Anna Kelleher, Tenley Bands and Billie Beckley

Mr. Brock

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The Little Things Run the World: Background

Soil bacteria are very important because it gives the plant the proper nutrients it needs to survive (Brundett, 1999). These nutrients are called nitrogen; nitrogen is the chemical that makes up amino acids, which make up proteins. The proteins (enzymes) control the chemical reactions between the chemicals in the cell: carbohydrates, nucleic acid, water and lipids. These chemical reactions result in the cells four tasks: transforming energy, regulation of environment, reproduction, and the manufacturing of chemicals. These proteins are what ultimately run the cell, and without them there fails to be the production of any cells. The bacteria gives the nitrogen to the plant, and when the plant dies the bacteria decomposes it. The bacteria then eats the nitrogen from the dead plant, and in return, uses the nitrogen to make their own proteins, giving those proteins to other living plants, in a process called the nitrogen cycle (Department if Primary Industries, 2005).

Bacteria are most commonly found on the plant roots, where the nitrogen cycle takes place (National Science and Technology Center, 2001). Plant roots take the nutrients from the bacteria and send it up to the plant leaves, which makes the nutrients into food, therefore giving the plant nourishment, and keeping the plant alive (Brundett, 1999). Without the bacteria on the plant's roots, then the plant can fail to get its proper nutrients, which can eventually kills the plant.

Calcium is critical to the bacteria because it gives the bacteria a strong cell wall and helps with the production of the bacteria's proteins. Without calcium in the soil, there can not be any bacteria, which kills the plant because the bacteria is what gives the plant its nitrogen (Larson, 2007). Also, we found that with low calcium there are high aluminum levels, which makes low soil pH, thus making the soil toxic (Yost, 2000). High aluminum levels make the soil toxic by inhabiting the root growth of plants, which limits the nitrogen going into the leaves, that produce the amino acids which make proteins that run the cells, that keeps the plant alive (International Rice Research Institute, 2003.) Therefore with high aluminum levels, there is a decreasing amount of bacteria, which limits the plants source of nitrogen, therefore killing off plants in the area of the toxic soil.

Although with high aluminum the soil can become toxic, with high amounts of calcium, the relationship between the bacteria and the plant becomes healthier. High amounts of calcium make the aluminum level drop (Yost, 2000) producing an environment that is less toxic to bacteria, and as a consequence, the number of bacteria increases. With the number of bacteria increasing, the nitrogen cycle becomes healthier, therefore making the plants healthier, and makes them grow at a more rapid pace.

This becomes even more important because plants are at the bottom of the food chain. Plants are constantly making all of the biological molecules. They give their molecules to the primary consumers (animals) and they give their molecules to us. These plants, or producers, are source for our food that is what we need to run our cells that run our bodies. Without these producers, none of us would be living. Hence plants are the foundation of the ecosystems, and without it everything would die. So, humans rely on primary consumers, that really on producers that rely on the bacteria in the soil. By having more calcium in the soil, the amount of bacteria increases, which makes the plants healthier, therefore making our ecosystem healthier.

Our group first became curious about the salt effects on soil organisms when we thought about how much salt we have seen on the ground after a snow storm. We wanted to find out if the run off from the salt affected the soil on our school campus. We found that the salt that we use on this campus to eliminate snow and ice was the exact same thing as calcium that is naturally in soil. So, with the amount of calcium going up in the soil, we think the aluminum will go down, causing the amount of bacteria to increase.

Works Cited

1.) International Rice Research Institute. (2003) Aluminum Toxicity. http://www.knowledgebank.irri.org/ricedoctor_mx/default.htm
2.) Yost, R. (2000) Plant Tolerance of Low Soil pH, Soil Aluminum and Soil Manganese. http://www.ctahr.hawaii.edu/oc/freepubs/pdf/pnm11.pdf
3.) Larson, David. (2007) Calcium is the King of Crop Nutrients. http://www.agrienergy.net/idex.htm
4.) Reid, Greg and Wong, Percy. (2005) Department of Primary Industries: Soil Bacteria. http://www.dpi.nsw.gov.au/__data/assets/pdf_file/41642/Soil_bacteria.pdf
5.) Brundett, Mark. (1999) ROOTS. http://www.ffp.csiro.au/research/mycorrhiza/index.html

The Little Things that Run the World: Lab Report

Question: Does the salt run off from melting ice and snow produce toxic levels of aluminum in the soil?

