The Effect of Humidity on the Growth of the Tuberous Roots of Spiderettes (*Chlorophytum comosum*)

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Planting Science

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Abstract III

The question under study in the experiment conducted was how varying levels of relative humidity affects the growth of tuberous roots of spiderettes. We predicted increased humidity levels to have a positive influence on the growth of tuberous roots of spiderettes. In order to collect data to test our hypothesis, we placed twelve spiderettes in a plastic bag with no sponge, which constituted the control group, and twelve other spiderettes in a ziploc bag with a wet sponge soaked in 10 mL, which comprised the experiment group. The bags were labeled with a number from 1-12 and a “W” to indicate if there is a wet sponge inside the ziploc bags. The spiderettes grew off of four different adult spider plants, each in a plastic hanging pot, and received westward light exposure. After a period of three weeks, we used a Vernier humidity sensors and the Loggerpro software to collect data for the relative humidity levels of each of the twenty-four plastic bags. Moreover, we counted the number of roots on each spiderette and used a metric ruler to acquire measurements for the lengths of each individual root. Using a pruning shear, we cut off each spiderette from the adult spider plants and photographed them on a graph paper alongside of a metric ruler. After analyzing the data, we determined that the increased humidity caused by the wet sponges in the plastic bags did not make much of a difference on the number of roots and average root length of the spiderettes in comparison to the levels of humidity in the plastic bags with no sponge. However, we noticed that spiderettes that were not contained in a plastic bag had significantly less root growth than those that were, prompting further investigation.

Introduction IV

Our team decided to conduct this study principally due to a lack of Wisconsin Fast Plant seeds. Notwithstanding, an abundance of spider plants inside the school were readily available for experimentation. After a brief perusing of facts on the spider plants, we were fascinated by how the plant reproduced: the spider plant produces spiderettes which have tuberous roots, which in turn can be rooted in soil or water to grow into a new spider plant. Additionally, the plants have been noted to reduce indoor air pollution by removing airborne chemicals such as benzene, formaldehyde, carbon monoxide, and xylene. We hope that our results and findings will inspire similar experiments with other beneficial houseplants.

Spider plants (*Chlorophytum comosum*) are perennial herbs that can grow up to sixty centimeters high. For our experiment, we decided to use the variegated variant (Variegatum) of the plant, which is found more often than purely green spider plants. Usually during autumn or winter, spiderettes, also known as tubers because of their tuberous roots, may stem from mature spider plants. These spiderettes act as the offspring of spider plants and may be snipped off from the mother plant and rooted in soil or water. Ultimately, spider plants are easy to grow since they inherently have a high tolerance for a wide range of abiotic factors including temperature, lighting, and humidity.

The objective of our study was to determine the effect of humidity on the growth of tuberous roots on spiderettes. Initially, we planned to do this by only counting the number of roots for eachs spiderette, but our mentor stated, “Can you also think of any other measurements you can take? What about root color and total root length for the longest root. Maybe also the total length of the shortest root. You may be surprised to find that the humidity changes more than just root number” (Blahut 2017). Thus, we decided to focus on finding the total root length for each spiderette.

Based on prior knowledge, we know that increasing the amount of water a plant receives to an extent will have a positive effect on the plant’s growth. This is most likely because higher levels of relative humidity cause the rate of transpiration of plants to decrease (Polygon 1). Before conducting the experiment, we predicted that increasing the relative humidity will have a noticeable positive impact on the root growth of spiderettes. The plants, which are “native to tropical South Africa where they thrive in hot [and humid] conditions,” were expected to thrive in an environment mimicking this. (Grant 1).

We made several assumptions to conduct this experiment because of our limited resources, such as time and technology constraints, as well as factors that we could not control, like gas exchange or the way fellow students would interact with the plants. We knew that gas exchange could not be perfectly regulated because each plastic bag was not exactly sealed consistently around the stem. We assumed that the gas exchange would not have a significant impact on the results of our experiment,since there would be minimal difference between each spiderette. We also supposed that other students in our building would not tamper with our experiment since surveillance and not always available on the experiment site. Finally, we predicted that the pattern we noticed in the root growth over the three weeks would mostly hold over a longer period of time. This was done as we could the experiment had a time constraint attached to it, and thus the option to observe the plants for a longer duration was not available..

In essence, spider plants are peculiar in the attributes of its spiderette; the spiderettes is able to grow tuberous roots under proper conditions. Our group tested this characteristic of spider plants by experimenting the effect of relative humidity on the growth of tuberous roots. In this process, minute assumptions were made, though attempts were made to minimize variations in data.

Hypotheses V

Alternate Hypothesis:

Increased humidity will have a positive influence on the growth of the tuberous roots of spiderettes.

Null Hypothesis:

Increased humidity will not have a significant influence on the growth of the tuberous roots of spiderettes.

Methodology: Materials / Equipment / Facilities VI

Consumable Materials

- Tap water [10 mL initially per sponge, 270 mL total (1.5 mL per day) added during experiment]
- Natural light (all day western light exposure)
- 2 Sponges (cut into 12 pieces of 4 cm x 3 cm)
- 24 Wegmans brand "Click 'N Lock Zipper Top Sandwich Bags" (16.5 cm x 14.9 cm)
- 24 Spiderettes (connected to previously grown spider plants at HTHS)
- 1 sheet 8.5in x 11in (.25 inch per square) Graph Paper
- 12-inch diameter hanging plastic pots

Equipment

- 1 Westcott Acrylic Ruler
- 1 Barrel Pipette
- 1 Graduated Cylinder
- 1 iPhone Calculator
- 1 iPhone 6S Camera
- 1 Loggerpro software
- 1 MacBook Pro
- 1 Vernier "LabQuest Mini" Relative Humidity Sensor
- 1 "Softgrip Micro Tip" Pruning Snip
- Ticonderoga Number 2 Pencil(s)
- 1"Sharpie" Permanent Marker

Facilities

- Classroom 155 in HTHS in Lincroft, NJ
- Hallway (western light exposure)

<u>Methodology: Experimental Design Diagram VII</u>

Title: The Effect of Humidity on the Growth of the Tuberous Roots of Spiderettes (*Chlorophytum comosum*)

Hypotheses:

Alternate
Increased humidity will have a positive influence on the growth of the tuberous roots of spiderettes.

