Measuring the Effects of Added Calcium on Lettuce Plants

Ashlee Kitzhoffer
Northampton Area High School
9th Grade

Rationale

The project that I chose is “Measuring the Effects of Added Calcium on Lettuce Plants.” A key goal of mine is to understand the reason why certain minerals such as calcium effects the plants. Having an understanding of this is a key to a successful growth of healthy lettuce plants for farmers and agriculturalists.

Research Questions

My investigation examines, “How does added calcium to potting soil affect the growth rate, plant height, and overall cellular health on romaine lettuce, *Lactuca sativa?*”

Hypothesis

If adding calcium to potting soil affects the height, growth rate, and cellular health of plants, then *L. sativa* grown in soil with added calcium will have a higher average height, faster growth rate, and healthier cellular structure than those *L. sativa* plants that are grown in potting soil without added calcium.

Background

Plants need materials for photosynthesis, which is the process of making food for growth and energy:

$$6CO_2 \text{ (from air)} + 6H_2O + \text{sunlight} \rightarrow C_6H_{12}O_6 + 6O_2$$

These necessities for growth will be in constant supply throughout the experiment, as stated in the procedures.

Plants also need nutrients like calcium, nitrogen, phosphates, potassium, and other trace minerals, which are normally in the soil.

Background Extended

Calcium is represented in biochemistry using the notation Ca^{2+}. This symbolizes a positive divalent cation with having two positive electrons.

Ca^{2+} is involved in nearly all aspects of plant development and regulatory processes.

Ca^{2+} is considered a messenger molecule and plays a role in responses to abiotic factors and other pathogens.

The root system is the assonance of the calcium and moves it through the plants by the xylem.

Background Extended

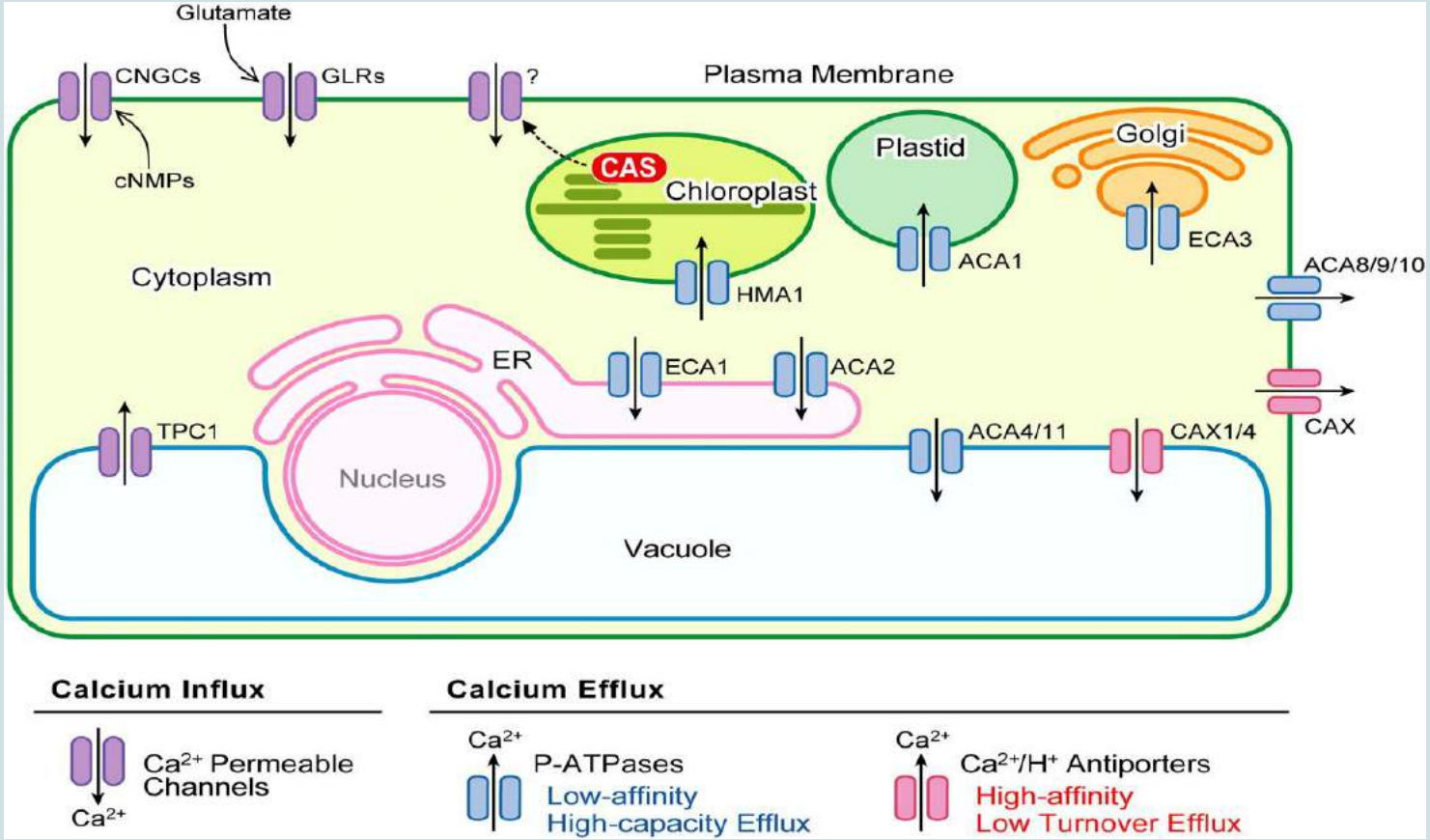
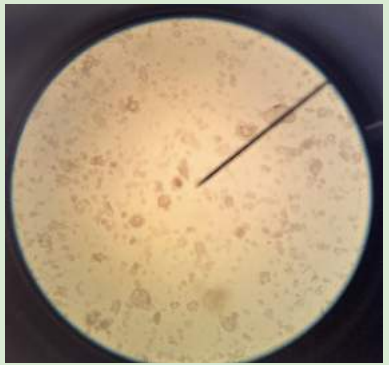


