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Background

Humans affect the ecosystem by using fertilizer on lawns, grounds, and fields. Many people when having to use fertilizer do not know the difference between commercial and organic. Normally people do not ask themselves the question, which fertilizer, commercial or organic, will increase the amount of bacteria in the soil? Our group researched and experimented for weeks trying to figure out this answer, and finally we did. Both types of these fertilizers are used to keep the ground fertile and to speed up the process of growing plants but there are many differences between them both and they are crucial to solving our problem. Commercial fertilizers make plant growth much faster than organic fertilizers because of the high dosages of chemicals that they are made of. The main ingredients in commercial fertilizers are nitrogen, phosphorus, and potassium compounds, along with other secondary nutrients. (Lawrence, 2004) Organic fertilizers work at a much slower rate, then commercial fertilizer for they are made up of organic materials such as, manure, seaweed, and bone meal. (Organic Gardener, 2004-2007) Because of these ingredients it takes a lengthy amount of time for the organisms in the soil to break down each of the elements. When organic fertilizer is put on soil, the organisms that break down each of the elements are the nitrifying bacteria, nitrogen-fixing bacteria, and denitrifying bacteria. Each of these bacteria are always present in soil so we tested it to see which fertilizer, organic or commercial increased the amount of bacteria.

We decided that organic fertilizer would increase the amount of bacteria rather than commercial fertilizer because one is much healthier. Commercial and organic fertilizers are made with three of the same ingredients, but they differ in many ways. Commercial fertilizers are made with many chemicals to speed up the process of growing plants when organic fertilizers are made with organic materials such as, manure, sewage, and bone meal. (EDIS Technical Staff, 2007) Organic fertilizers work slowly but they keep the plants and soil healthy. Because of all of the chemicals that are in commercial fertilizer many of the micro-organisms that are essential for the plants life's roots burn and the soil structure becomes destroyed. Organic fertilizers balance the growing process and no chance that the soil or roots will be either burned or destroyed. (The Organic Gardener, 2004-2007) Each of these fertilizers work at different speeds but the organic fertilizer is much healthier for the soil and the microbes living there, the bacteria.

The Roland Park Country school community affects one of the most important components in the ecosystem, soil. The strong use of pouring fertilizer throughout the school grounds, such as on the lawns, playing fields, and flowerbeds, creates potential danger for the microbes and other bacteria in the soil. Although both kinds of fertilizer help plants grow at a faster rate, one is more harmful to the bacteria in the soil than the other. Because of the nutrients and organic materials that organic fertilizer is made of it keeps the soil and bacteria in the soil healthy. Yet without the use of both of these fertilizers, soil would still be able to grow and stay in good shape. The reasons for this is because of the nutrient cycles, such as the nitrogen, potassium, phosphorus, carbon, oxygen cycle and more. All of the cycles are extremely relevant but the one that applies most to our experiment is the nitrogen cycle. This cycle keeps plants alive and keeps the food chain going.

Nitrogen (N) is one of the most important elements on the planet. Cells are made up of the five biological molecules, water, carbohydrates, lipids, nucleic acids, and proteins or enzymes. Enzymes are one of the main elements in Nitrogen and they are made up of amino acids. Ammonium (NH_4^+) and nitrates ($N0_3^-$) are two key components in amino acids. Nitrogen gas (N_2) takes up about 80 percent of the Earth's atmosphere. For producers to be able to use nitrogen, nitrogen-fixing bacteria in the soil convert N_2 into ammonia gas (NH_3). Deeper in the soil the NH_3 is converted into ammonium compounds (NH_4^+) and a type of bacteria called nitrifying bacteria consume the NH_4^+ so that they will remain living and the excess NH_4^+ is converted into $N0_3^-$. The plant then takes in the nitrates to make its own enzymes. Another type of bacteria called the denitrifying bacteria produce $N0_3^-$ in the soil and it is then transformed back into N_2 which is then released into the atmosphere. Consumers then eat the plants, but all levels of the food chain use NH_4^+ and $N0_3^-$. Decomposition is the next step that occurs and the process starts allover. (Campbell, Williamson, and Heyden, 2004) Essentially if the nitrogen cycle did not occur, life would be nonexistent. Without nitrogen there would not be any chemical reactions or DNA and RNA. The nitrogen cycle is crucial to everyday on Earth because without it, there would be no "blue prints" for life.