Null
Increased humidity will not have a significant influence on the growth of the tuberous roots of spiderettes.

Independent Variable: Relative Humidity Level (%)

Levels:	Regular Humidity (no sponge inside plastic bag)	Increased Humidity (wet 4 cm x 3 cm sponge inside plastic bag with 10 mL of water, +1.5 mL every day)
# trials:	12	12
Control?	control	

Dependent Variable: Growth of tuberous roots (increase in total root length)

Operational definition of dependent variable: increase in total root length of the tuberous roots of spiderettes= (final total length – initial total length)

length measured in centimeters

Constants:

Photoperiod (~10 hours light, 14 hours dark)

Temperature outside the bags (~73°F)

Size of plastic bag (16.5 cm x 14.9 cm)

Time given to grow (3 weeks)

Methodology: Experimental Setup, Graphics, Illustrations VIII

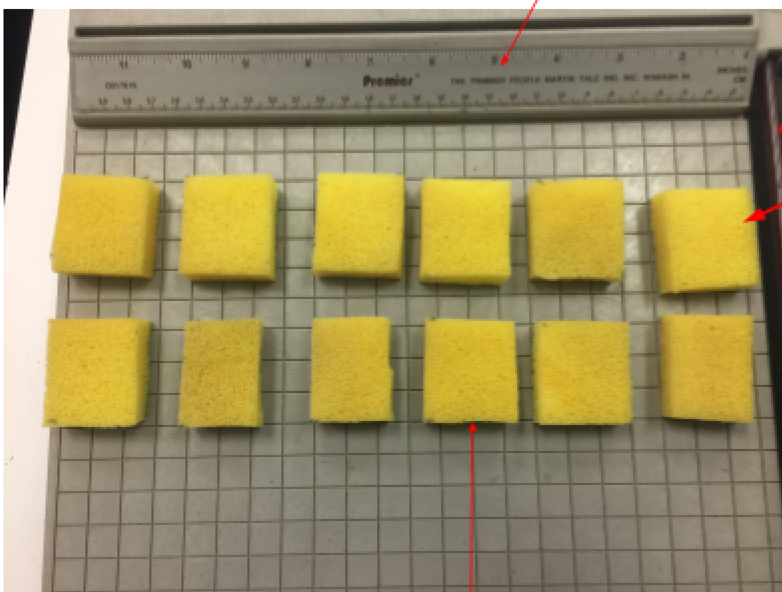

Figure 1: Sponges on Cutting Board

Figure 2: Single Spiderette in Plastic Bag

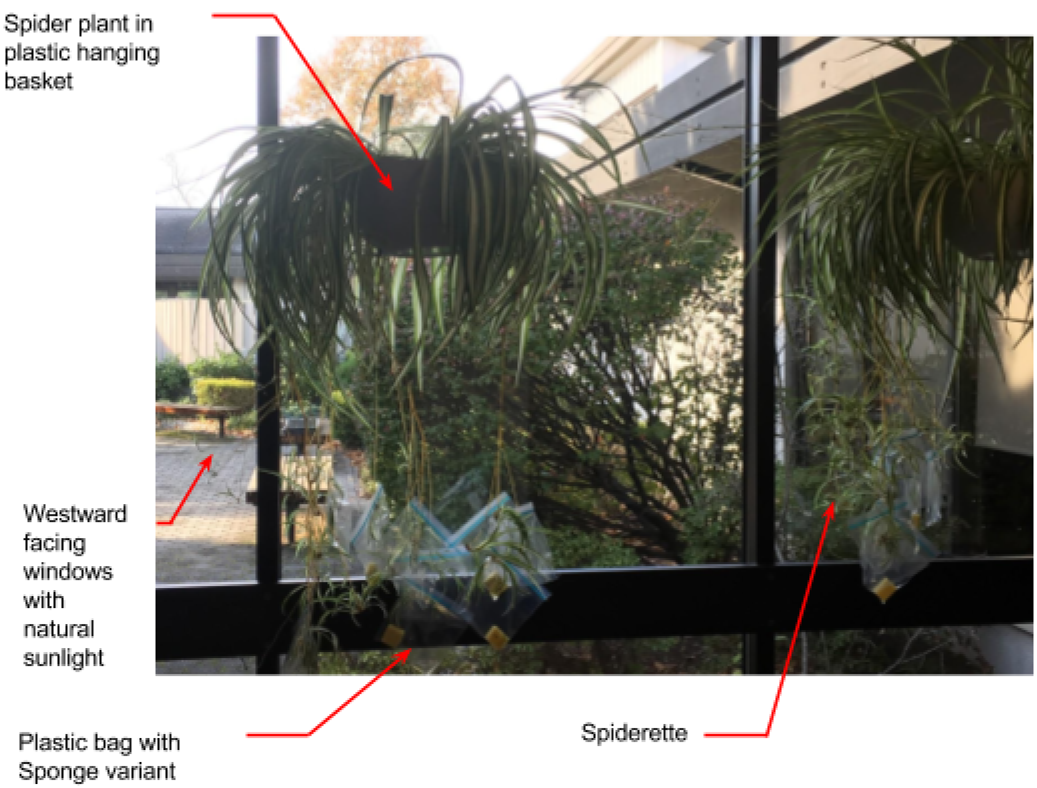

Figure 3: Several Spiderettes Hanging Near Window

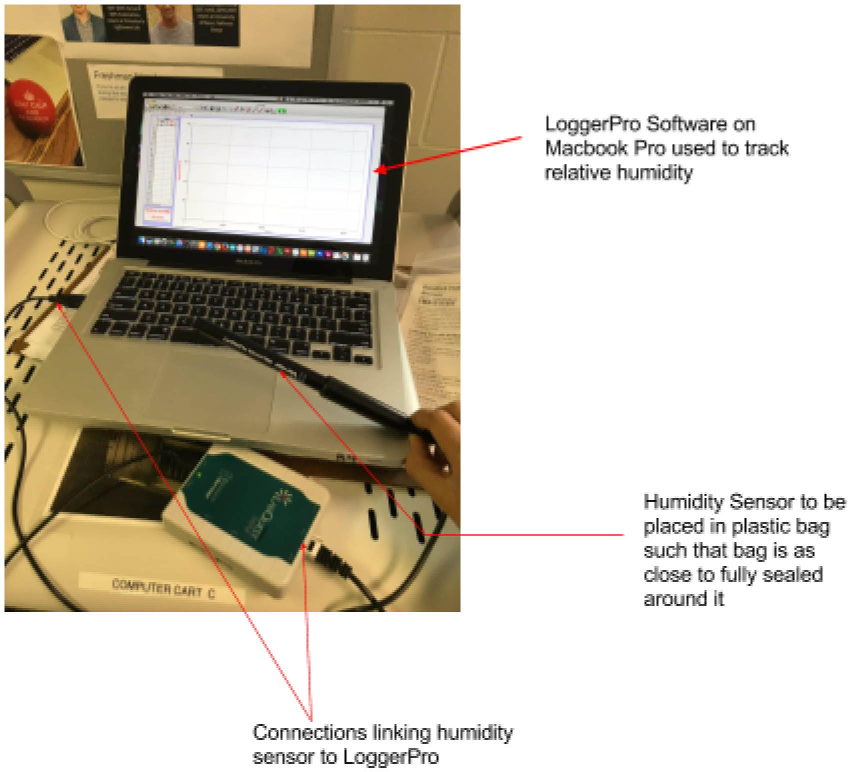

Figure 4: Humidity Sensor and LoggerPro Software

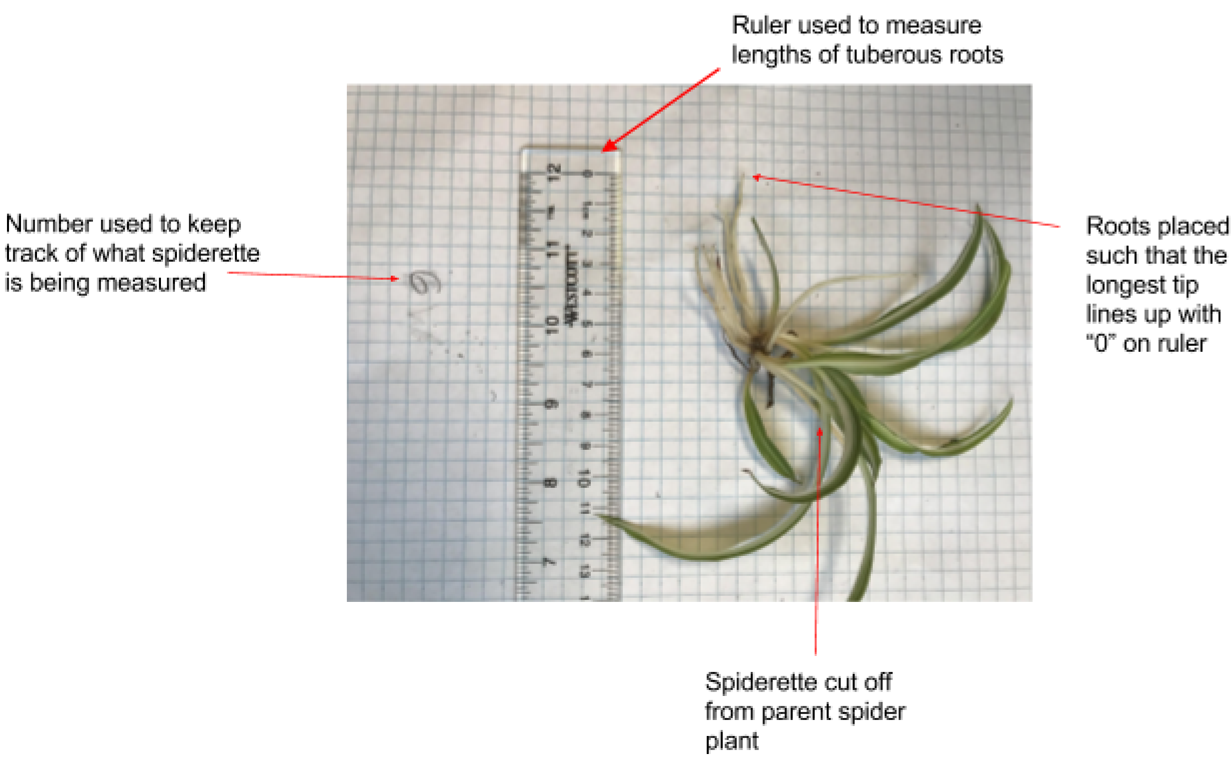

Figure 5: Spiderette Being Measured on Graph Paper

Methodology: Procedure IX

1. Procure all materials and appropriate equipment.
2. On the plastic bags, mark the plastic bags from 1-12 inclusive.
3. On the remaining plastic bags, mark the plastic bags 1W, 2W, …, 12W.
4. Mark all sponges into division of thirds along its longer side.
5. Mark all sponges into division of halves along its shorter side.
6. Using a paper cutter, excise the scour pad, the rough green, side of the sponge thoroughly.
7. Using a paper cutter, line up the sponge so that the blade will cut perpendicular to the previously marked division lines as to ensure equal size sponge pieces.
8. Fill up a beaker with 1 L of water.
9. Pour the water from the beaker into a graduated cylinder as to fill it up to the 10mL mark. Utilize barrel pipettes to increase accuracy.
10. Place a sponge into a bowl.
11. Pour the water from the graduated cylinder into the bowl.
12. Apply downwards pressure on the sponge as to contract it.