Figure 1: Calcium (Ca^{2+}) Transport System

Background Extended

Farmers and gardeners commonly add calcium to the soil in the form of lime and gypsum additives. Since lime raises the pH you can track the addition of calcium by measuring the pH.

pH measures the concentration of hydrogen ion in solution in water and in soil. Plants exhibit a healthy growth in neutral soils around a pH of 7.



Variables

Independent Variable- Amount of Calcium

Dependent Variable- Plant Height, Growth Rate and Cellular Health

Constants- Fish tanks, Light source, Temperature, Amount of water, Source of water, Measurement probe, Soil type, Duration of light/darkness, Brand and species of seed

Procedures

1. Gather materials.
   - Growth bulb and Stand (Brand- Sylvania Spot-Gro; 50 watts) (2)
   - 20.8 L fish tank (Brand-Top Fin) (2)
   - Romaine Lettuce Seeds *(Lactuca sativa*) (Brand- Burpee)
   - A metric ruler to measure height
   - Thermometer (2)
   - Rapid Lime Organic pH Balancer
   - Miracle Grow Potting Soil
   - Soil probe (Testing: Soil pH, Moisture, and Light)
   - Microscope (Total Magnification 40x, 100x and 400x)
   - Glass Slide
   - Cover Slip
   - Distilled Water
   - 25 mL Measuring Spoon
   - On/Off Timer

Procedures Continued

2. Fill fish tanks with soil leaving 1.25 centimeters space at the top.

3. Attach a growth bulb to the top of each stand approximately 30 cm above tank for growth of lettuce.

4. Set growth on/off timer to 16 hours on/8 hours off.

5. 127.2 grams of Rapid Lime Organic pH Balancer was divided equally among the plants in the experimental tank.

6. 2.5 cm deep holes were created in the soil for seed placement.

7. Water daily with 25 mL distilled water per plant.

Procedures Continued

8. Make daily observations and record the following everyday at the same time:
   - Plant Height
   - Soil pH
   - Moisture
   - Light
   - Temperature