Hypothesis: Salt run off from ice and snow does not produce toxic levels of aluminum in the soil

Independent Variable: addition of salt (calcium chloride) to the plots of soil

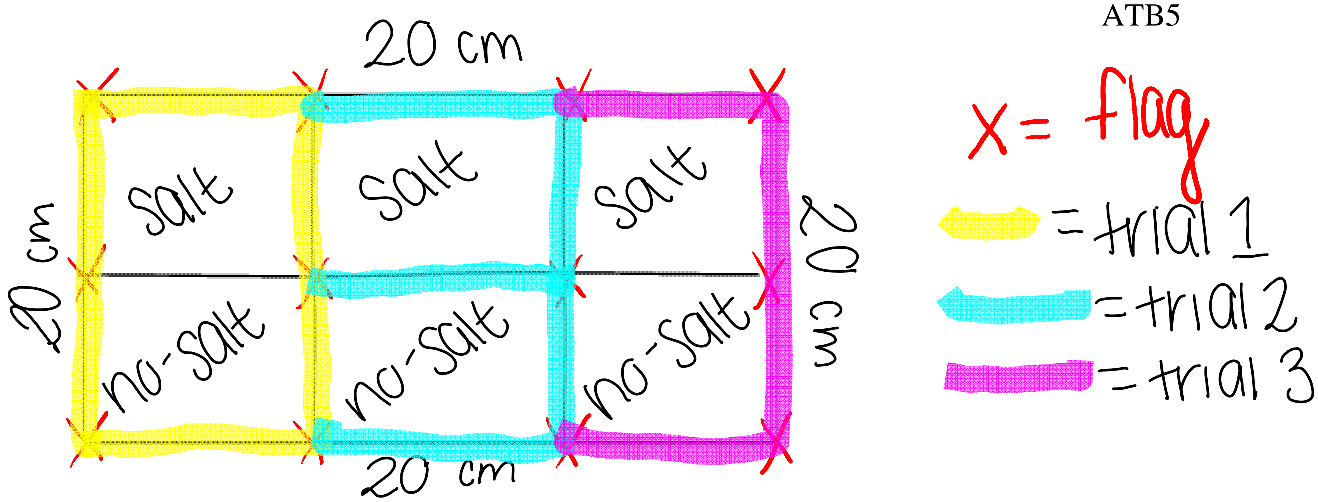
Dependant Variables: Calcium, aluminum levels and quantity of bacteria in the soil sample

Negative control: The plot of land that only has water added to it.

List of Controlled Variables:
Amount of water added (not including rain)
Amount of salt (diluted) added (not including rain)
Area of land
How big land is
Location of land
*Pick land in open space where there is only grass
Time of day (same time of day)
Type of salt
Amount of soil for testing
Using the basic La Motte model STH-14 soil test kit
Amount of soil extracted when doing an experiment
Amount of liquid put in each tube
Amount of liquid transferred to plate
Type of plate
Number of plates
Number of tubes

Procedure:

1. Mark 6 20cm by 20cm areas at North: 39.35804 and West: 76.63631 with marked flag poles surrounding each plot (each area next to the other) mark the top row "Control" for the plots that will not have salt added and write the bottom row "salt" for the plots that get salt added (see diagram below:)



2. Take 1 sample with the soil core tester from each plot (15.5cm) at the same time, and put each sample of soil in a separate labeled plastic bag with a permanent marker by what trial it is, and if it is salt or no-salt
3. Test steps 4-6 all in the same time to each sample of soil on each separate sample of soil.
4. Complete the extraction procedure before each calcium and aluminum test using La Motte model STH-14 soil test kit.
5. Test these samples each for their aluminum level using La Motte model STH-14 soil test kit.
6. Test samples for their Calcium level using La Motte model STH-14 soil test kit.
7. Test to see the quantity of bacteria that grows in a Petri dish from each sample of soil using serial delusion.