13. Release pressure from the sponge to return it to the normal state so that the sponge is able to soak up the water at a greater rate.
14. Repeat steps 12-13 until the sponge has soaked water to its maximum capacity
15. Dry the bowl with a paper towel
16. Open the bag marked 1W.
17. Place the sponge in the bag marked 1W.

18. Seal the bags.
19. Repeat steps 8-18, though starting with bag 2W and increasing in increments of 1 (eg. 3W, 4W, …, 12W).
20. Open the bag denoted as “1”.
21. Place a spiderette inside the bag so that the stem runs parallel along the edge of the plastic bag.
22. Seal the bag.
23. Repeat steps 18-20 with bags labeled 2-12.
24. Open the bag denoted as “1W”.
25. Place a spiderette inside the bag so that the stem runs parallel along the plastic bag and is not tangent to the sponge.
26. Seal the bag.
27. Repeat steps 22-24 with bags labeled 2W-12W.
28. Every 24 hours, open the bags labeled 1W-12W.
29. Using a barrel pipette, swiftly place 1.5mL of water directly onto each sponge as to minimize gas exchange between the bag and the environment.
30. Seal each bag.
31. After a period of fourteen days, measure the humidity within each plastic bag using the humidity sensor, with the humidity sensor running parallel along the edge of the bag as to ensure that the humidity sensor does not directly touch moisture and minimize gas exchange. Caution must be taken as to guarantee the sensor does not come in contact with excessive amounts of moisture.

32. Using pruning snip, shear the plastic bag off the plant by cutting immediately above the plastic bag.
33. Take each spiderette out of the plastic bags
34. Count the number of roots
35. Place the spiderette on a sheet of gridded paper
36. Measure the lengths of each root using a ruler
37. Place all spiderettes in a container of water to be used for re-planting.

Data: Tables / Graphs X

Table 1: Plant Relative Humidities Raw Data Table

Plant #	**With Sponge Relative Humidity (%)**	**Without Sponge Relative Humidity (%)**	**Difference (%)**
1	84.12	65.84	18.28
2	79.53	63.37	16.16
3	77.96	69.01	8.95
4	80.17	75.97	4.20
5	80.41	63.06	17.35
6	70.63	70.41	0.22
7	81.96	85.07	-3.11
8	71.15	60.23	10.92
9	78.55	65.40	13.15
10	80.53	71.20	9.33
11	79.31	64.43	14.88
12	82.31	69.67	12.64

