



Significant Growth of Spinach Leaf Length with Ethylene Gas Supplementation

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Introduction

- Researchers recognized the natural production of ethylene gas, C_2H_4 .**¹ Ethylene gas has influenced the physiological properties of plants.¹ Chemical evidence has been reported on how ethylene gas is produced by plants.¹ Ethylene gas has been discovered to be a natural growth stress hormone.² In experiments that test the effects of different types of gases on plants, it is shown that plant growth is caused from ethylene gas.⁴
- Ethylene gas is ecologically relevant because of stimulating plant maturation within the farming industry.**⁵ Faster plant growth is a necessity in growing populations.⁵ Natural plant maturation in a more ecosystem-friendly way.⁵ Ethylene gas could serve as a better alternative compared to fertilizers.^{6,7} Fertilizers negatively affect the soil microbial biomass and community composition over time.⁸ Our motivation stems from the possibility of ethylene gas becoming a novel method of maturing plants in the agricultural industry.
- Research Question:** How does ethylene gas from apples impact the growth of crop plants?
- Hypothesis:** If crops are exposed to ethylene gas, then they will grow faster than crops without exposure because ethylene gas promotes plant maturation.

Methods

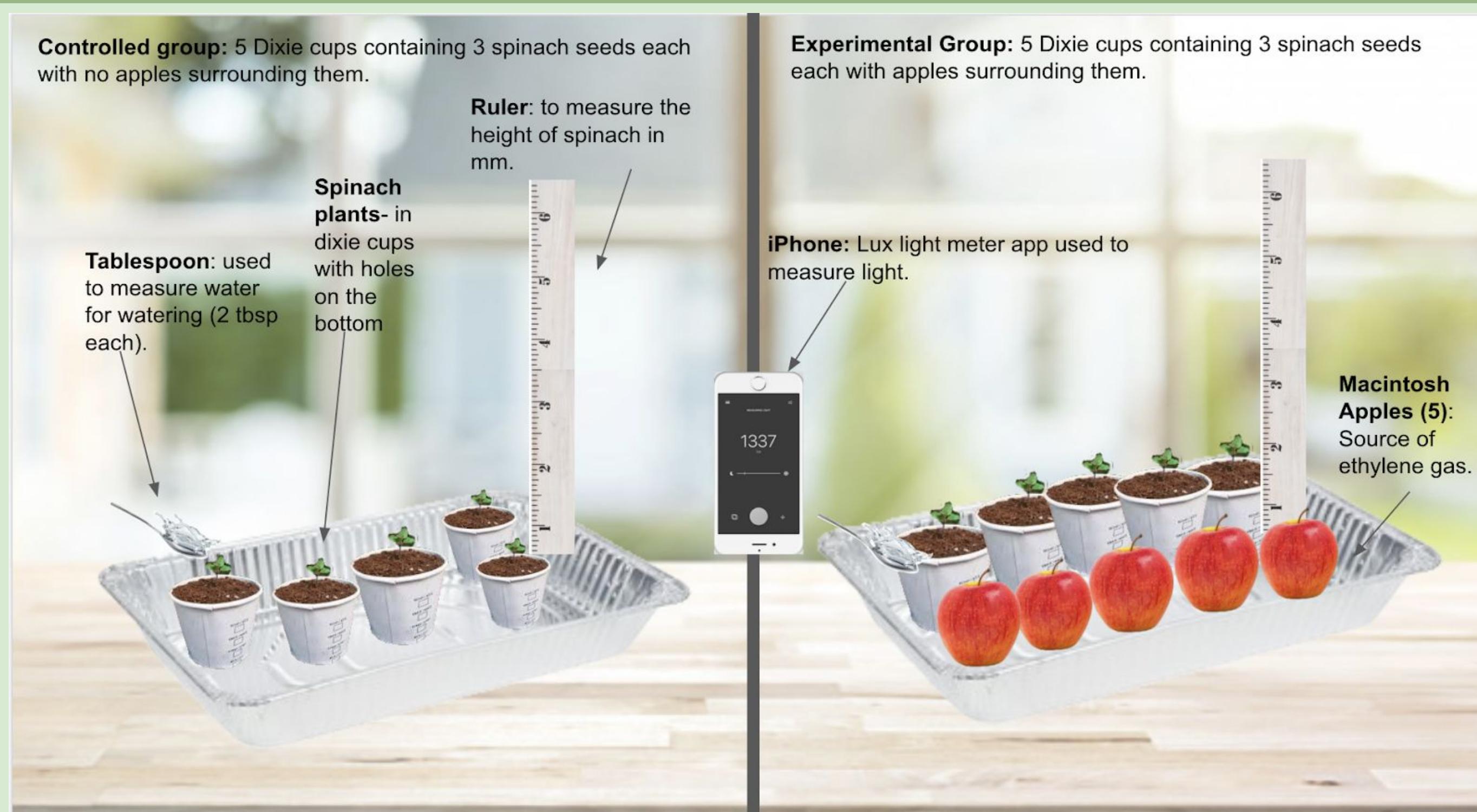