Procedure:

- Place 1cc of your soil sample into a culture tube
- Label that culture tube and 3 others with the right names starting at 10^0
- Add 10 ml of sterile water to the first tube 100 using a pipette marked “sterile water”
- Shake vigorously
- To the second tube 10^{-1} add one ml of the liquid in the 10^{-0} using a different pipette marked “ml”
- Add 9 ml of water to 10^{-1} with pipette marked “sterile water”
- Shake vigorously
- Then add one ml of the 10^{-1} tube using the “ml” pipette to the 10^{-2}
- Add 9 ml water using “sterile water” pipette to 10^{-2}
- Shake vigorously
- Take one ml with the “ml” pipette from 10^{-2} and transfer that into 10^{-3}
- Add 9 ml of sterile water using “sterile water pipette”
- Shake vigorously
- Then label 2 bacteria plates. Label one with 10^{-2} and 10^{-3}
- Use a micro pipette to take 100 µl out of the 10^{-2} tube and place it on the 10^{-2} plate and use a spreader to spread evenly

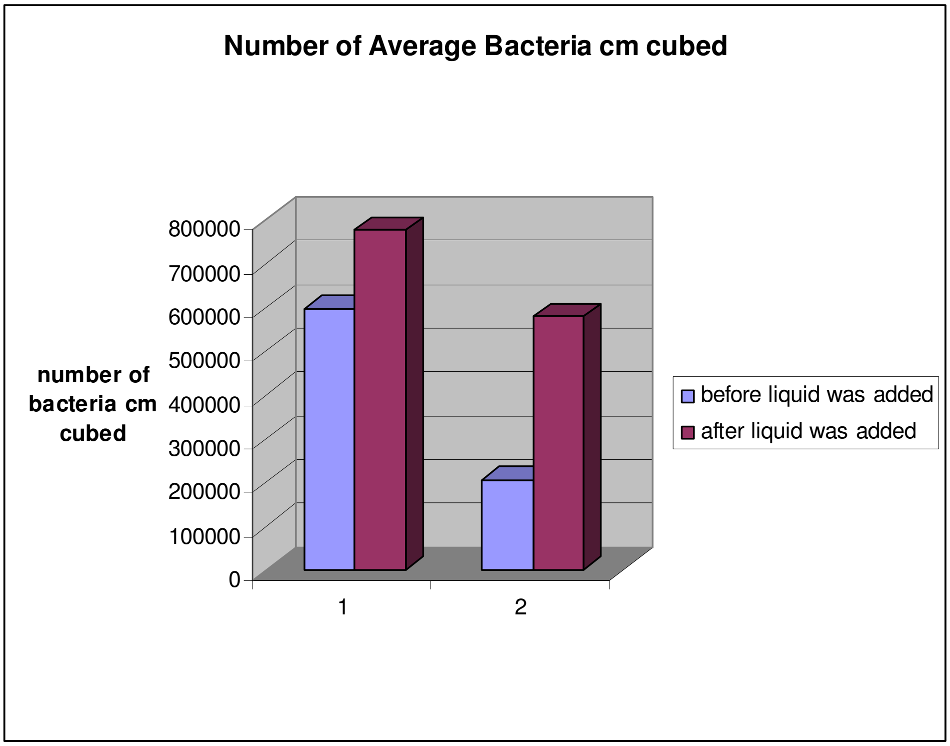
- Use a micro pipette to take 1 µl out of the 10^{-3}tube and place it on the bacteria plate
- Leave the plates in room temperature for two days
- Then count the number of bacteria colonies

8. Pour 500 ml of water into each of the 3 different containers and add 23.6 grams of calcium chloride to each. Then shake until salt has dissolved.
9. Pour 500 ml of regular water into each of the other 3 different containers
10. Pour one container of the 500 ml salt solution evenly on one of the plot marked salt. Repeat with the remaining containers and salt plots.
11. Pour one container of the 500 ml regular water evenly on one of the plots marked non-salt. Pour evenly.
12. Wait a class period (2 days)
13. Repeat steps 1-7,
14. Record the data:
    - Level of aluminum, level of calcium and amount of bacteria.