To answer our problem of which fertilizer increases the amount of bacteria we chose three places around the RPCS (Roland Park Country school) campus to examine the amount of bacteria in the "before" stages. Our first section of land was a grassy site in the back of the school at N 39.35684°, W 076.63598°. The second section was on the front lawn at N 39.35828°, W 076.63628°. The third section also on the front lawn was N 39.35795°, W 076.63609°. Each section of land was divided into three plots with one labeled NF (no fertilizer), another as F1 (organic fertilizer), and the last as F2 (commercial fertilizer). Samples of the soil were taken from all three plots in each section and then serial dilutions were preformed to get the count of the bacteria in the "before" samples. Soon after, in the NF plots which is our negative control, only water was poured on. In all F1 plots, organic fertilizer was poured on and in the F2 plots commercial fertilizer was poured on. By adding water, organic, and commercial fertilizers to all plots serial dilutions like in the "before" stages had to be preformed. The "after" samples of collected soil were the final steps of our experiment that would prove whether our hypothesis was correct or incorrect.

Citations

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Lab

Problem- Which specific fertilizer increases the amount of bacteria in the soil, organic or Commercial fertilizer?

Hypothesis- If organic and commercial fertilizers are put into two separate plots of land than the amount of bacteria in the organic plot will increase much more then in the commercial plot.

Independent variable- The different kinds of fertilizers that are being applied to the soil (Organic and Commercial)

Dependent Variable- The number of bacteria in the soil samples

Negative Control- The third plot of land that has no fertilizers added and only water

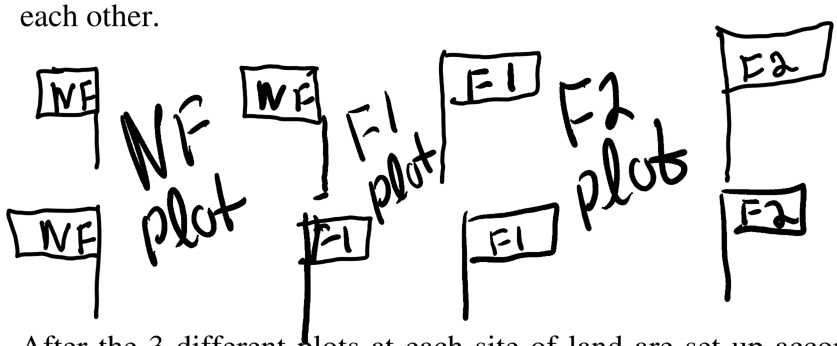
List of Controlled Variables-

1. How many plots of land there are (3)
2. Size of the 3 plots of land (20x20 cm each)
3. How much fertilizer that is put on the two plots of land (one liter of water and fertilizer mixed)
4. How much water that is added to the No fertilizer plot of land (one liter)
5. How much dirt that is sucked up into the Soil Core Tester (15 cm) from each of the three plots
6. How many times the soil is tested using the Soil Core Tester
7. How much water is added with the soil in each culture tube
8. How long/much the culture tube is shaken
9. How hard the culture tube is shaken
10. The number of times each soil sample is tested for bacteria growth
11. Taking all the trial 1 plot, trail 2 plots, and trail 3 plots, samples all on the same day to control for the weather.
12. When conducting the serial dilutions whether you Trails 1, Trails 2, and all of trails 3 of the trails (1-3) in the same day
13. How much dirt is put in the scooper (1cc) for the serial dilution
14. Which pipettes are used to transfer the dirt and water from test tube to test tube in the serial dilutions
15. How much sterile water is put into the first test tube of the trail (10 cc)
16. How much sterile water is put into the second, third, fourth and fifth test tube for the serial dilutions (9 cc)
17. The types of Petri film plates that are used (bacteria film plates)
18. How much of the diluted water is put on the Petri film plates

Step-by-step procedure-

NF- No fertilizer
F1- Plot with organic fertilizer
F2- Plot with non- organic fertilizer

