What is the Effect of Coffee Grounds on Weed Control?

Sahith Mangu, 8

Category of Research: Agronomy

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Abstract

This experiment is testing the effect of coffee grounds on weed control. This experiment uses the Dutch White Clovers as the testing weed. The hypothesis was that if coffee grounds are sprinkled on white clover plants in lawns, then there will be fewer white clover plants in the lawn. The purpose of this experiment is to figure out how effective coffee grounds are in eliminating specific weeds. The experiment was done by placing white clover seeds in pots with soil and letting them germinate. This would be done in twenty-five pots with three to four seeds in each pot. Once germinated, coffee grounds and cow manure were placed in their respective pot. The weeds, with neither cow manure nor coffee grounds, grew at an average and moderate rate. Only one plant died from this section. The weeds with ½ teaspoon of coffee grounds died around the fifth to sixth day. The weeds with one teaspoon of coffee grounds died around the fourth to fifth day. The weeds with cow manure didn't show any signs of wilting or death other than one plant. The results proved the hypothesis true because the white clover plants did die when higher dosages of coffee grounds were added.

Background (Literature Review)

Introduction

Weed control is a time-consuming problem in turf management. Many residential owners engage commercial organizations like Lawn Doctor or the Weed Man to get rid of weeds. There are many natural ways to control weeds, and one of them is to use coffee grounds. They have the same mitigating influence on Chickweed, Dandelion, Purslane, Bindweed, and Crabgrass (Loughrey et al., 1). This is a much more environmentally friendly solution compared to the chemical treatment of soil.

Coffee grounds are the remnants of brewing and making coffee. There are two types of coffee grounds. Spent Coffee Grounds (SCG) and Used Coffee Grounds (UCG). Spent Coffee Grounds are defined as grounds that were roasted and depleted of their water-soluble compounds. Used Coffee Grounds are defined as grounds that are leftover after brewing. On average, in the United States alone, nine pounds of coffee is drank a year per capita. Many people usually trash these coffee grounds without realizing how beneficial they can be.

Coffee Grounds consumption and waste product

On average, in 2019, individuals consumed 24.2 gal of coffee per year in the United States of America alone. At present, this number has more than doubled. While this per capita is

based on liquid consumption, it does not account for the solid waste or coffee residue left over after the brewing process. It is estimated that the daily volume of coffee residue is 0.91 kg for each kilogram of soluble coffee. Spent coffee grounds (SCG), the coffee residue after brewing, are considered municipal solid waste and typically end up in landfills. Once in a landfill, they take up space until they are degraded, and due to the high presence of organic material, there needs to be an adequate amount of oxygen in order for it to be degraded. Usually, due to the large amounts of trash in these landfalls, there is not an adequate amount of oxygen, which leads to longer degradation times. (Cochran et al., 1)

Coffee Grounds' positive effect on soil.

PHA, otherwise known as Polyhydroxyalkanoates, is a polymer or polyester that is naturally made in the environment. Coffee oil, which is derived from coffee grounds, can be added to soil in order to speed up PHA production. PHAs are used as a standard replacement for synthetic plastic due to their lack of biodegradability. As synthetic plastic is known to harm the environment, an increase in PHA will be tackling that issue. PHA is also used to make packaging materials, including films, boxes, coating, fibers and foam materials, biofuels, medical implants, and drug delivery carriers. (Rhee, 1) Coffee Grounds also improve soil structure and drainage. Soil that is compacted, too wet, or poorly draining can lead to root rot or disease problems. The coarse texture of coffee grounds helps aerate soil, allowing water and nutrients to reach plant roots more efficiently. (Loughrey et al., 1)

Coffee grounds adverse effects on certain species of plants.

A research paper showed that different types of plants react differently to coffee grounds. Specifically, viola, radish, sunflowers, broccoli, and leek. Weeds that are negatively affected by coffee grounds are dandelions, Chickweed, Dandelion, Purslane, Bindweed, Crabgrass, and

more. When applied at volumes of 2.5%, the only real accomplishment the coffee grounds did was suppressing weed growth rather than making seeds germinate quicker. The soil texture types were also different, so there were no discrepancies in the soil quality/health. (Hardgrove et al., 1)

Effects of coffee grounds mixed with Horse Manure

Research Gate conducted a study where they mixed both coffee grounds and horse manure to see if there was a faster germination rate or not. The findings show that the addition of coffee grounds, especially at higher concentrations, to soil devoid of horse manure inhibited the growth of green manure crops. However, when horse manure and coffee grounds were introduced at lower concentrations, the drop was inhibited, and crop growth resembled that of the control group. The oddity of this is that crop growth dramatically increased when coffee grounds and horse manure were put at a higher concentration. (Yamane et al., 5-7)

Plants that work best with coffee grounds.