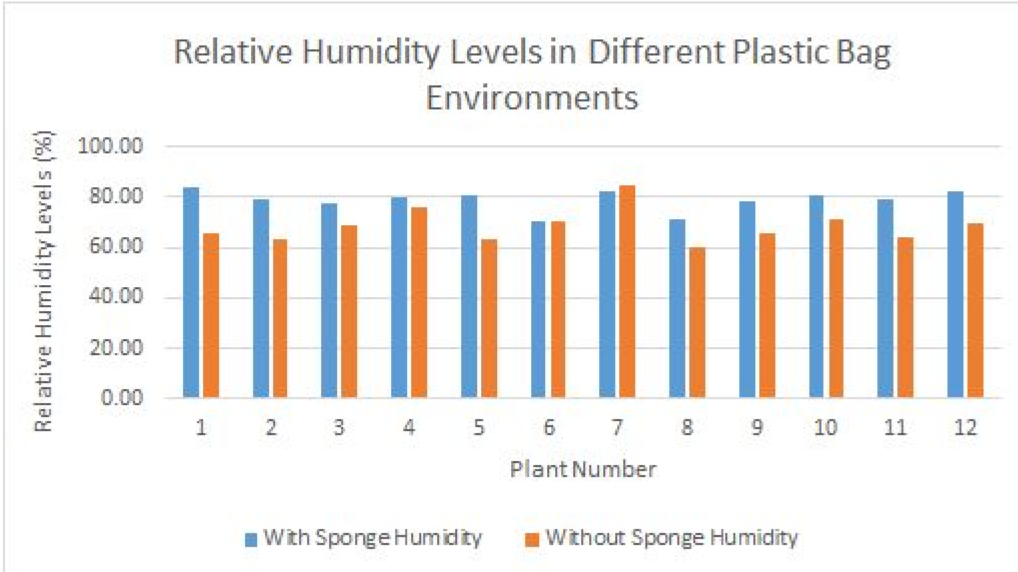

Figure 6: Relative Humidity Levels in Different Plastic Bags Environments

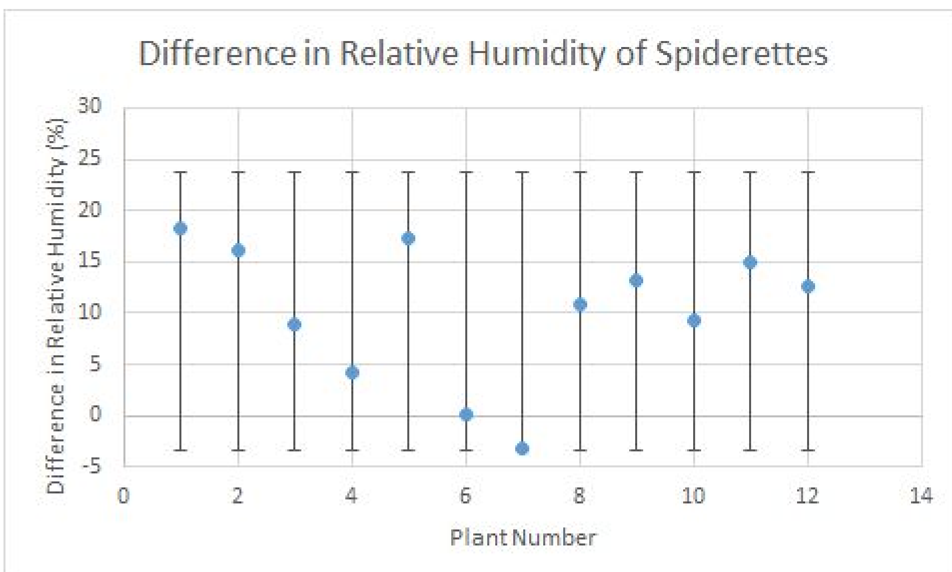

Figure 7: Difference in Relative Humidity of Spiderettes

Table 2: Summative Data Table of Difference in Plant Relative Humidity Levels (%)

Mean	10.248
Standard Deviation	6.769
Variance	45.823
n	12

Table 3: Raw Data Table of Number of Roots of Spiderettes in Different Plastic Bag Environments