9. Prepare wet mount slides on Day 45.

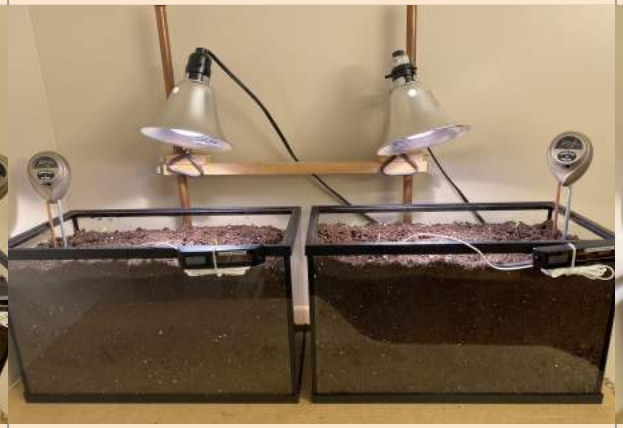
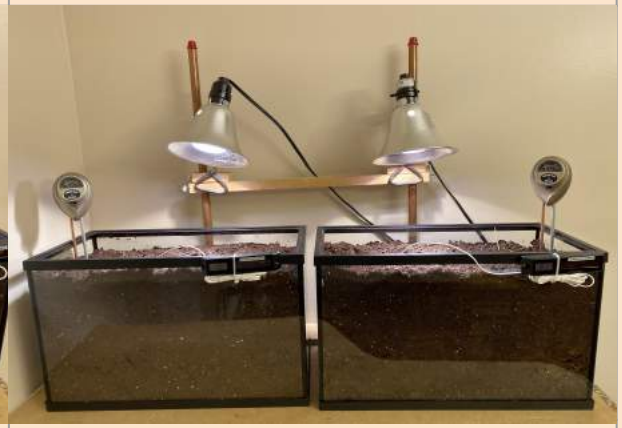
10. Observe and photograph slides under microscope on power 100x and 400x.

Soil Probe Measurements

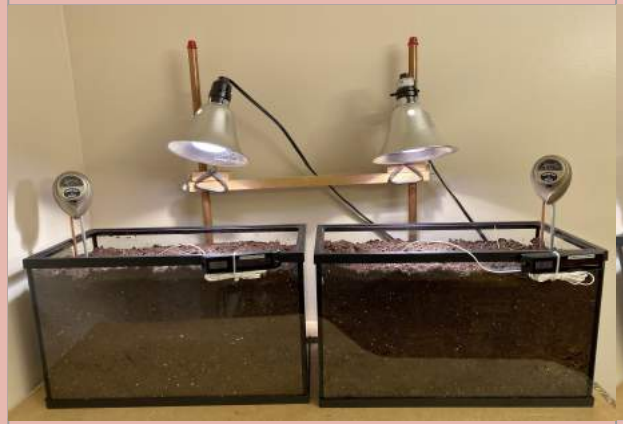
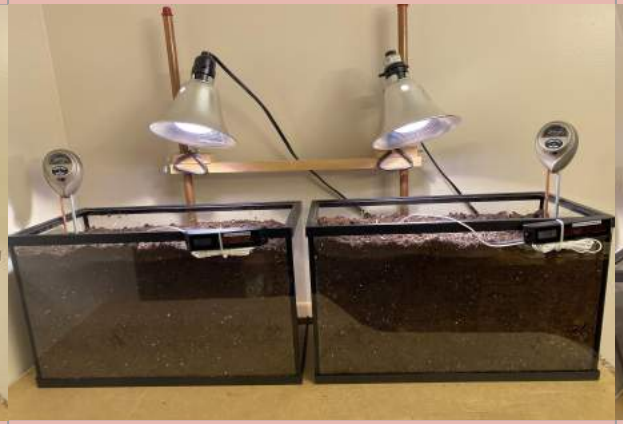
	Soil pH	Moisture (1-10)	Temp. on Top Soil	Light Intensity
Indep. Variable (Added Calcium)	7.8	6	23°C	1000 lux
Control (No Added Calcium)	6.9	6	23°C	1000 lux

The measurements remained stable with little fluctuation through the experiment.