Coffee grounds are neutral to slightly acidic (pH can range from about 6.2 to 6.8), with fresh grounds containing more acid, which can affect soil pH. Acidic-loving plants such as azaleas, blueberries, hydrangeas, rhododendrons, and roses will benefit from a sprinkling of coffee grounds around the base of plants. Vegetable crops that may benefit from coffee grounds include carrots, cucumbers, peppers, potatoes, and radishes. Though these plants tend to work well with coffee grounds, excessive grounds can cause nitrogen toxicity since coffee grounds contain a substantial amount of nitrogen. (Loughrey et al., 1)

Experimental Design

Rationale for Conducting This Research: The purpose of this research is to figure out how effective coffee grounds are in eliminating specific weeds.

Hypothesis: If used coffee grounds are sprinkled on white clover plants in lawns, then there will be fewer white clover plants in the lawn.

Impact: The impact of this experiment is that used coffee grounds are able to efficiently kill certain weeds.

Description of Experiment

Independent Variable: The soil type, the white clover seeds, and the seedling pots.

Dependent Variable: Measuring the height of the white clovers.

Control Variable: The plant without any coffee grounds or cow manure.

Constants: The amount of full direct sunlight, each pot gets ¾ - ½ cups of water a day, each pot gets 3-4 seeds, and each pot gets 50 grams of soil.

Materials Needed:

- Black Kow cow manure
- Dutch white clovers (*Trifolium repens*)

- Potting soil
- Coffee grounds
- BlumWay Seed Starter Tray with Grow Light, 2 Pack 80 Cells Seedling Tray Kit with Humidity Dome/Indoor Plant Starter Kit (25 cells used)
- Adjustable Brightness Plant Germination Trays
- Gloves
- Tablespoon
- Teaspoon
- Ruler
- Water
- Notebook
- Cups

Methods

1.) In a seed starter tray, place a slightly dampened paper towel until it is covered.
2.) Then, place approximately seventy-five to one hundred seeds approximately 0.5-1cm apart.
3.) Once seeds have germinated, place soil to the brim into all 25 planting cells.
4.) Now, transplant all seedlings to the sells approximately 0.635 centimeters deep.
5.) Once that's done, wait one to two days.
6.) Add ½ teaspoon of used coffee grounds to five cells.
7.) Add one teaspoon of used coffee grounds to another five cells.
8.) Now, add ½ teaspoon of cow manure to five cells.
9.) Finally, add one teaspoon of cow manure to five cells.

10.) Make sure the area is lit with full sun during daytime hours.

11.) Also, make sure the room temperature is at approximately 18 to 27 degrees Celsius.

12.) Water plants every day after germination, with approximately ¾-½ cups of water a day for all plants.

13.) After germination, Record the height of each plant every day.

14.) Flowers should start to bloom on these plants within 45-55 days. Record the exact time taken.

15.) Once every plant has fully matured, measure the height of each plant and record the observations.

Experimental Design Table

Independant Variable	The soil type, the white clover seeds, and the seedling pots.
Dependant Variable	Measuring the height of the plants
Control	The plant without any used coffee grounds or cow manure.
Constants	The amount of sunlight, the amount of water, the amount of seeds each pot gets, and the amount of soil each pot gets.