Figure 1. Data collection methods for each group. The ruler and iPhone Lux application were the tools used to measure data every 3 days. 1 tray included the experimental group and 1 tray included the control group that were in different rooms facing sunlight near a window. Data was collected for 18 days, and each time data was collected, pictures of the growth progress were taken for the spinach crops which were then uploaded to ImageJ. The software of ImageJ was used to measure the height, length, and width of each spinach leaf (in mm) in each cup from their corresponding tray. The average was calculated for each variable, and T-Tests were conducted to see if there was a significant difference between the experimental group and controlled group.

Results



Figure 2. This shows the plant growth at the final day of data-collection for the control group.

Figure 3. This shows the plant growth at the final day of data-collection for the experimental group.

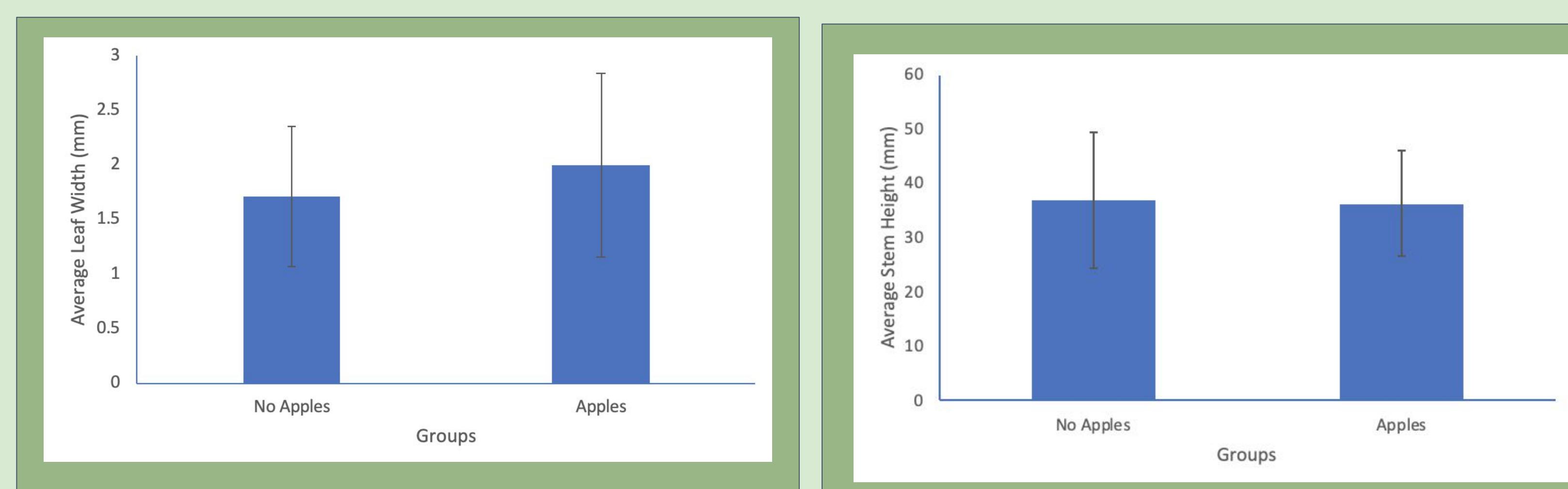


Figure 4. Mean of means of leaf width in spinach seeds surrounded by apples or no apples. The data was collected for the T-test via finding the averages and standard deviation of both the tallest spinach plant per each of the 5 cups in the apples group and the no apples group. Utilizing a t-test provided a p-value of >0.05 and a t-statistic of 0.095, showing that there is no significance between the leaf widths of the apple and no apple group. The error bars are included to visualize variation around the mean.

