizers—regular strength, half strength, double strength—to see which would grow best (the fertilizers were Miracle-Gro mixed with water by our teacher using the dilution recommended on the box). One group of plants was given tap water as a control group. To set up our experiment, we massed three bean seeds (three seeds were used to control for individual seed variations which might affect our results) and placed them in a Styrofoam cup with vermiculite, a substance which acts as soil but provides no nutrients to the plants. In the bottom of the cup, we poked a hole to allow the excess water to drain when the plants were treated. We gave them 25 mL of water or the appropriate strength of fertilizer every school day. We measured the height of each plant on the 3rd, 6th, 9th, and 12th day after germination. On the 12th day, we removed the plants from their cups and massed them again. From this, we could determine the increase in mass as the beans went from seeds to plants, and we calculated the percentage of mass increase.

(Summary of your results - Use actual numbers from your data to support your position, interpret/make some sense of the data.)

Our results showed that half strength fertilizer grew the plants the best. Our average height on day 12 for the half strength plants was 24 cm, which was slightly greater than that of tap water and regular strength—20 cm and 18 cm—and was far more than the height of double strength, 2 cm. Our mass data also showed that half strength was best; it had a 748% mass increase compared to 525% for tap water and 457% for regular strength and 115% for double strength. This shows that, although the heights were comparable between half strength and tap water, the mass increase was much higher for half strength, indicating that these plants were fuller and healthier.

(Discuss your results; tell why they turned out like they did.)

These results were surprising; my hypothesis stated that the regular strength fertilizer would grow the plants the best. I thought this because I guessed that the fertilizer manufacturer would have done a similar experiment to make up the proper dilution directions for his product. Our results clearly show that double strength provides too many nutrients, which becomes like a poison to the plant. Our double strength plants looked withered and rotten and they barely sprouted at all. I then came to find out that there was a significant source of error in our experimental design that affected our results.

(Discuss errors; tell which ones DID occur or were likely to have occurred and their effects on the results.)

The manufacturer's directions say to fertilize the plants every 1-2 weeks and water them the rest of the days. If we fertilized the plants every day, then the regular-strength dilution was still too much for the plants to thrive, so half strength ended up being the best dilution for fertilizing and watering them every day. Tap water was almost as good because it does contain some minerals. But as the experiment progressed, these plants looked less green and

healthy. If our experiment were to continue for another week or two, I feel fairly confident that the tap water plants would have run out of nutrients and died. The seeds themselves have the nutrients necessary to start out the life of the plant, but eventually they run out and the plant must get its nutrients from the soil. Not proceeding long enough was another shortcoming in our experimental design.

(Concluding statement – Tell why this lab is important; list any practical applications which can be drawn from it.)

This lab can show us a lot about the real-world applications of growing plants, whether in a garden or on a farm. The fertilizer directions should be followed; fertilize once every two weeks and water on the other days. If a farmer were to fertilize and water every day, he should dilute his fertilizer down to half strength or less.

Beans Lab

Introduction: This lab will help you to become more familiar with the scientific method, making measurements using the metric system, and experimental design. We will grow bean seeds in three different strengths of fertilizer to see which one grows the best. All measurements MUST be made in metric (grams, milliliters, centimeters, etc. . . .)!

Purpose: To determine in which strength fertilizer bean plants grow the best.

Materials:

Bean seeds	Vermiculite (non-nutrient soil)
Styrofoam cups	Marker
Grow lights	Pen or pencil
Plastic trays	Water
Regular strength fertilizer solution	Graduated cylinders
Half strength fertilizer solution	Beakers
Double strength fertilizer solution	Ruler

Hypothesis: Write a complete sentence below to answer the purpose question.

Procedures:

1. Work in groups of four (by lab table). Assign a plant treatment to each partner: regular strength fertilizer, half-strength, double strength, or water.
2. Each partner gets a Styrofoam cup and pokes a hole in the bottom with a pen or pencil (for drainage). ***Failure to do this will ruin your plant and results!**
   Label your cup with your initials, period, group number and treatment.
3. Fill the cup about 2/3 full with vermiculite.
4. Get three bean seeds (for each cup) and mass them on the electronic balance. Record your results.
5. Place your three massed seeds into your cup. Cover with vermiculite.
6. Water (treat) with 25 mL of your fertilizer treatment over a sink. (It will drip!)
7. Place under grow lights in a tray with your partner's cups.
8. Continue to treat/water with 25 mL every day.
9. Measure the height of each plant on days 3, 6, 9 and 12 days after germination. Record.
10. On day 12, after measuring heights, carefully remove your plants from the cup. Wash the vermiculite out of the roots carefully so you do not remove any plant material! Pat dry and mass your plant material.
11. Calculate the percent change in mass of your plant.
    % change in mass = final plant mass – seed mass/seed mass.
12. Get data for your group and record in your data tables.
13. Graph your plant height data.

Results:

Mass Data Table:

Plant Treatment	Mass of Three Seeds	Total Plant Mass on Day 12	% Change in Mass
Tap Water			
Regular Strength			
Half Strength			
Double Strength			

Heights of Plants (cm)

Plant Treatment	Day 3	Day 6	Day 9	Day 12
Tap Water				
Regular Strength				
Half Strength				
Double Strength				

Conclusion:

Write a conclusion in which you tell what you did (briefly summarize procedures), what you found (summarize results) and why (discuss results, answer purpose question, discuss errors, tell why important).