Results

Data Tables

Control Condition **No Used Coffee grounds**					
Constant: Soil quantity and Soil mixture; Same amount of sunlight; Same amount of water; Same temperature					
	Plant 1	**Plant 2**	**Plant 3**	**Plant 4**	**Plant 5**
Day 1 growth	4cm	4.2cm	3.8cm	4cm	3.75cm
Day 2 growth	4.4cm	4.3cm	4.0cm	4.1cm	4cm
Day 3 growth	5cm	4.6cm	4.2cm	4.25cm	4.25cm
Day 4 growth	5cm	5cm	4.6cm	4.25cm	4.5cm
Day 5 growth	5.1cm	5.25cm	5.0cm	4.5cm	4.75cm
Day 6 growth	5.5cm	5.33cm	5.25cm	Plant Died	5cm
Day 7 growth	5.5cm	5.5cm	5.25cm	Plant Died	5.25cm
Day 8 growth	5.8cm	5.5cm	5.5cm	Plant Died	5.5cm
Day 9 growth	6cm	5.7cm	5.6cm	Plant Died	5.75cm

Day 10 growth	6.25cm	5.8cm	5.6cm	Plant Died	5.75cm

Control Condition **½ teaspoon of Used Coffee Grounds**					
Constant: Soil quantity and Soil mixture; Same amount of sunlight; Same amount of water; Same temperature					
	Plant 1	**Plant 2**	**Plant 3**	**Plant 4**	**Plant 5**
Day 1 growth	4cm	3.8cm	3.5cm	3.8cm	3.85cm
Day 2 growth	4.4cm	4cm	3.75cm	4cm	4cm
Day 3 growth	4.6cm	4.5cm	Plant Died	4.25cm	4.25cm
Day 4 growth	4.25cm	4.6cm	Plant Died	4.5cm	4.25cm
Day 5 growth	4.5cm	4.6cm	Plant Died	4.75cm	4.25cm
Day 6 growth	Plant Died	4.6cm	Plant Died	4.75cm	4.25cm
Day 7 growth	Plant Died	Plant Died	Plant Died	4.75cm	4.25cm
Day 8 growth	Plant Died	Plant Died	Plant Died	Plant Died	Plant Died
Day 9 growth	Plant Died	Plant Died	Plant Died	Plant Died	Plant Died

Day 10 growth	Plant Died	Plant Died	Plant Died	Plant Died	Plant Died

Control Condition **1 teaspoon of Used Coffee Grounds**					
Constant: Soil quantity and Soil mixture; Same amount of sunlight; Same amount of water; Same temperature					
	Plant 1	**Plant 2**	**Plant 3**	**Plant 4**	**Plant 5**
Day 1 growth	4cm	3.5cm	3.75cm	4cm	4.25cm
Day 2 growth	4cm	3.75cm	4cm	Plant Died	4.25cm
Day 3 growth	4.5cm	4cm	4.25cm	Plant Died	4.3cm
Day 4 growth	Plant Died	4.25cm	4.25cm	Plant Died	Plant Died
Day 5 growth	Plant Died	Plant Died	4.25cm	Plant Died	Plant Died
Day 6 growth	Plant Died	Plant Died	Plant Died	Plant Died	Plant Died
Day 7 growth	Plant Died	Plant Died	Plant Died	Plant Died	Plant Died
Day 8 growth	Plant Died	Plant Died	Plant Died	Plant Died	Plant Died
Day 9 growth	Plant Died	Plant Died	Plant Died	Plant Died	Plant Died

Day 10 growth	Plant Died	Plant Died	Plant Died	Plant Died	Plant Died

Control Condition ½ teaspoon of cow manure					
Constant: Soil quantity and Soil mixture; Same amount of sunlight; Same amount of water; Same temperature					
	Plant 1	**Plant 2**	**Plant 3**	**Plant 4**	**Plant 5**
Day 1 growth	4cm	3.75cm	4.25cm	4.5cm	3.85cm
Day 2 growth	4.25cm	4cm	4.25cm	4.75cm	4cm
Day 3 growth	4.25cm	4.15cm	4.5cm	4.75cm	4cm
Day 4 growth	4.25cm	4.15cm	4.75cm	5cm	4cm
Day 5 growth	4.5cm	4.25cm	5cm	5.25cm	4cm
Day 6	4.75cm	4.3cm	5.25cm	5.25cm	4.25cm

growth					
Day 7 growth	5cm	4.5cm	5.25cm	5.25cm	4.75
Day 8 growth	5.25cm	4.6cm	5.25cm	5.5cm	5cm
Day 9 growth	5.5cm	5cm	5.5cm	5.75cm	5.5cm
Day 10 growth	5.75cm	5.25cm	5.5cm	6cm	6.25cm

