Part 1: Lab Reports

Some of your science classes at Millersville University will require you to complete lab reports or term papers for simple experiments to show that you understand the scientific method. The scientific method usually includes (1) an Introduction section, (2) a Materials and Methods section, (3) a Results section, (4) a Discussion section and a Literature Cited section.

The goal of a lab report should be to simply present the facts. The goal of science is truth, thus no persuasion is necessary in this type of document.

Overall writing formats or guidelines for these lab reports should include the following:

1. The reports should be typed and double-spaced using a computer. Reports should be in 12 point size, Times New Roman style, have 1 inch margins, and organized neatly for the reader to understand your experiment.

2. Correct spelling and grammar is a must, and the report should be written in complete sentences (with subject and verb). Points may be deducted for incorrect spelling and grammar.

3. Past tense should be used whenever writing about what you did in lab, since what you did happened in the past.

4. Each section should be labeled with the appropriate heading (Introduction, Materials and Methods, Results, Discussion, Literature Cited).

5. Do not plagiarize (the "wrongful appropriation" and "stealing and publication" of another author's "language, thoughts, ideas, or expressions" and the representation of them as one's own original work).

6. To help with clarity: proof-read, then have somebody else proof-read, and then proof-read again.

The Following page begins an example lab write-up. Comments throughout this example outline the reasoning for the writing style and further details on how to follow a proper scientific writing style. THIS EXAMPLE IS TEXT LIGHT FOR YOUR BENEFIT.

YOUR PAPER WILL HAVE MORE SOURCES AND WAY MORE TEXT FOR EACH SECTION.
JOHN SMITH, Millersville University, Millersville, PA, 17551.

Abstract: We wanted to evaluate the effect of nitrogen fertilizer on American water weed (Elodea Canadensis) biomass growth. Our hypothesis was that more nitrogen fertilizer would increase plant biomass. We used 5 culturally bowls in which to grow plants. Each cultured bowl contained an increasing amount of nitrogen fertilizer, starting with bowl 1 with the least amount with increasing to bowl 5. We conducted 2 separate experiments to evaluate consistency of results. We found that plant biomass growth increased with more nitrogen fertilizer to a point. At the highest levels of nitrogen, plant growth declined dramatically. Both experiments had the same conclusion with results having no significant difference (P > 0.05). We suggest further research into the potential toxic impacts of too much nitrogen fertilizer on plant growth.

Introduction: The purpose of this lab was to examine the effect of nitrogen fertilization on plant growth. Nitrogen occurs in all living organisms and is believed to be an important nutrient for plant growth (Chalk 1991). To evaluate the impacts of nitrogen on plant growth, the aquatic plant American water weed (Elodea canadensis) was grown in water containing different amounts of nitrogen. Ammonium nitrate was used as our source of nitrogen fertilizer.

The hypothesis tested was that since American water weed requires nitrogen to make organic compounds like proteins (Chalk 1991), the more nitrogen it has available, the better it should grow. The null hypothesis was that nitrogen would have no impact on plant growth.
Materials and Methods

Five glass cultures bowls were filled with one liter of distilled water. Each bowl was given a different amount of ammonium nitrate as displayed in [Table 1].

<table>
<thead>
<tr>
<th>Bowl no.</th>
<th>Ammonium nitrate (g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0 g (negative control)</td>
</tr>
<tr>
<td>2</td>
<td>0.1 g</td>
</tr>
<tr>
<td>3</td>
<td>1 g</td>
</tr>
<tr>
<td>4</td>
<td>10 g</td>
</tr>
<tr>
<td>5</td>
<td>100 g</td>
</tr>
</tbody>
</table>

Five sprigs of American water weed, with a mass of about 0.4 g, was placed into each culture bowl. The culture bowls were placed in a growth chamber set to a 12 hr light period per day and an average temperature of 28 °C for three weeks. Water was added during the course of the experiment to keep the solution level at one liter in each bowl, but no additional ammonium nitrate was added. At the end of the three-week period, the mean final mass of each American water weed plant from each culture bowl was recorded and then compared for analysis. This same procedure was run again for 5 more bowls to test for experiment consistency.