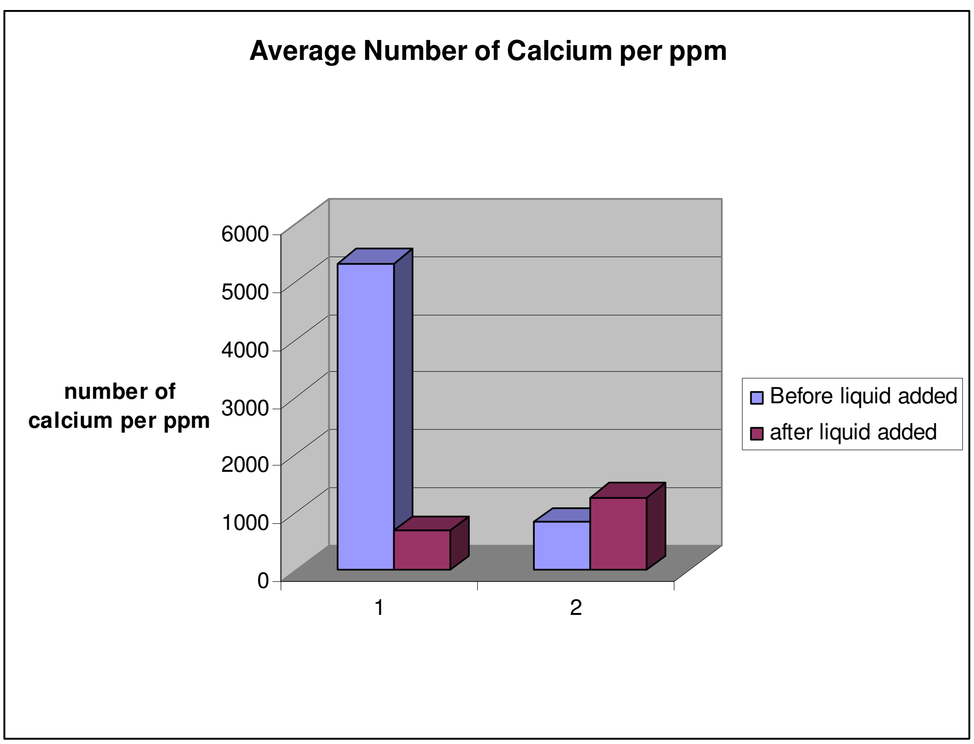
*using the basic Model StH-14

Data Tables:

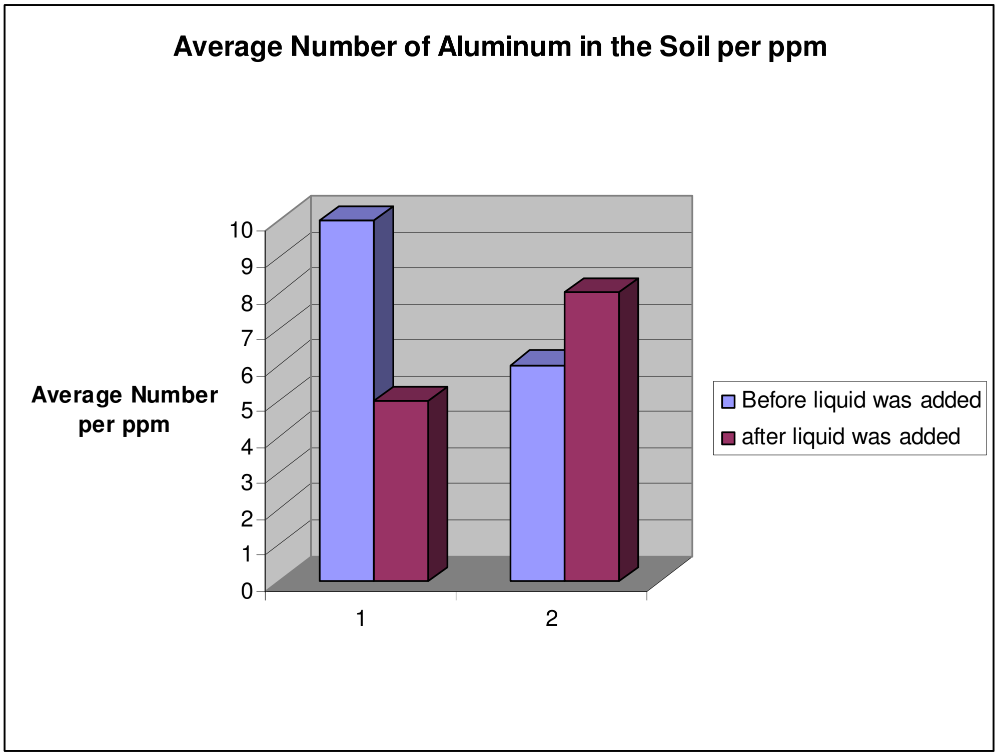
Trials	WATER ONLY						SALT ONLY					
	Number of Bacteria cm^3 soil		Ca+ ppm		Al ppm		Number of Bacteria cm^3		Ca+ ppm		Al ppm	
	Before	After	Before	After	Before	After	Before	After	Before	After	Before	After
Trial 1	90,000	940,000	1,000	800	10	7.5	290,000	250,000	1,000	1,000	5	5
Trial 2	600,000	290,000	1,000	700	10	5	250,000	900,000	700	1,400	5	10
Trial 3	1,100,000	1,100,000	14,000	1,000	10	7.5	80,000	590,000	350	1,400	5	10
Trial total averages	596666	776666	5333	833	10	6	206666	580,000	683	1266	5	8