Control Condition **1 teaspoon of cow manure**					
Constant: Soil quantity and Soil mixture; Same amount of sunlight; Same amount of water; Same temperature					
	Plant 1	**Plant 2**	**Plant 3**	**Plant 4**	**Plant 5**
Day 1 growth	4cm	3.75cm	4.25cm	4.5cm	3.85cm
Day 2	4.25cm	4cm	4.25cm	4.75cm	4cm

growth					
Day 3 growth	4.25cm	4.15cm	4.5cm	4.75cm	4cm
Day 4 growth	4.25cm	4.15cm	4.75cm	5cm	4cm
Day 5 growth	4.5cm	4.25cm	5cm	5.25cm	4cm
Day 6 growth	4.75cm	4.3cm	5.25cm	5.25cm	4.25cm
Day 7 growth	5cm	4.5cm	5.25cm	5.25cm	4.75cm
Day 8 growth	5.25cm	4.6cm	5.25cm	5.5cm	5cm
Day 9 growth	5.5cm	5cm	5.5cm	5.75cm	5.5cm
Day 10 growth	5.75cm	5.25cm	5.5cm	6cm	6.25cm

Graphs

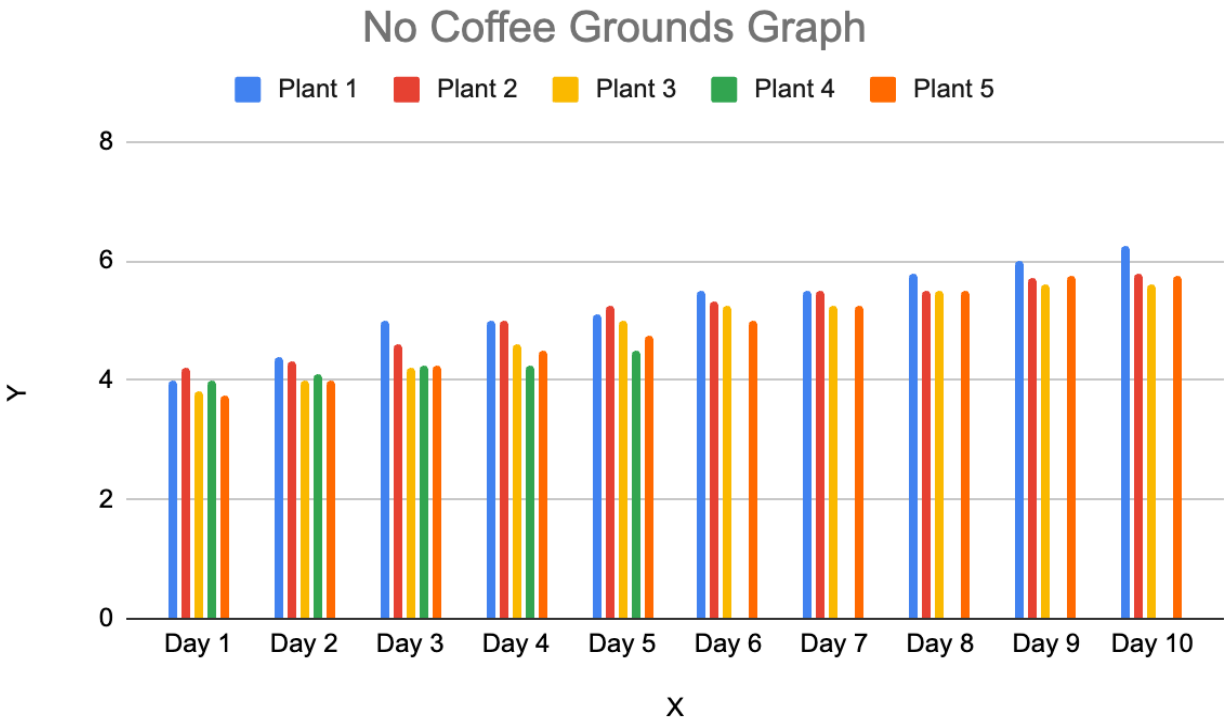
There were five experimental conditions that were explored. The leaves and stem were very thin on all five experimental conditions.

Condition 1 - Control plants: There were five plants that received no manure or used coffee grounds.