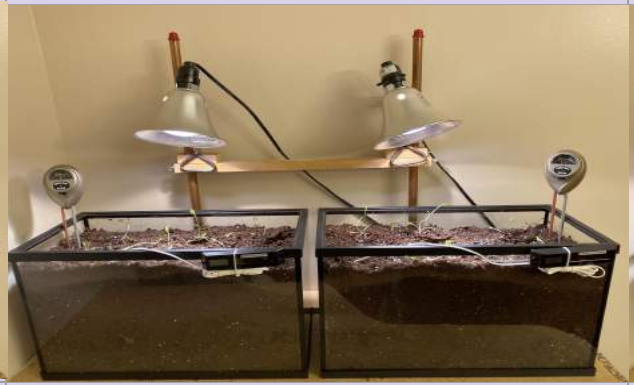
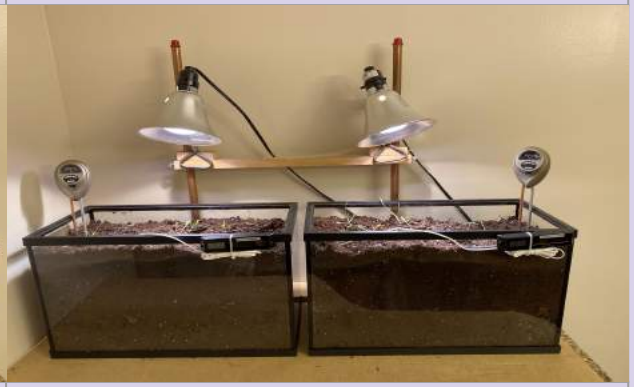
Data Set 1: Days 1-9

Day 1	Day 6	Day 9
		
Average Plant Height (Added Calcium): 0 cm **Average Plant Height (No Calcium):** 0 cm	**Average Plant Height (Added Calcium):** 1.6 cm **Average Plant Height (No Calcium):** 0.7 cm	**Average Plant Height (Added Calcium):** 2.1 cm **Average Plant Height (No Calcium):** 1.2 cm

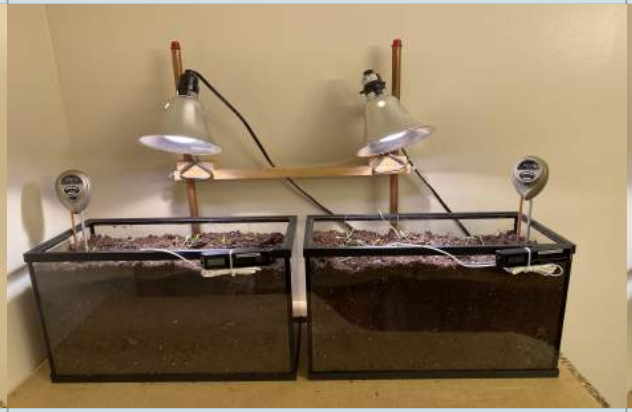
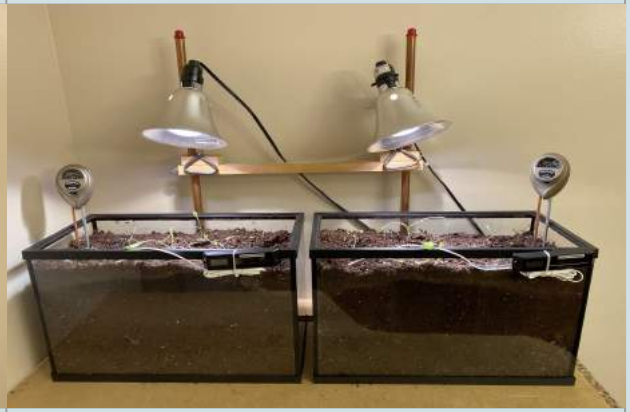
Data Set 1: Days 12-18

Day 12	Day 15	Day 18
		
Average Plant Height (Added Calcium): 2.9 cm **Average Plant Height (No Calcium):** 1.9 cm	**Average Plant Height (Added Calcium):** 3.4 cm **Average Plant Height (No Calcium):** 2.3 cm	**Average Plant Height (Added Calcium):** 4.1 cm **Average Plant Height (No Calcium):** 2.7 cm