Plant #	Plant With Sponge Number of Roots	Plant Without Sponge Number of Roots	Difference
1	9	10	-1
2	3	3	0
3	4	1	3
4	4	5	-1
5	2	3	-1
6	3	6	-3
7	2	5	-3
8	3	5	-2
9	5	10	-5
10	3	6	-3
11	18	11	7
12	6	3	3

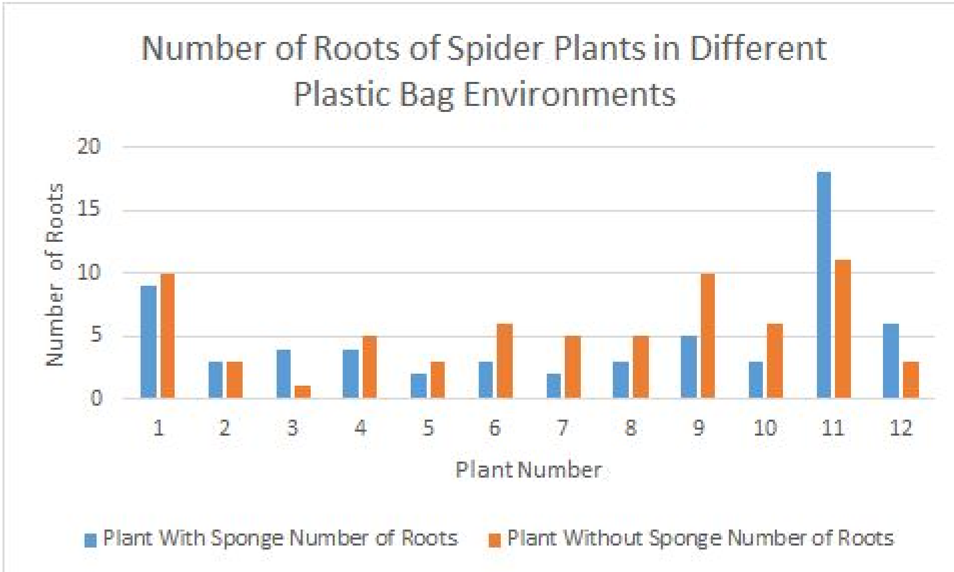

Figure 8: Number of Roots of Spider Plants in Different Plastic Bag Environments

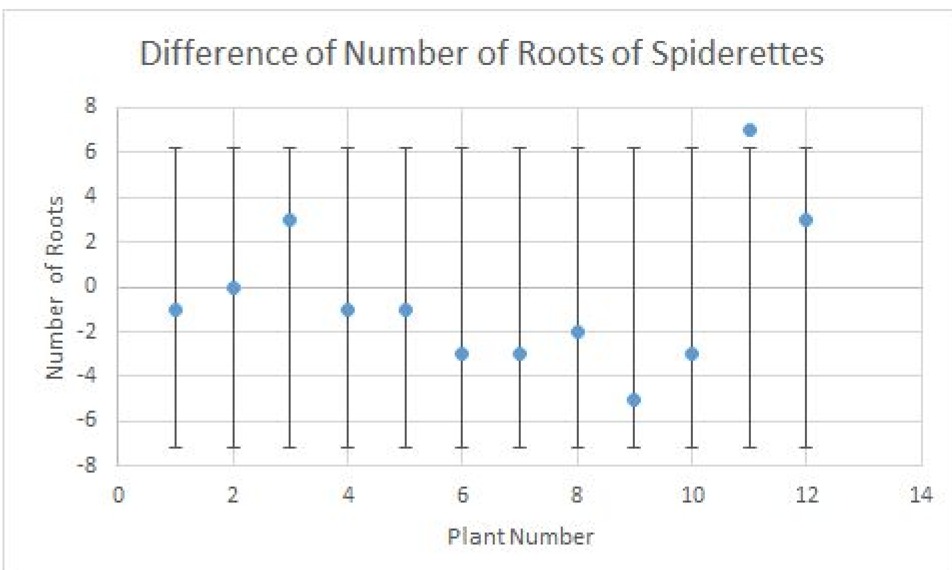

Figure 9: Difference of Number of Roots of Spiderettes

Table 4: Summative Data Table of Difference in Number of Roots of Spider Plants in Different Plastic Bag Environments