The graph below shows the growth of these plants.

All plants survived other than plant 4, which died on day 5.

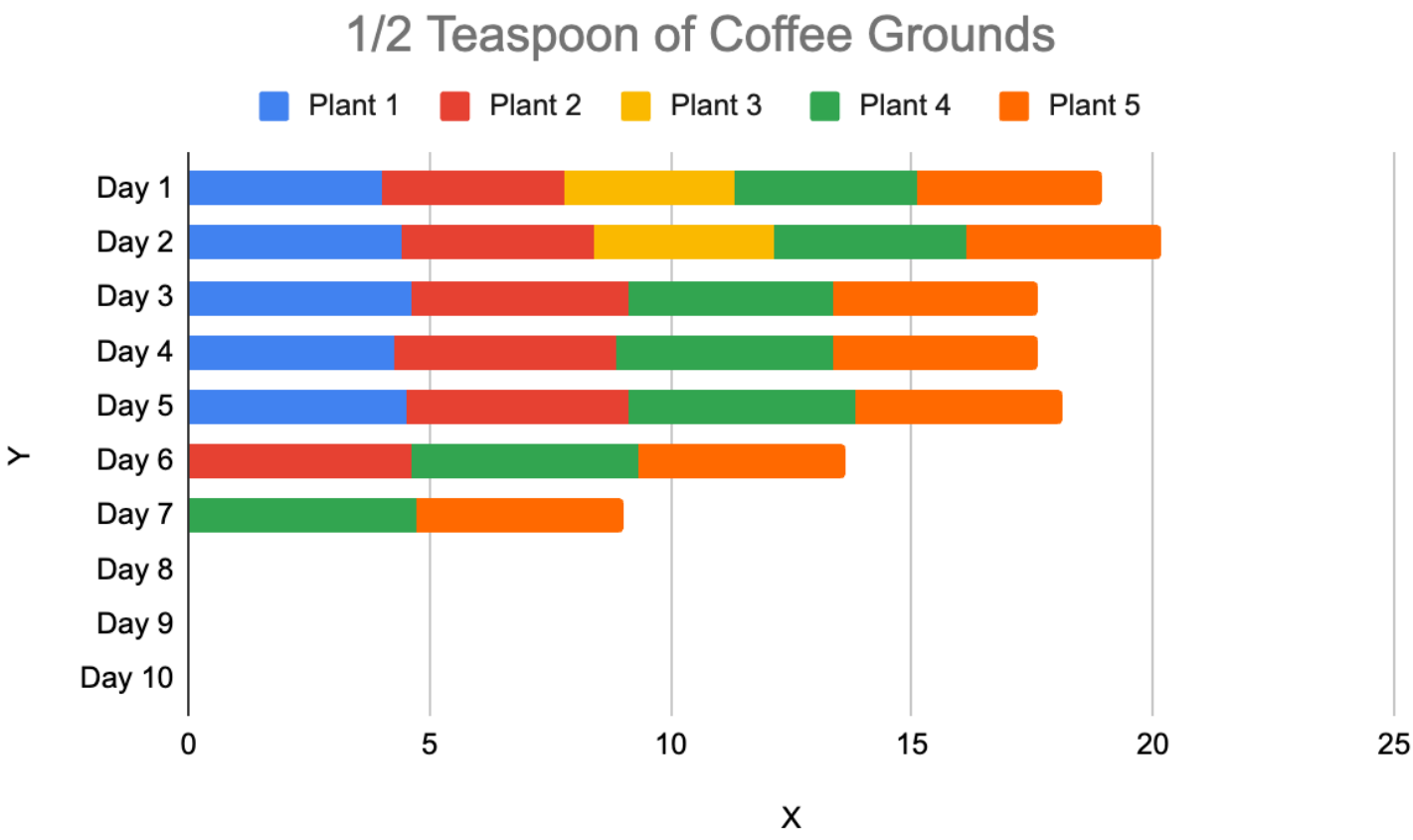
The average height of each plant was 4.93 cm.



Condition 2: Plants were enriched with half a teaspoon of used coffee grounds.

Five plants were treated with half a teaspoon of used coffee grounds, which were added to the soil after the seeds germinated.