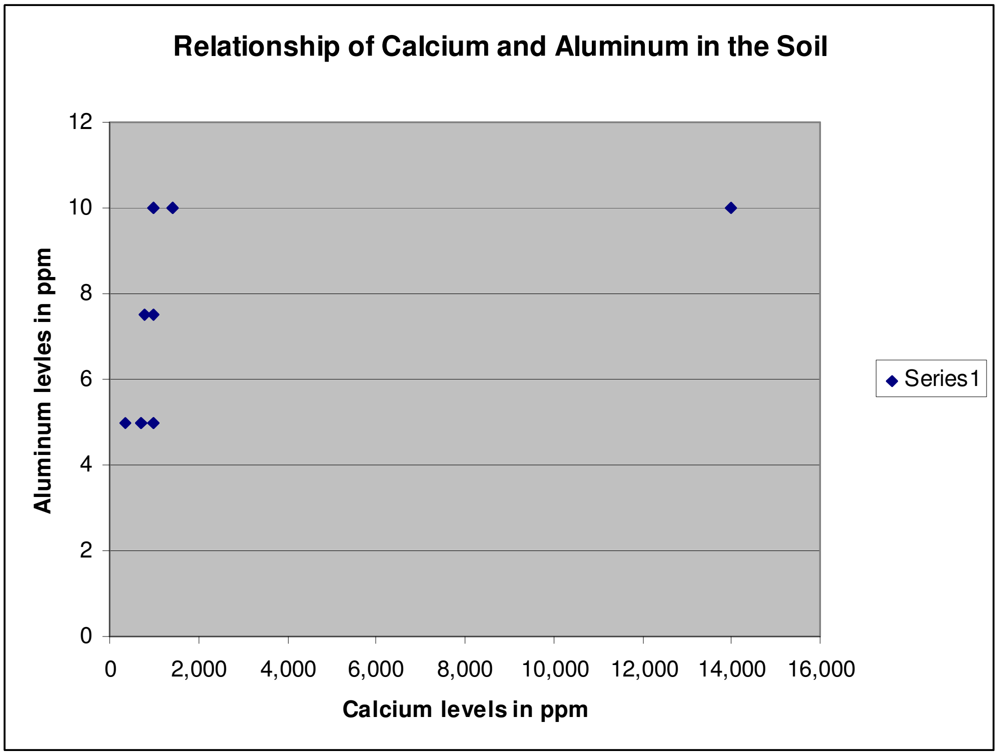
*1→No salt
*2→Salt

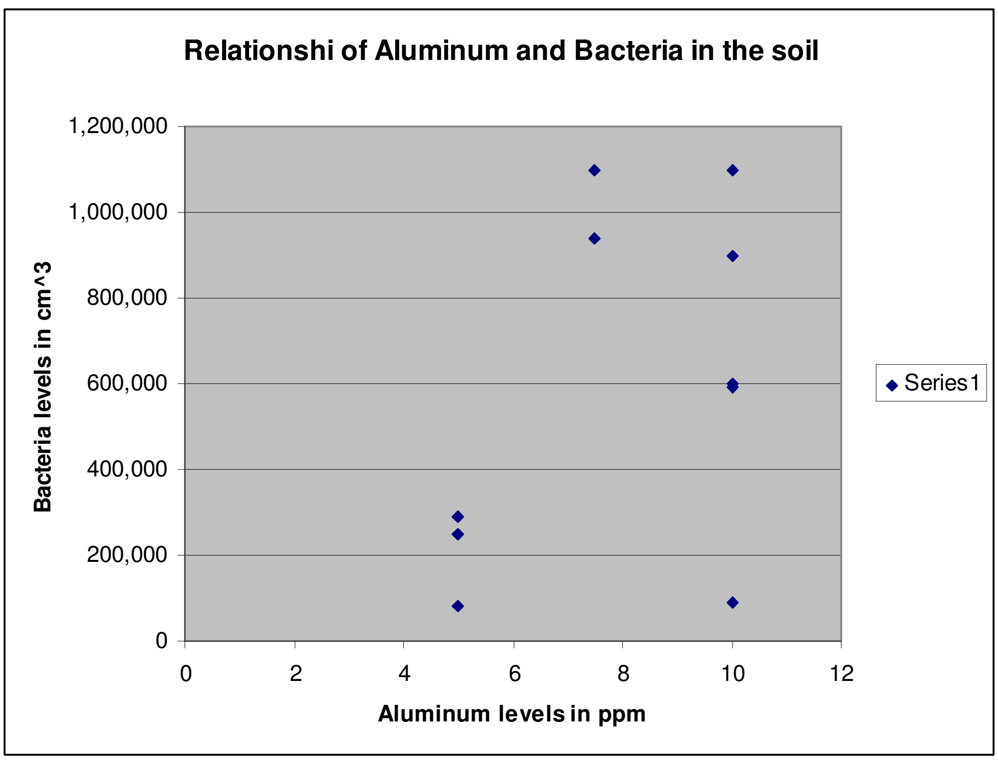


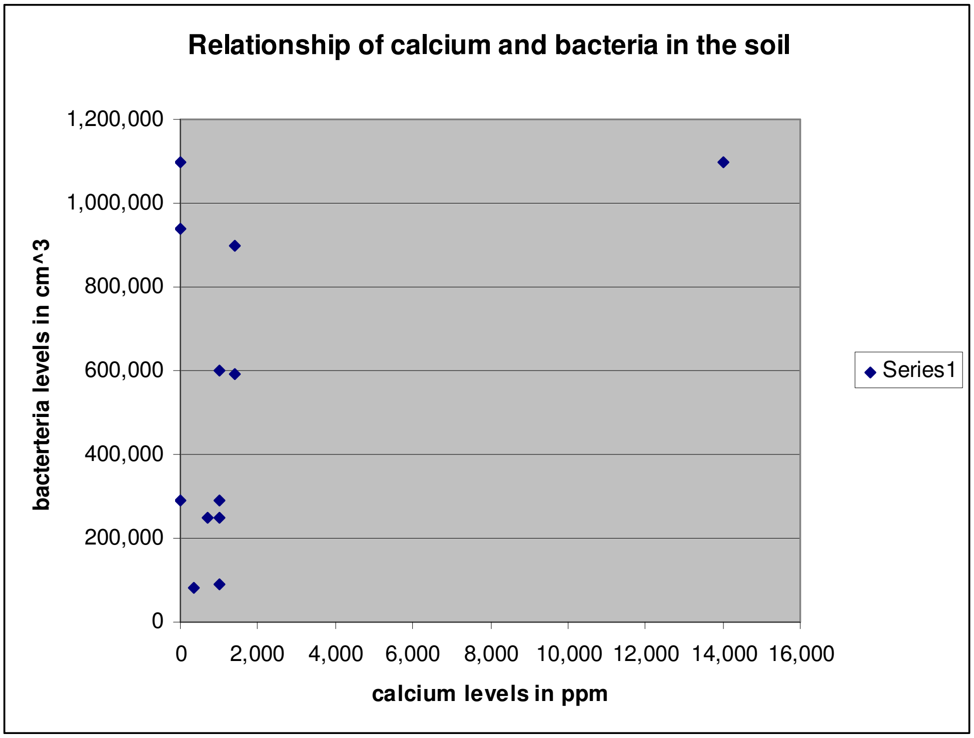
*1→no salt
*→ salt



*1→No salt
*2→Salt


Relationship of Calcium and Aluminum in the Soil
12
10
8
6
4
2
0
Aluminum levles in ppm
0
2,000
4,000
6,000
8,000
10,000
12,000
14,000
16,000
Calcium levels in ppm
Series1


Relationshi of Aluminum and Bacteria in the soil
1,200,000
1,000,000
800,000
600,000
400,000
200,000
0
Bacteria levels in cm^3
0
2
4
6
8
10
12
Aluminum levels in ppm
Series1



The Little Things the Run the World: Conclusion

In Conclusion, our hypothesis was correct. The Average Number of Calcium graph shows that after the salt solution was added, the amount of calcium increased from 750ppm to 1000ppm. The calcium levels went up 250ppm. According to the Number of Average Bacteria graph it also shows that after both liquid were added, the amount of bacteria increased, which is what we had predicted to happen. Before the non salt solution was added, the average number of bacteria per centimeter cubed was 596,666. After the liquid was added, the bacteria per centimeter cubed were 776,666 having the number increase by 18,000. Also, before the salt solution was added, the average number of bacteria per centimeter cubed was 206,666. After the calcium chloride solution was added, the bacteria per centimeter cubed were 580,000 increasing by 373,334 per cubic centimeter.

However, the reasoning behind our hypothesis was incorrect. We hypnotized that with the added amount of calcium in the soil, the aluminum levels would go down, causing an increase in bacteria. However, by looking at the Average Number of Aluminum in the Soil graph, after the calcium chloride