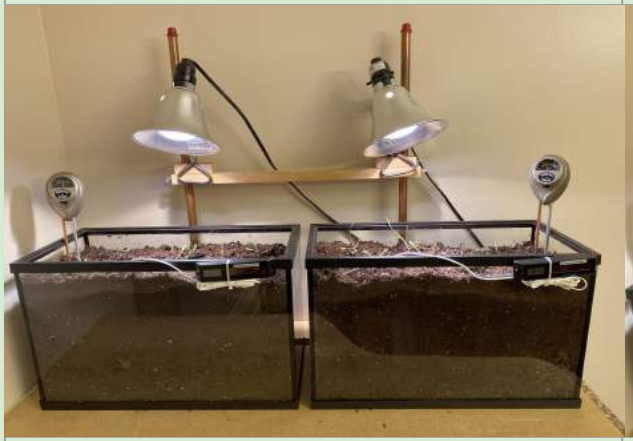
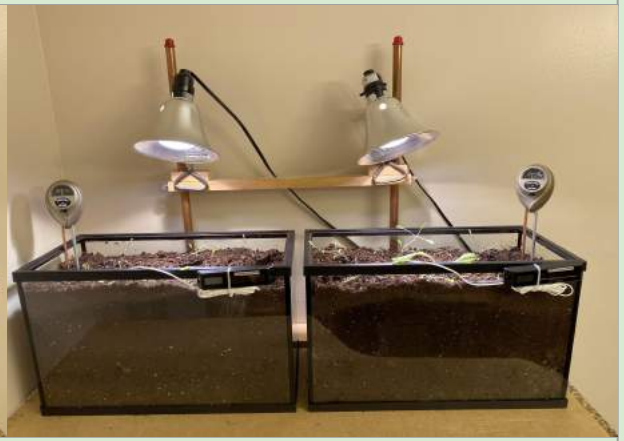
Data Set 1: Days 21-27

Day 21	Day 24	Day 27
		
Average Plant Height (Added Calcium): 4.8 cm **Average Plant Height (No Calcium):** 3.4 cm	**Average Plant Height (Added Calcium):** 5.5 cm **Average Plant Height (No Calcium):** 3.8 cm	**Average Plant Height (Added Calcium):** 6.1 cm **Average Plant Height (No Calcium):** 4.5 cm

Data Set 1: Days 30-36

Day 30	Day 33	Day 36
		
Average Plant Height (Added Calcium): 7 cm **Average Plant Height (No Calcium):** 5.2 cm	**Average Plant Height (Added Calcium):** 7.7 cm **Average Plant Height (No Calcium):** 5.7 cm	**Average Plant Height (Added Calcium):** 8.2 cm **Average Plant Height (No Calcium):** 6.1 cm

Data Set 1: Days 39-45

Day 39	Day 42	Day 45
		
Average Plant Height (Added Calcium): 8.8 cm **Average Plant Height (No Calcium):** 6.9 cm	**Average Plant Height (Added Calcium):** 9.4 cm **Average Plant Height (No Calcium):** 7.3 cm	**Average Plant Height (Added Calcium):** 10.3 cm **Average Plant Height (No Calcium):** 7.7 cm