Mean	-0.500
Standard Deviation	3.344
Variance	11.182
n	12

Table 5: The Raw Data Table of Total Root Lengths of Spider Plants in Different Plastic Bag Environments (centimeters)

Plant #	Plant With Sponge Root Lengths Total (cm)	Plant Without Sponge Root Length Total (cm)	Difference (cm)
1	23.1	32.5	-9.4
2	6.0	16.7	-10.7
3	13.6	3.8	9.8
4	16.0	17.1	-1.1
5	10.3	10.8	-.5
6	7.5	26.8	-19.3
7	7.6	29.6	-22.0
8	6.4	7.5	-1.1
9	4.8	25.6	-20.8
10	13.7	18.5	-4.8
11	54.6	32.5	22.4
12	26.8	14.4	12.4

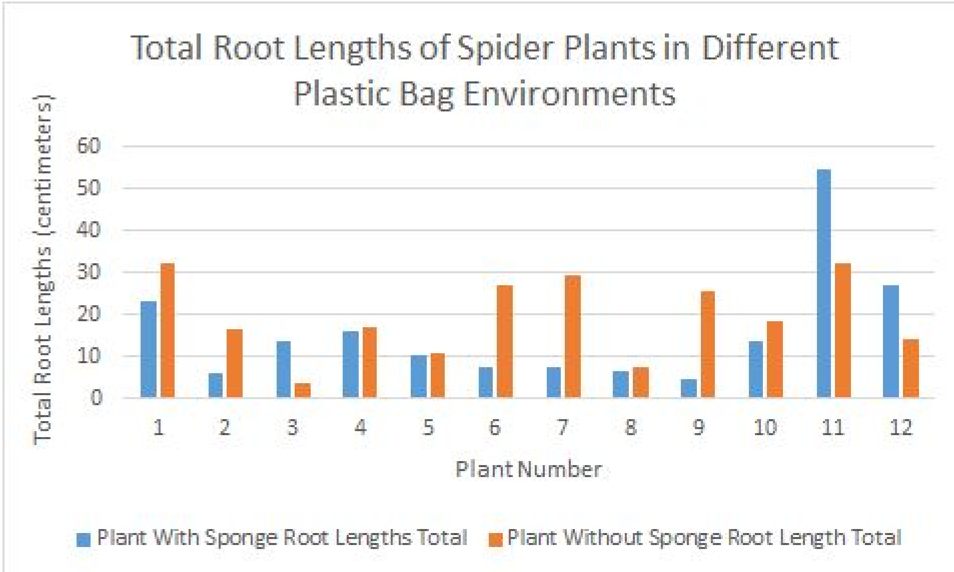

Figure 10: Total Root Lengths of Spider Plants in Different Plastic Bag Environments

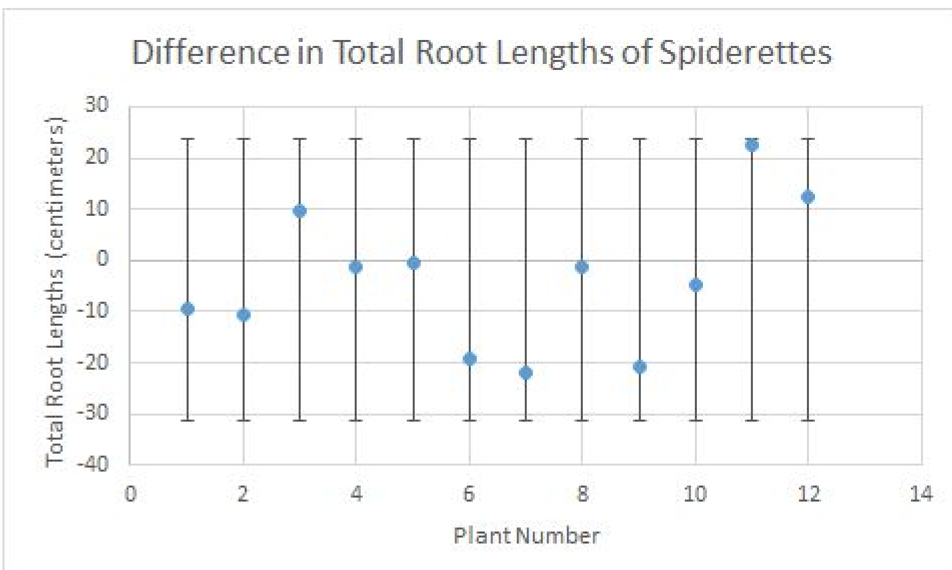

Figure 11: Difference in Total Root Lengths of Spiderettes

Table 6: The Summative Data Table of Total Root Lengths of Spider Plants in Different Plastic Bag Environments (centimeters)