solution was added the aluminum levels actually increased unlike the levels of aluminum when the water was added. For example before the water solution was added, the aluminum level was 10ppm. After the water was added, the average aluminum level was 6ppm decreasing by 4ppm from before the liquid was added. Before the calcium chloride solution was added, the average aluminum level in the soil was 5ppm. After the calcium chloride solution was added the average aluminum level was 8ppm increasing by 3ppm. The Relationship of Calcium and Aluminum graph shows that there is actually no relation between calcium and aluminum. The Aluminum levels did not change as the calcium levels increased. Even though the calcium and aluminum showed no relationship with each other, the Relationship of Aluminum and Bacteria graph shows that with the increasing level of aluminum there was an increase in bacteria. This data can be seen by the slop in the Relationship of Aluminum and Bacteria graph, with a slop of undefined.

According to our research, what should have happened is that with the calcium level increasing, the bacteria should have increased as well. But in our graph, The Relationship of Calcium and Bacteria shows no relation at all. This graphs slope's was also undefined. Surprisingly, the graph of The Relationship of Aluminum and Bacteria did show a relationship. This graph has an equation of y=84800x+-96000, which means that there was a slope of 848000.   Therefore there must have been some other factor in the soil that made the both aluminum level and bacteria level increase, causing the bacteria to increase. The next step would be to figure out what was in the soil that caused the aluminum levels and bacteria to increase.