Results: Average Height of L. sativa

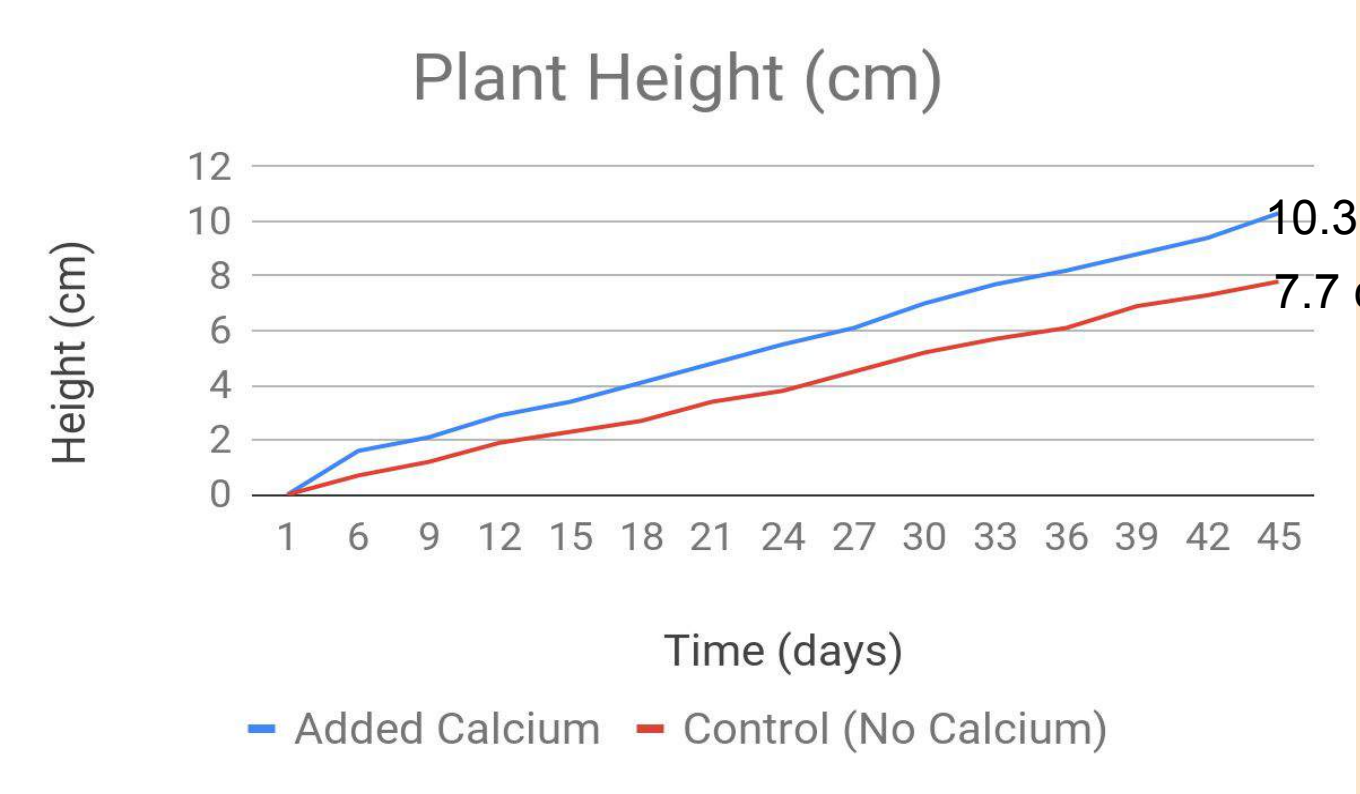


Figure 2: Average height of L.sativa

Results: Average Growth Rate of L. sativa

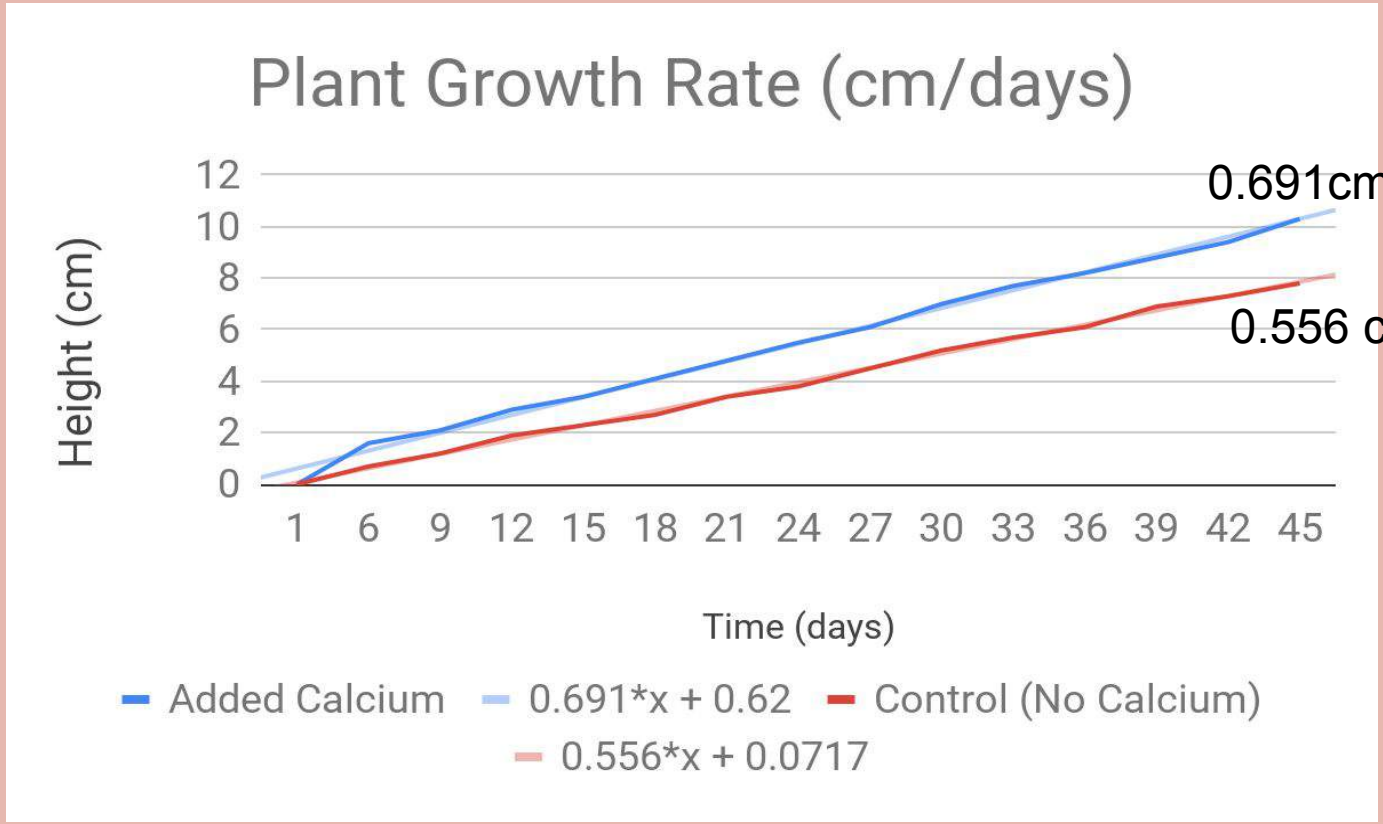
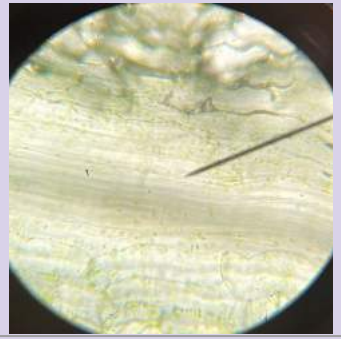
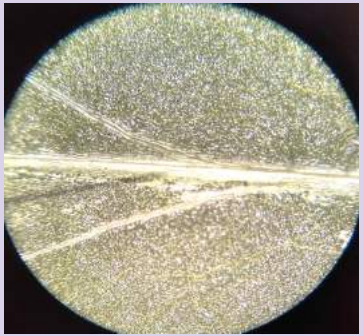
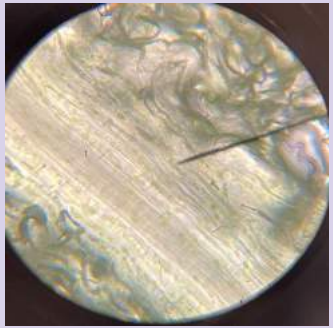


Figure 3: Average growth rate per 3 days

Results: Cellular Health on Day 45

	100x	400x
Added Calcium		
No Added Calcium		

Chloroplast Count

	Average Chloroplasts in 5 cells	Average Chloroplast per Cell
Added Calcium	215	43
No Added Calcium	155	31

Data Table 1: Cellular Microscope Images of *L. sativa* Cells

Conclusion: Height & Growth Rate

The *L. sativa* grown with added calcium to the soil had an average height of 10.3 cm. This is approximately 2.4 cm taller than the *L. sativa* plants grown in soil without added calcium.

The *L. sativa* grown with added calcium to the soil had an average growth rate of 0.691 cm/3 days when compared to the *L. sativa* grown in soil without added calcium which had an average growth rate of 0.556 cm/3 days.

Conclusions: Cellular Health

The *L. sativa* plants grown in soil with added calcium had a wider vein, more visible chloroplasts, and thicker cell walls when compared to those L. sativa plants that were grown in soil without added calcium. One can account for these differences by observing the microscopic images shown in data table 1 in the results.

Conclusion

I accept my hypothesis because overall it was found that growing *L. sativa* with added calcium yielded plants that had a greater height, a faster growth rate, and better overall cellular health than those plants that were grown in soil without added calcium.

Possible Experimental Errors

There were multiple leaves taken from each plant from each environmental condition that were observed under the microscope. This could have led to qualitative differences in the overall cellular health of L. sativa plants samples.

Future Research

Through my research I have accepted my hypothesis. To extend my experiment I would like to manipulate the amount of calcium received. The testing of different amounts of calcium would help to find what the optimal calcium amount is. I think this could help farmers and agriculturalists to find a effective way to enhance valuable traits of their crops.

Bibliography

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Thank you for your time and attention!