Mean	-3.783
Standard Deviation	13.765
Variance	189.467
n	12

Table 7: Individual Root Lengths Raw Data

Plants #	Plant With Sponge Root Lengths	Plant Without Sponge Root Lengths
1	2.1, 2.5, 2.6, 2.7, 2.8, 3.0, 3.2, 3.5, 3.7	1.2, 2.2, 3.1, 3.1, 3.2, 3.2, 3.5, 3.9, 4.5, 4.6
2	1.8, 1.9, 2.3	4.7, 5.1, 6.9
3	1.5, 3.0, 4.3, 4.8,	3.8
4	2.7, 3.3, 5.0, 5.0	1.9, 2.3, 3.3, 4.5, 5.1
5	4.5, 5.8	3.1 3.2, 4.5
6	1.4, 1.5, 4.6	3.8, 3.9, 4.1, 4.3, 4.9, 5.8
7	4.2, 3.4	5.2, 5.8, 5.9, 6.1, 6.6
8	0.5, 2.7, 3.2	1.7, 1.6, 1.6, 1.7, 0.9
9	1.1, 0.7, 1.3, 0.9, 0.8	2.9, 3.1, 3.3, 3.4, 1.9, 2.9, 3.3, 0.8, 0.6, 3.4
10	4.2, 5.1, 4.4	4, 4.2, 3.3, 3, 2, 2
11	3.7, 3.1, 4.2, 3.1, 2.1, 2.7, 2.0, 2.6, 4.2, 3.3, 3.4, 1.7, 3.8, 4.1, 2.7, 2.8, 3.1, 2.0	4.2, 4.5, 3.4, 1.9, 3.5, 3.0, 2.9, 2.0, 2.6, 1.3, 3.2
12	5.6, 4.4, 3.3, 5.1, 4.5, 3.9	3.5, 5.8, 5.1

Table 8: Difference in Total Root Length Compared to Difference in Humidity

Plants #	Difference in Total Root Length (cm)	Difference in Humidity (%)	Difference in Root Length / Difference in Humidity (cm / %)
1	-9.4	18.28	-0.51
2	-10.7	16.16	-0.66
3	9.8	8.95	1.09
4	-1.1	4.20	-0.26
5	-0.5	17.35	-0.03
6	-19.3	0.22	-87.73
7	-22.0	-3.11	7.07
8	-1.1	10.92	-0.1
9	-20.8	13.15	-1.58
10	-4.8	9.33	-0.51
11	22.4	14.88	1.51
12	12.4	12.64	0.98

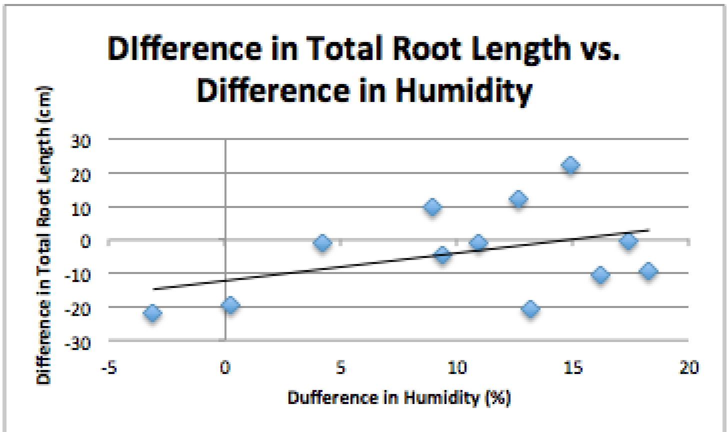

Figure 12: Difference in Total Root Length vs. Difference in Relative Humidity

Table 9: Summative Data Table for Difference in Root Length Compared to Difference in Humidity

Mean	-6.728
Standard Deviation	25.604
Variance	655.581
n	12

Table 10: Difference in Number of Roots Compared to Difference in Humidity

Plants #	Difference in Number of Roots	Difference in Humidity (%)	Difference in Number of Roots / Difference in Humidity (# / %)
1	-1	18.28	-0.05
2	0	16.16	0
3	3	8.95	0.34
4	-1	4.20	-0.24
5	-1	17.35	-0.06
6	-3	0.22	-13.64
7	-3	-3.11	0.97
8	-2	10.92	-0.18
9	-5	13.15	-0.38
10	-3	9.33	-0.32
11	7	14.88	0.47
12	3	12.64	0.24

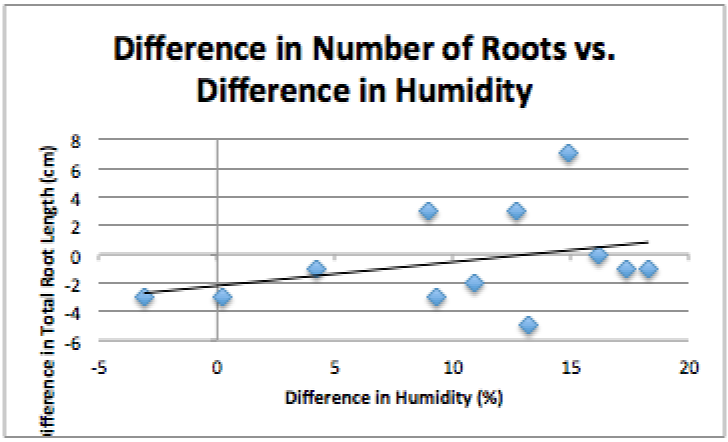

Figure 13: Difference in Number of Roots Compared to Difference in Relative Humidity

Table 11: Summative Data Table for Difference in Number of Roots Compared to Difference in Humidity

Mean	-1.071
Standard Deviation	3.977
Variance	15.815
n	12

Findings: Discussion of Research Results XIII

After a period of three weeks, we observed that the inclusion of a sponge in the plastic bag that contains a spiderette had no significant effect on the growth of spiderettes when compared to their counterparts that lacked a sponge. Despite this, further observations concerning spiderettes lacking any plastic bags were made: the majority of the plastic bag lacking spiderettes displayed minimal growth. This has led our group to speculate that the presence of a plastic bag itself may have a positive effect and stimulate the growth of spiderettes. Primarily, the bag was able to restrict loss of humidity. We noticed condensation forming around the inside of the bags, regardless of whether the sponge was present, as a result of transpiration.

