DO NOT WRITE ON THIS LAB.

Introduction to Experimental Design

Introduction

In this lab you will learn the process of designing a controlled experiment using radishes as a test organism. You will assess the impact of increasing salt concentration on seed growth and analyze your data using a t-test and learn issues of statistical probability.

Background

Science moves forward through the committed action of scientific research. After observing something of interest a scientist forms a *hypothesis*. Some research is exploratory and descriptive in nature (describing the life cycle of a star for example). Other research is based on experiments. If you had observed that plants with in gardens seemed to grow faster than plants in the wild, you could design an experiment based on your hypothesis that it's fertilizer that helps plants grow. To be valid and accurate an experiment needs to create a basis for comparison between what is being tested and the normal population. In order to do this, scientists strive to keep conditions constant, or the same, among the groups they are observing. Ideally, the only things that differ are the experimental treatment and the results at the end. These are called *variables*. Controlled experiments are designed to compare *experimental/treatment groups* (subjects that have been exposed to a variable of interest) and *control groups*. The control groups represent the normal conditions. At the end of the experiment the groups are compared based on a parameter called the *dependent variable* (the outcome depends on which group the subjects were in).

In this lab we will determine if different concentrations of salt water have an effect on the germination of radish seeds. Germination is defined as the radicle (embryonic root) breaking through the seed coat and emerging as a healthy white filament.

In order to understand whether the difference between the dependent variable for a control group and an experimental group is big enough to warrant greater attention, scientists use statistics. A very simple statistical test is called the t-test. A t-test uses the averages between two groups and the variability between raw scores in a group to calculate how likely the observed differences in averages are random or due to chance. A t-test value greater than 0.05 indicates that there is more than 5% chance that the difference between the control and treatment groups is random. Another way of saying this is that the experimental variable had no effect. If the t-test value is less than 0.05 that implies that the results are most likely not due to chance but rather due to the effect of your experimental variable. Another way to say this is that the results were significantly different. The use of the word "significant" in statistics means that there is less than 5% likelihood that the observed results were due to chance.

This experiment also addresses an issue that is relevant to agriculture today. With our increasing misuse of water resources and applications of fertilizers, salts accumulate in soils. This is called *salinization*. Many farmers find that their harvests decrease each year as salts build up in the soils. How much salt does it take before plants show effects? We will use varying concentrations of salt water to address this question.

In your Lab Notebook answer the pre-lab questions, record your data, analyze your data, and answer the conclusion questions.

Pre-Lab Questions

1. What is the independent variable in this experiment? Explain why.
2. What is the dependent variable in this experiment? Explain why.
3. Explain why statistics are important in scientific research.
4. Write a hypothesis about what effect you think saline solution (salt water) will have on the germination of radish seeds. (HINT: You may want to look at the procedure to get an idea of what you will be doing in the experiment prior to writing your hypothesis.)

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Materials

Zip-top bags or Petri dishes
Serial dilutions of salt concentrations
Graduated cylinders
Balances
Plastic spoons
Flasks or beakers
Radish, squash or wheat seeds
Permanent markers

Procedure

1. Gather materials, and label each bag or Petri dish with the lab group number and period.
2. Count five seeds per bag or Petri dish.
3. Place five seeds onto each paper towel, fold over the towels, place in each Petri dish or bag, and label. Repeat for 4 Petri dishes.
4. Pour 20 Ml of the salt solutions into one of the zip bags or Petri dishes.
5. Cover the Petri dish with a lid (or seal the bag) to avoid evaporation and label the concentration of salt used. Use the original concentrations for the labels.
6. Complete steps 4 and 5 until all amounts of salt are used.
7. Construct data tables in order to count the number of seeds that germinate for each salt concentration.
8. Check seeds daily for 4-5 days, recording data in the table.

Data Analysis (To be completed after all data is collected)

1. To understand your results you must compare T-test values. (We will do these tests together using excel.) If any comparisons between the control group and the saline groups have a value that is smaller than 0.05 it means that salinity affected germination. Describe the results of your T-tests. Which comparisons were significant (<0.05)? Which were not? Make sure to use real T-test values in your description.

2. Graph the germination results for your group and the average results for the class ON THE SAME GRAPH. Be sure to include/consider the following when constructing your graph.

- Descriptive Title
- Labeled Axes (DRY MIX)
- Key
- Appropriate Scale

3. Describe any overall trends you observe in your individual group data as well as the combined class data. Does your group follow the same trend as the class or are they different.

4. Error Analysis. Write a few sentences to address any problems your group encountered in completing the lab. Use the following questions to get you thinking about possible error in the procedure.

- Did you follow the procedure as it was meant to be done?
- What about other potential sources of error?
- Were the bags with the seeds in a controlled environment?
- Could some bags have experienced different temperatures than others?
- Could some have been exposed to contaminants more than others?
- Are there any other inadvertent variables that might have influenced your results?

Conclusion Questions

1. Was the purpose of the experiment fulfilled? Explain.
2. Was your hypothesis accurate? Why or why not?
3. Explain the purpose of the control group?
4. Explain how you could take this lab to the next level. What other dependent variables could you measure to determine the effect of saline solutions on radishes?
5. What other independent variables could you test using the radish lab protocol?