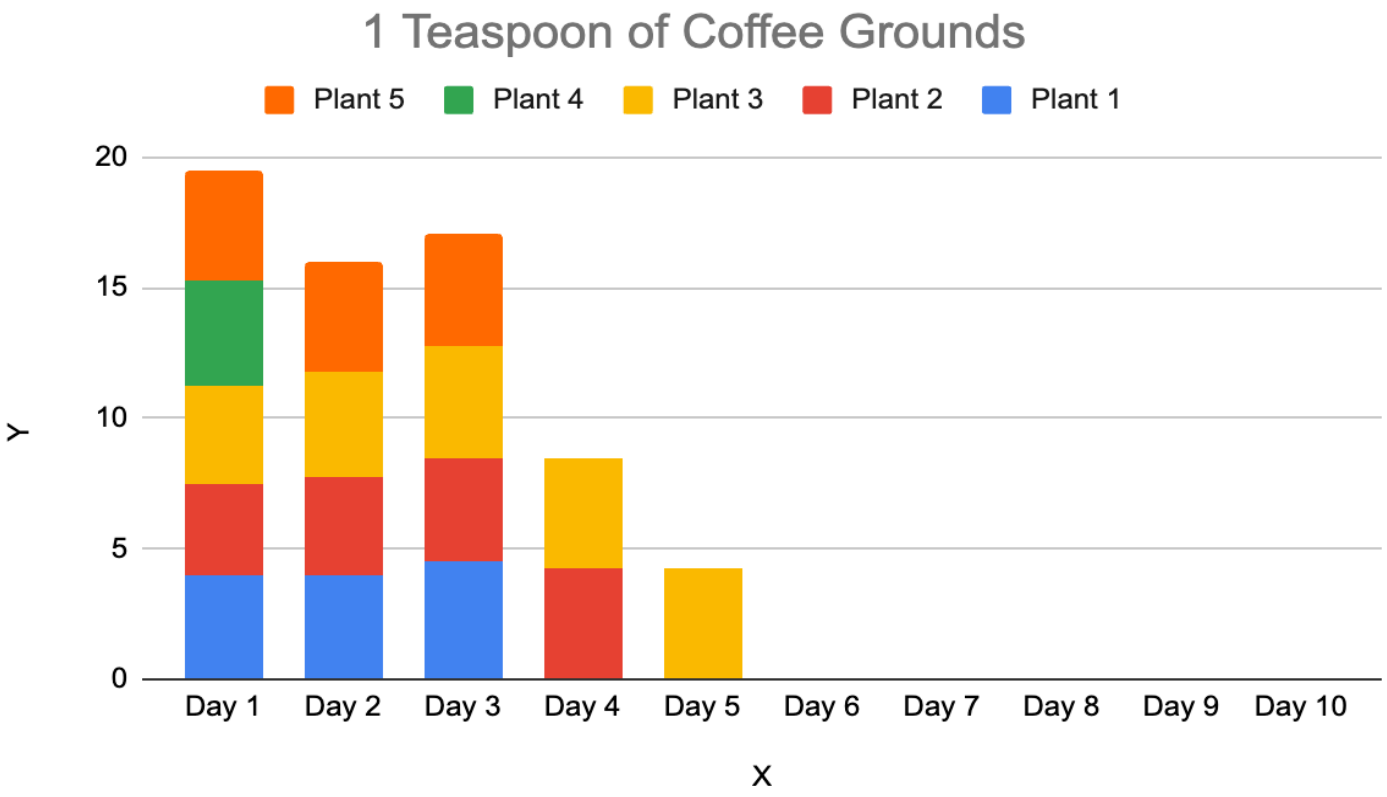
Plant one survived for five days, plant two survived for six days, plant three survived for two days, plant four survived for seven days, and plant five survived for seven days.



Condition 3: Plants were enriched with one teaspoon of used coffee grounds.

Five plants were treated with one teaspoon of used coffee grounds, which were added to the soil after the seeds germinated.

