**LAB 8: Drought Stress (70 pts)**

INTRODUCTION

Water stress may arise through either an excess of water (e.g. flooding) or a water deficit (e.g. drought). When a plant is injured by stress, if the stress is moderate or short term the plant may recover if the stress is removed in time. Some plants are stress escapers. For example, in desert ecosystems, ephemeral plants germinate, grow, and flower very quickly following seasonal rains thus allowing them to complete their life cycle before the onset of the dry season, avoiding drought stress. Many other plants have the capacity to resist stress through either stress avoidance or stress tolerance. Stress avoidance mechanisms (e.g. developing deep roots to reach the water table in a desert environment) help a plant to survive by reducing the impact of a stress. Stress tolerance requires that a plant come to thermodynamic equilibrium with the stress. In other words, a plant's internal conditions are in equilibrium with the conditions outside of the plant. An extreme example is resurrection plants. The vegetative parts of these plants can undergo extreme dehydration without injury.

In this experiment, you will work in groups and study how plant growth is affected by low water potential. Students will impose a predetermined drought stress on their plants, using either corn (*Zea mays*), basil (*Ocimum basilicum*), or radish (*Raphanus raphanistrum*). At the end of three weeks, you will attempt to determine how and in what way drought affects plant growth. This will require time outside of lab!

Procedure:

1. Each team will be assigned three pots, each with 3-4 plants. For each set of plants there will be a control, a moderate, and a full drought. The plants were grown from seed under artificial light with a 10-12 hour light cycle. For the next three to four weeks, make biweekly measurements (in metric) of the plants' height and number of leaves. Average each treatment’s **leaf number** for each week. Be sure to record any plant characteristics or problems that may occur in the plants.
2. Each day the plants will be watered by your teammates or instructor. The amounts and how often will be determined during class depending on the decided drought [e.g. full saturating water (control); half saturating water (moderate drought); no water (full drought)].
3. Once the experiment is over, the plants will be carefully removed to analyze the root structures for each treatment in class. Count the number of roots and calculate the **final average for the number of leaves & number of roots** for each treatment. Be sure to **record** your observations.
4. Dry each plant and weigh (g) each plant to obtain the total plant fresh weight. Wrap the plants loosely in foil and place them in the drying oven for a few days. Then record the weight (g) for each plant to obtain the dry weight. Use this to calculate the **plant moisture content** for each plant per treatment: (fresh weight-dry weight)/dry weight.
5. Next separate the root portion for the shoot portion of each dried plant and weight per plant for each treatment. Use this to calculate the **root/shoot biomass ratio** for each plant per treatment. Plants with a higher proportion of roots can compete more effectively for soil nutrients, while those with a higher proportion of shoots can collect more light energy.
6. Remember leave the room cleaner than you found it! Also do not touch any plants besides your own! If there are any complaints from the researchers about cleanliness or damage to plants, **points will be taken off for everyone**!

**Results (30 pts): (must be typed)**

Record your measurements and observations each week in your lab notebook/Excel worksheet. Be clear and organized in your notebook/worksheet (redo it if you have to).

Using Excel, create the following figures, showing each treatment:

1. average leaf number & root number for the end of the experiment – column graph
2. average root/shoot ratio for biomass – column graph
3. average plant moisture content – column graph

Copy each graph into a Word document. **Under** each figure, provide a proper title. You will use your calculated standard error to create error bars for each of your column graphs. **Do not** use the program standard error bars. In case you have forgotten, it is calculated by: standard error = standard deviation / square root of total # of samples

Using Excel, perform an ANOVA to test for an effect of your treatment on plant moisture content and biomass ratio. You can copy and paste each ANOVA output table (round values and add a descriptive title **above** it). You will have three tables:

1) final leaf number ANOVA

2) plant moisture content ANOVA

3) root/shoot biomass ratio ANOVA

For both your figures and statistic tables, you must describe the pattern you see for each treatment in the figures and summarize the statistical results in words for each treatment (do **NOT** explain it).

**Discussion (40 pts): (must be typed)**

Write three or more paragraphs explaining your results and observations. Use your results to help explain your discussion. So for this lab, how did the different drought conditions affect each of your growth measurements (leaf number & root number) for each treatment? Why? How did the shoot/root biomass ratio and moisture content statistically compare with each treatment? Why? Was each measurement useful? Why or why not? What would’ve worked better? Be sure to explain **each**treatment as well as discuss the differences in root structure! Be sure to explain **each** treatment!

Include anything that may have gone wrong and how your experiment may be improved, explaining why your suggestion would improve the experiment. Make sure you **explain** your results as well as explain any unusual results/observations, what could have caused them, and how to correct in future studies. DO NOT RESTATE YOUR RESULTS!

**Submit** your results and discussion in a Word document or PDF and your Excel spreadsheet via D2L Dropbox **by 11:00 pm on Wednesday, December 1**. Please name your file **“LastName\_Drought”.** Your report needs to be typed in no greater than 12 size font and written in past tense. Make sure to put your name on the document. Points will be taken off for incorrect spelling and grammar or for not following instructions!