Due to the nature of the method we used to obtain relative humidity sensor readings, the information collection phase of our experiment was not completely consistent since the humidity sensor required us to open the plastic; therefore, there exists the possibility of small variations of data due to operation error stemming from gas exchange between the plastic bag and the environment. Furthermore, the experiment site was located in a hallway that is frequently used in our school, and the plants may have been tampered without our knowledge.

Originally, our team hypothesized that increased relative humidity levels would have a positive effect on the growth of spiderettes. This hypothesis was negated by the experiment since the presence of a sponge had no significant effect on the growth of spiderette roots. Moreover, increased humidity may have had a negative effect on tuberous root growth; the spiderettes in the plastic bag without increased humidity had, on average, 3.783 cm more growth of total root length than the spiderettes with increased humidity. The number of roots was also greater in the spiderettes without increased humidity by an average of 0.5 compared to the increased humidity spiderettes. The reason for the increased root growth in the spiderettes without increased humidity is unclear, but it may be that the humidity was too high for growth in the increased humidity conditions, which was detrimental to the plant.

We graphed the data collected from the relative humidity sensor and compared them to the tuberous roots, as shown in figures 12 and 13. We measured the difference in relative humidity levels by subtracting the relative humidity of the plastic bag without the sponge from the relative humidity of the plastic bag with the sponge, in order to ascertain the effect of humidity on the growth of tuberous roots. The respective line graphs show similar patterns: at relative humidity difference around 15%, the conditions are optimal for the growth of tuberous roots, and at 13%, the conditions are detrimental to the growth of tuberous roots. Furthermore, there is an increase in the growth of tuberous roots of difference in relative humidity levels from -3 to 8%, and a decline after 15%. This suggests that the tuberous roots are sensitive to temperature, and there is a specific zone of as shown in the difference of humidity in 15%, whereupon the tuberous roots grow the best at. Also, the trendline in both graphs indicate that growth is slightly increasing as the difference in relative humidity is increasing, though this may be attributed to sample size.

The data was also very inconsistent, which would suggest that there was error in procedure whilst conducting the experiment or because of factors we could not control. Although the graph had a positive trendline, the data was very sporadic; it rises sharply and falls with no noticeable pattern. The standard deviation and variance were also very high when comparing humidity levels to number of roots and total root growth, which suggests a high margin of error and low confidence

Overall, the results of our experiment show no direct correlation between humidity and tuberous root growth. This could have been due to human error, a small sample size, or uncontrollable factors. Our experiment is inconclusive, and would need to be refined and done under more controlled conditions to effectively show a connection between humidity and tuberous root growth.

Suggestions for Further Study IXV

Preeminently, the largest problems with our experiment was the limited amount of time and the relatively small sample size. The results do not hold much value because the experiment only lasted three weeks with twenty four plants. A longer experiment could determine the impact humidity truly holds on tuberous root growth. An experiment could also be conducted in more controlled conditions where gas exchange, human interaction, and human error would not be significant factors.

One observation we noted over the course of the experiment was the significant difference between the root growth of all of the plants inside the plastic bags compared to the spiderettes that were not involved in our experiment and were hanging naturally. The spiderettes that were grown naturally had effectively negligible growth, if any, while all plants involved in our experiment had a significant amount of root growth. In a future experiment, the significance of the plastic bag environment, or the container of the plant, could be determined.

Works Cited XV

Blahut, Johnathon. "Online Discussion with Mentor." *Planting Science* 10 Oct. 2017.

Often, we would correspond on our planning and procedure and receive feedback for it from our mentor, Johnathon Blahut. Instances of this included a conversation regarding possible dependent variables for our experiment. He commented that in addition to root number, we could take other measurements such as root color, total root length for the longest root, and total length of the shortest root. We decided to heed his advice and record all the roots lengths for each spiderette, then calculate the total root length of each spiderette.

Grant, Bonnie L. "My Spider Plant Has Tubers – Explanation For Thick Spider Plant Roots." *Gardening Know How*, 12 May 2016, www.gardeningknowhow.com/houseplants/spider-plant/spider-plant-swollen-roots.htm.

Spider plants have thick tuberous roots along with a tangled root mass and are well adapted to hot conditions. The plant will thrive if its tubers and roots are healthy. Spiderettes can be cut off from the mother plant and rooted in soil or water, and thick roots will form quickly.

“How Humidity Affects the Growth of Plants.” *Polygon*, www.polygongroup.com/en-US/blog/how-humidity-affects-the-growth-of-plants/.

According to this source, relative humidity compares the water vapor in the air to the maximum capacity of how much water vapor the air can hold. There is a certain level of relative humidity that is optimal for water circulation in the plant. However, excess amounts of relative humidity could cause the plant to rot.

“How to Care For Spider Plants (Chlorophytum Comosum).” *Epic Gardening*, 22 Oct. 2017, www.epicgardening.com/spider-plant

According to this source, during the summer, spider plantlets start to propagate off adult spider plants. These spider plantlets receive water through the stems which are connected to the adult spider plants. In our experiment, spider plantlets were able to get their nutrients from the mature plants so that they survive during the three week period.

Ray, Kim. "Growing and Caring for Spider Plants." Growing and Caring for Spider Plants DoItYourself.com, DoItYourself.com, 14 Sept. 2011, www.doityourself.com/stry/spiderplants.

This source explains how their is an optimal range of humidity that plantlets grow the best in; however, it is very susceptible to rotting if the humidity levels are too high. This might explain why the root growth for the plantlets exposed to higher humidity levels did not have better root growth than the control.