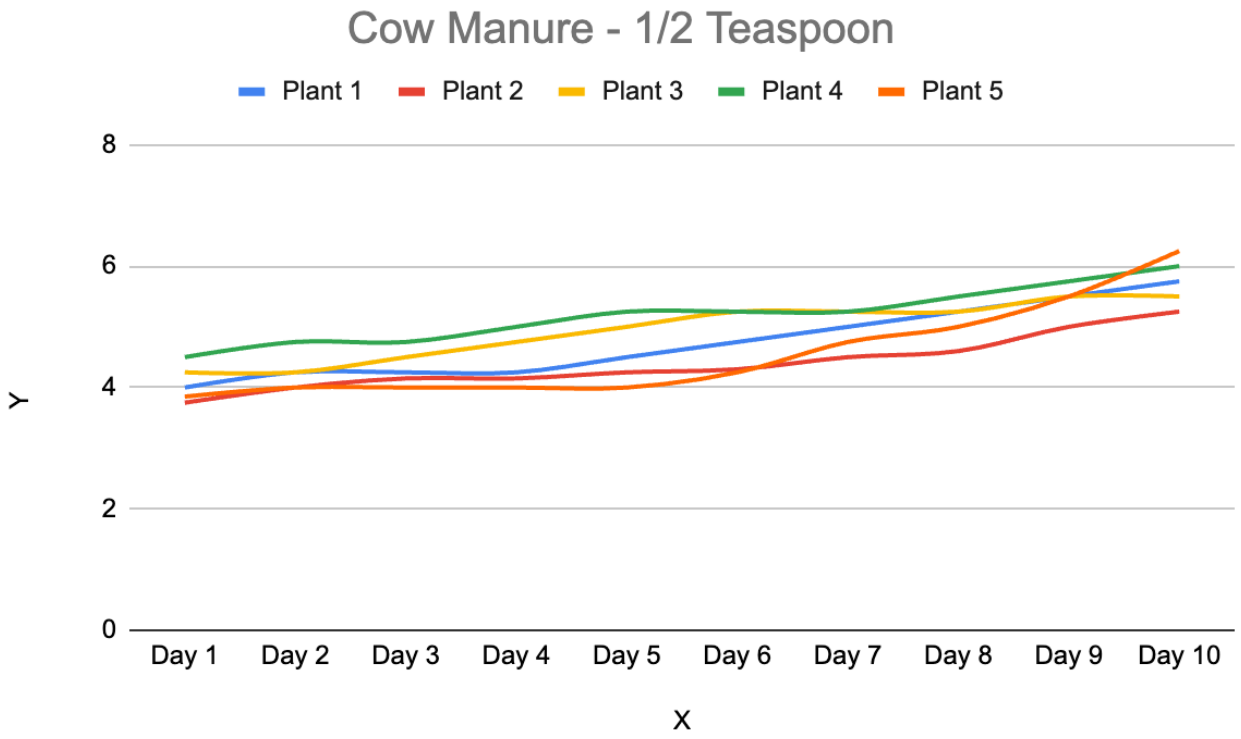
Plant one survived for three days, plant two survived for four days, plant three survived for five days, plant four survived for one day, and plant five survived for three days.



Condition 4: Plants were enriched with ½ teaspoon of cow manure.

Five plants were treated with ½ teaspoon of cow manure, which were added to the soil after the seeds germinated.