Figure 5. Mean of means of stem height in spinach seeds surrounded by apples or no apples. The data was collected for the T-test via finding the averages and standard deviation of both the tallest spinach plant per each of the 5 cups in the apples group and the no apples group. Utilizing a t-test provided a p-value of >0.05 and a t-statistic of 0.95, showing that there is no significance between the stem height of the apple and no apple group. The error bars are included to visualize variation around the mean.

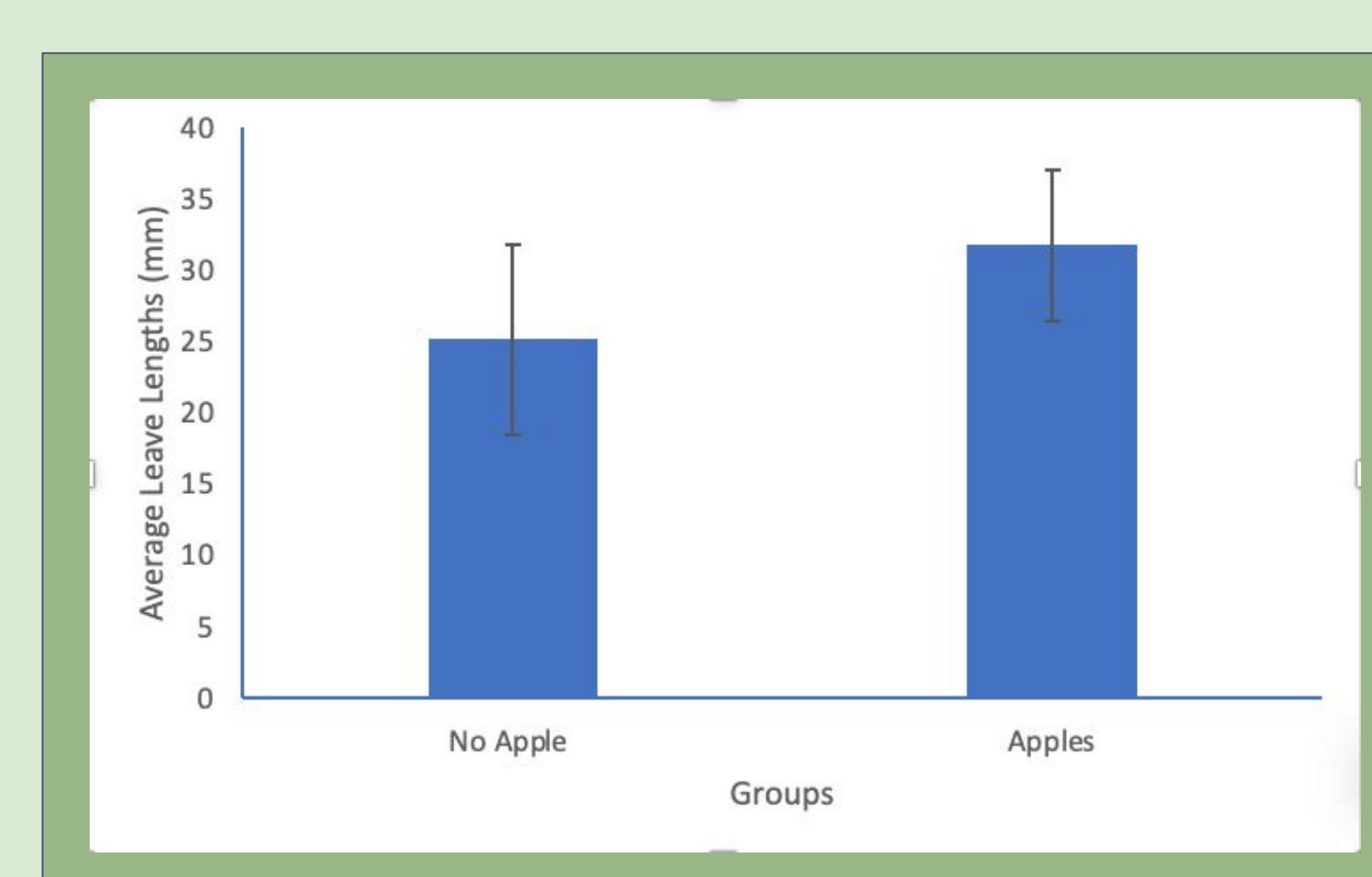


Figure 6. Mean of means of leaf length in spinach seeds surrounded by apples or no apples. The data was collected for the T-test via finding the averages and standard deviation of both the tallest spinach plant per each of the 5 cups in the apples group and the no apples group. Utilizing a t-test provided a p-value of <0.05 and a t-statistic of 2.70, showing that there is significance between the leaf lengths of the apple and no apple group. The error bars are included to visualize variation around the mean.

Discussion

Interpretation

- There was a significant difference in leaf length between the ethylene group and the no ethylene group (p -value=0.00647).
- There was no significant difference in the leaf width or stem height between the ethylene and no ethylene group. (p -value >.05 for both)
- It was our interpretation that the ethylene gas only positively impacted leaf length; in the context of the experiment.
- Beneficial to the agricultural industry by producing more product in a more efficient manner in order to benefit from supply of crop.¹

Future Research Questions

- Future work on the role of ethylene gas in crop plants involving monitoring cell cycle phases and rate of replication of mitotic cells as well as gene expression rates of crop plants exposed to ethylene gas.⁵