2. Get 8 flags for each land site and set them up so each plot of land is right next to each other.



3. After the 3 different plots at each site of land are set up accordingly marked by flags. Then take one sample of the soil from each of the 9 plots of land using the soil core. Make sure all soil from that one site is collected in one day.
4. Get nine plastic bags and label 3 NF, 3 F1, and 3 F2.
5. Take the soil core with a diameter of 2 cm and place it on top of plot NF at a 90 degree angle.
6. The strongest member of the group will push the soil core 15 centimeters into the ground collecting the soil by using a hammer to hit the soil core.
7. Then put the NF sample in the plastic bag labeled NF.
8. To make the concentrations for the fertilizers that will go in all plots labeled F1 and F2, add a liter of water to all the 6 bottles (plots NF, F1, F2). Add 111 grams of inorganic fertilizer to the 3 bottles labeled F1. Add 278 grams of commercial or non-organic fertilizer to the 3 bottles labeled F2. Pour each of the bottles on to the corresponding plots (bottle F1 will be poured on plot F1).
9. Pour the 1 liter bottles labeled "NF" of water all around the no fertilizer plot.
10. Wait 2 days or next class period to take a sample of soil 15 cm by 2 centimeters wide from the all three plots (NF, F1 and F2) inside all three sites (so the fertilizer and water actually have an effect on the soil and make the bacteria grow). Take all of the after samples on the same day to assure that no changes have been made to the soil.
11. Perform a serial dilution on all soil samples to determine bacteria density.

Data and Observations

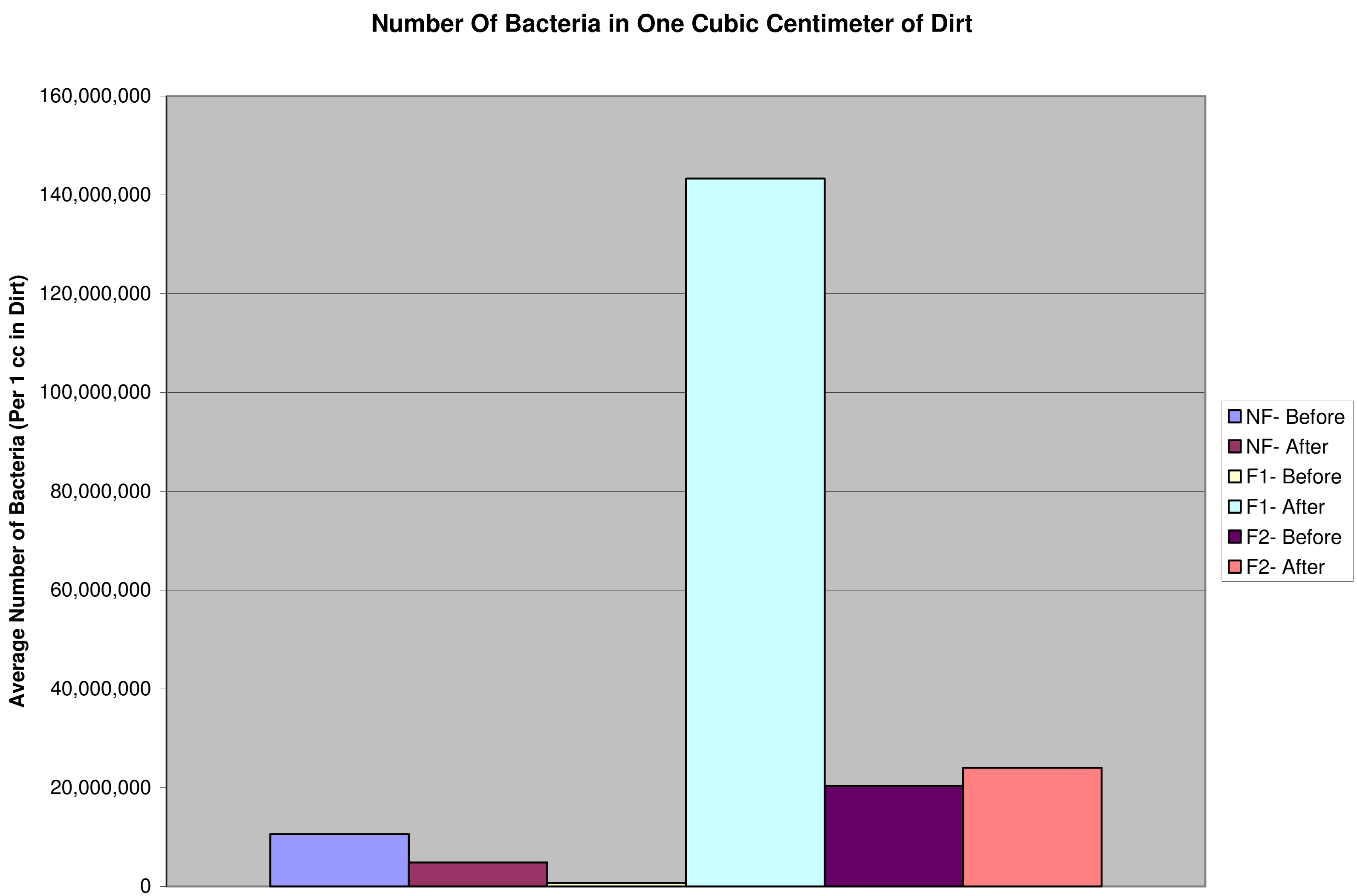
Number of Bacteria in One Cubic Centimeter of Dirt