We used a student t-test assuming equal variance to compare the means between the 2 experiments using the EXCEL program. Statistical significance was based on a p-value ≥ 0.05.
Results

We wanted to test to see if the amount of nitrogen fertilizer impacts plant biomass growth. Plants with higher levels of nitrogen had greater plant mass except for bowl number 5 (Figure 1). We found the same results for both experiments, where the mean of experiment 1 was 2.23 and mean of experiment was 2.10 (Figure 2). The t-statistic value was 0.25 and was less than the t-critical value of 2.31, also the p-value was 0.81 which is greater than 0.05 (Table 2), thus we found no significant difference in plant mass between experiments 1 and 2. The American water weed plant in bowl 5 had started to turn brown and looked like it was dying, but the plants in all other bowls looked green and healthy.

![Graph showing Mean Plant Mass vs Bowl Number](image1.png)

**Figure 1.** Mean plant mass in bowls of increasing amounts of nitrogen for 2 experiments. Bowl one had low levels of nitrogen while bowl 5 had very high levels as outlined in Table 1.
Figure 2. Mean plant mass and standard deviation error bars for all 5 bowls in experiment 1 and 2. Comparative statistics are outlined in Table 3.

Table 2. Results of a student t-test assuming equal variances between 2 experiments that both tested impacts of nitrogen levels on plant biomass growth. There was no significant difference between the two experiments (t-statistic $t < t_{critical}$; p-value = 0.81).

<table>
<thead>
<tr>
<th>Experiment 1</th>
<th>Experiment 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean</td>
<td>2.23 g</td>
</tr>
<tr>
<td>Variance</td>
<td>2.20 g</td>
</tr>
<tr>
<td>t-statistic</td>
<td>0.25</td>
</tr>
<tr>
<td>t-critical</td>
<td>2.31</td>
</tr>
<tr>
<td>2-tailed p-value</td>
<td>0.81</td>
</tr>
</tbody>
</table>
Discussion

The results of the experiment generally matched what was expected based on the hypothesis being tested, with the exception of the bowl 5 results. It was thought that increases in nitrogen would lead to increases in plant growth. Plant mass did increase with increasing nitrogen in bowls 1 through 4, but declined in bowl 5 (Figure 1).

The plant in bowl 5 showed the least growth. It only had one-third of the mass when compared with the negative control (i.e., bowl 1). Even though it was given the most nitrogen, the plant in bowl 5 appeared to be dying. There could be various reasons for this result. It is possible that the plant had developed a disease during the experiment (Campell and Madden 1990), but this would have to be investigated more. Another possibility is that the nitrogen level in bowl 5 was too high, and was toxic to plant growth at that level. Britto et al. (2001) found that high levels of ammonium (a nitrogen source) can have toxic implications for a number of plant species. Repeating the experiment may help determine which of these possibilities is correct, and if high levels of nitrogen can be toxic to plants.

Literature Cited


COMMON WRITING ERRORS

Written and oral communications are extremely powerful ways of representing yourself to others. Using proper grammar when speaking and writing for professional audiences can be a tremendous asset to your professional success. Obviously, inadequate writing or speaking will severely limit your career development.

**Attention to detail and proofreading your work will be critical to successful writing!**

- **Incomplete sentences**
  - Topping the list of writing errors is incomplete sentences.
  - Incorrect: The two extractions were combined. Then dried for five hours.
  - Correct: The two extractions were combined. They were then dried for five hours.

- **Subject-verb agreement**
  - If the subject is singular (or plural) the verb must match appropriately. In the following defective sentence, the noun is plural while its verb is singular.
  - Incorrect: Our results indicate the significance of intracellular signaling systems.
  - Correct: Our results indicate the significance of intracellular signaling systems.