- Exploring how ethylene gas reacts with native crops plants to offset GMO crop plant dependency on toxic fertilizers.⁶
- Explore the ethylene gas potential epigenetic influence on gene expression in regards to the methylation and acetylation of the specific genome sequences (exons) that code for traits beneficial to produce fit crop plants such as longer leaves, longer stems, etc. ⁷. Explore effect on metabolic rates, strength, production genetic material.⁷

Take Home Message

To support the farming industry, ethylene gas is a novel method for growing crops that could be implemented in agriculture practices.

References

- Arshad, M., & Frankenberger Jr, W. T. (2012). *Ethylene: agricultural sources and applications*. Springer Science & Business Media.
- Dubois, M., Van den Broeck, L., & Inzé, D. (2018). The pivotal role of ethylene in plant growth. *Trends in Plant Science*, 23(4), 311-323.
- Geisseler, D., & Scow, K. M. (2014). Long-term effects of mineral fertilizers on soil microorganisms—A review. *Soil Biology and Biochemistry*, 75, 54-63.
- Dhall, R. K., & Singh, P. (2013). Effect of ethephon and ethylene gas on ripening and quality of tomato (*Solanum lycopersicum* L.) during cold storage. *Journal of Nutrition & Food Sciences*, 3(6), 1.
- Li, S., Chen, K., & Grierson, D. (2019). A critical evaluation of the role of ethylene and MADS transcription factors in the network controlling fleshy fruit ripening. *New Phytologist*, 221(4), 1724-1741.
- Corbinaud, F., Xia, Q., Bailly, C., & El-Maaroof-Bouteau, H. (2014). Ethylene, a key factor in the regulation of seed dormancy. *Frontiers in plant Science*, 5, 539.
- Burg, S. P., & Burg, E. A. (1962). Role of ethylene in fruit ripening. *Plant Physiology*, 37(2), 179.
- Iqbal, N., Khan, N. A., Ferrante, A., Trivellini, A., Francini, A., & Khan, M. (2017). Ethylene Role in Plant Growth, Development and Senescence: Interaction with Other Phytohormones. *Frontiers in plant science*, 8, 475.