No Fertilizer (NF) **Organic Fertilizer (F1)** **Commercial Fertilizer (F2)**

NF- No Fertilizer Plot

F1- Organic Fertilizer
F2- Commercial Fertilizer

Trials:	**Before**	**After**	**Before**	**After**	**Before**	**After**
1-Back Woods	27,000,000	590,000	600,000	28,000,000	60,000,000	23,000,000
2- Front Lawn	1,100,000	900,000	1,200,000	206,000,000	420,000	14,000,000
3- Front Lawn	3,600,000	13,000,000	500,000	196,000,000	700,000	35,000,000
Average:	10,566,666	4,830,000	766,666	143,333,333	20,373,333	24,000,000


Number Of Bacteria in One Cubic Centimeter of Dirt
Average Number of Bacteria (Per 1 cc in Dirt)
160,000,000
140,000,000
120,000,000
100,000,000
80,000,000
60,000,000
40,000,000
20,000,000
0
NF- Before
NF- After
F1- Before
F1- After
F2- Before
F2- After

Analysis of Tables and Graphs:

Statistically there is no difference between the before and after plots for the No Fertilizer and Commercial fertilizer conditions; in fact the P value of the No fertilizer plot is .58 and the P value of the Commercial fertilizer plot is .88 which basically means there is no difference in either of the two plots. Statistically for the Organic fertilizer there is a .13 chance that the organic fertilizer did in fact make the bacteria numbers increase by a large amount, which means that the fertilizer *did* impact the bacteria number. The different number of bacteria between the before and after of the Organic fertilizer plot is 142,566,667 (per cc of soil). The number of bacteria increased 142,566,667 (per cc of soil) when we subtracted the before and after averages in the Organic fertilizer plots.

Conclusion

Our group's hypothesis was correct. Our group thought that if organic and commercial fertilizers were put into two separate plots of land then the amount of bacteria in the Organic fertilizer plot will increase much more than the bacteria in the commercial fertilizer plot. The data we collected from testing the soils with no fertilizer, organic fertilizer and commercial fertilizer proves that we were correct in our hypothesis. To make sure all of our data would produce the correct results, we set up three stations around the Roland Park Country School campus so that we could test our hypothesis three times each. In each station we made three separate plots each twenty centimeter apart from one another. We tested all three stations for bacteria per cubic centimeter of soil before we added any water or fertilizer in to the soil. We then added water, organic fertilizer and commercial fertilizer to the separate plots in the stations to see whether or not organic fertilizer would increase the number of bacteria in the soil. We thought that the soil with organic fertilizer would have an increased number of bacteria in the soil because the organic is much healthier for the plants and bacteria in the soil as opposed to commercial. The Espoma Plant-Tone for Organic Gardening is made up of organic materials such as, manure, seaweed, and bone meal (Organic Gardener, 2004-2007). These ingredients support and feed the plants and bacteria living in the organic fertilizer soil. Jonathan Green New Seeding Lawn Fertilizer has chemicals used for artificial lawn growth using a strong amount of chemicals such as nitrogen, phosphorus and potassium (14-28-15). Once we had all of our soil samples and preformed the serial dilutions, the results told us whether we were right or wrong in our hypothesis. Our data table shows that the No fertilizer, organic fertilizer and commercial fertilizer samples taken from all three stations and the number of bacteria from each of the stations averaged out. Our graph also shows the number of bacteria from all three stations averaged out. The P value for the no fertilizer is .58 and the P value for the commercial fertilizer is .88 which essentially means that the fertilizer and water did not change anything in either of the two plots. Statistically for the organic fertilizer plot there was a .13 chance that the organic fertilizer did in fact make the bacteria numbers increase by a large amount, which means that the organic fertilizer *did* impact the increasing number of bacteria. The difference between the before and after soil samples in the organic fertilizer plot was that the bacteria number increased by 142,566,667 (per cc of soil). In conclusion our hypothesis was proven correct, but if we were to continue our research, our hypothesis would be that there are more bacteria in organic fertilizer because the bacteria seem to feed off of the nutrients of the organic fertilizer more than the commercial fertilizer or the water.