- **Misspelled words**
  - Use your spell checker!
  - Remember, the only way to really check spelling is to **PROOFREAD** your work because spell checkers do not catch all errors.

- **Affect vs. effect**
  - "Affect" is a verb, "effect" is a noun. Remembering the acronym "NEVA" (noun effect verb affect) may help. Examples:
    - The effect of the medication was noticeable.
    - Medication rates affect the level of hypertension.

- **Data vs. datum**
  - "Data" is plural, "datum" is singular.
  - Examples:
    - The data are ....
    - The datum is...

- **Do NOT use quotes**
  - Avoid using verbatim quotations from technical references. Instead, reword phrases/ideas from the reference and then cite the reference that presented that idea.
  - Example:
    - “To be or not to be, that is the question”.
  - Revision:
    - The ultimate question is whether or not one should pursue existence in this life (Shakespeare, 1592).

- **Use of contractions (especially its vs. it's)**
  - "It's" is the contraction of "it is". In general, avoid using any contractions in scientific writing.
  - Incorrect: Results didn't differ among treatment groups.
  - Correct: Results did not differ among treatment groups.

- **Writing numbers less than 1.0**
  - (.78 vs. 0.78)
  - When writing a number that is less than 1.0, always place a zero to the left of the decimal.
  - Incorrect: .454, .8, etc.
  - Correct: 0.454, 0.8, etc.
9. **Writing numbers**

(A general rules - these rules vary somewhat in different style manuals)

Spell out numbers at the start of a sentence and one digit numbers (zero – nine) appearing anywhere in a sentence. Never begin a sentence with a numeral. Use numerals when a number has a unit of measure, when reporting statistics or when the number refers to a page, time, date, figure, table, magnification, etc. In a series containing some numbers greater than nine, use numerals for all.

Note the appropriate use of numbers in the following examples:

- Fifteen chickens crossed the road. (incorrect: 15 chickens crossed the road.)
- Insects have six walking legs.
- We had 425 insect specimens in our collection.
- All 10 of us attended lab this week.
- Ten of us attended lab this week.
- Most tissue samples weighed less than 15 grams.
- Several tissue samples weighed less than 4 grams.
- The audience included three students and eight instructors.
- The audience included 3 students, 8 instructors, and 13 chinchillas.
- The experimental diet caused body mass to increase by 5% (Table 2).

10. **Writing species names**

Biologists are especially 'picky' about writing species names. See lab manual pg. 42 for important rules that apply to zoological nomenclature.

Incorrect: homo sapiens, Homo sapiens, Homo Sapiens, Homo Sapiens, etc.

Correct: Homo sapiens (or Homo sapiens when handwritten)

11. **Since vs. Because**

"Since" should be restricted to making time comparisons.

Incorrect: Since they have rich soil, tall-grass prairies were rapidly converted to row crop agriculture.

Correct: Since settlement by Europeans, tall-grass prairies have largely disappeared. Because of its rich soil, tall-grass prairies were rapidly converted to row crop agriculture.

12. **When to use "et al.?**

The phrase "et al." is used when making an internal citation of a work that has three or more authors. (Review internal citation format, pg. 24 in your lab manual.) Because this phrase is derived from Latin, it is usually italicized.

Examples:
- Smith et al. (1983) found that... (indicates that this reference had at least three authors, the first of whom was Smith).
- Smith and Jones (1999) found that... (indicates that this reference had two authors).

13. **Than vs. Then**

The word “then” is used in many ways, but it is always used to denote time or sequence in some way, shape or form. The word “than” is a conjunction used in comparisons. To put it simply, if you are doing a comparison, use “than”; if not, use “then.”

14. **There vs. Their vs. They’re**

The word “there” indicates location. The word “their” is the possessive for “they.” The word “they’re” is a contraction for “they are.”