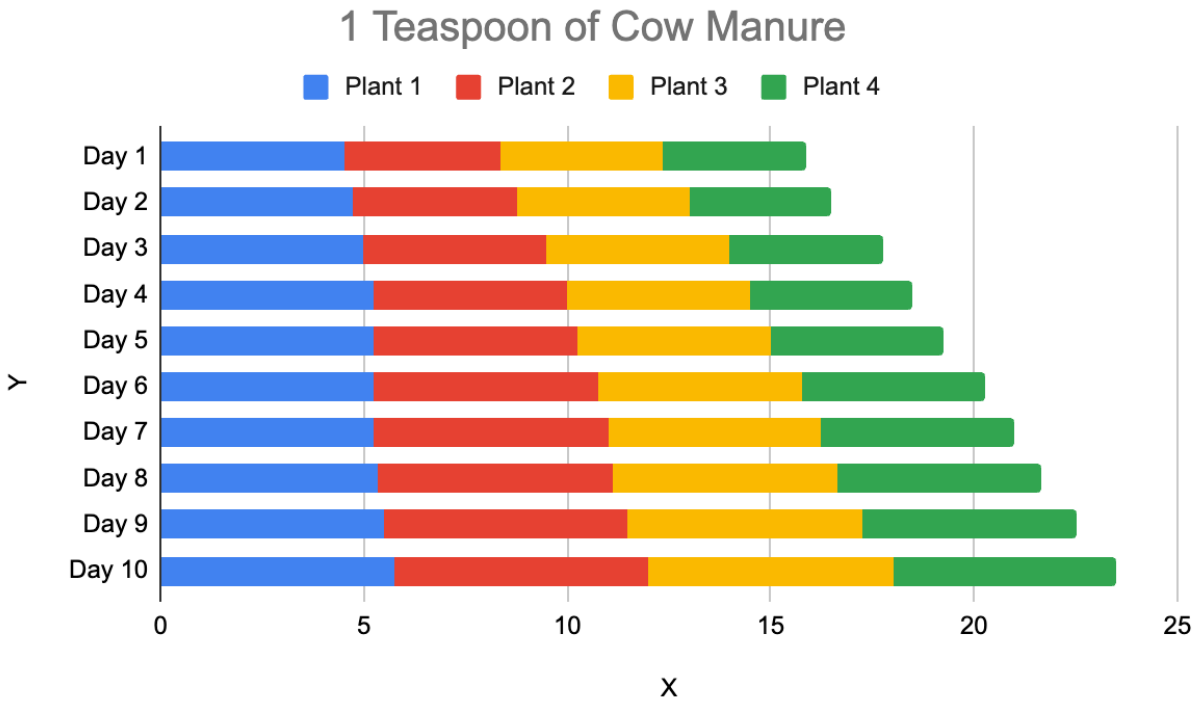
All five plants survived for all ten days.



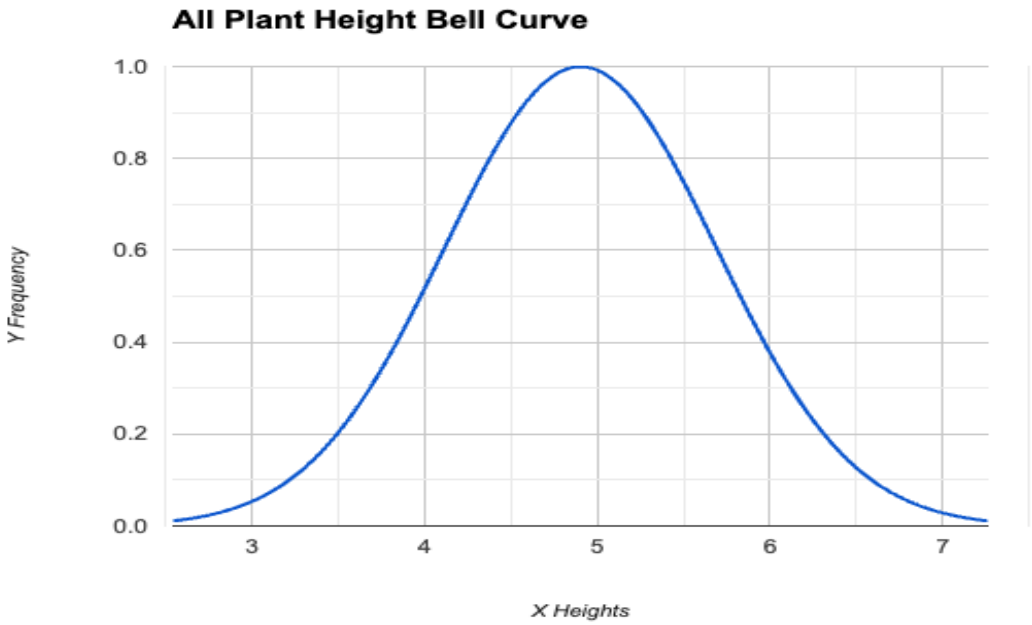
Condition 5: Plants were enriched with one teaspoon of cow manure.

Five plants were treated with one teaspoon of cow manure, which were added to the soil after the seeds germinated.

All five plants survived for all ten days.



Bell Curve: This is the overall bell curve that shows all plant heights from conditions one through five.



Discussion

The results clearly indicate that used coffee grounds did have a negative effect on the Dutch White Clovers. The white clovers that did not have any used coffee grounds or cow manure added to them were able to grow at a moderate pace. The white clovers with cow manure performed similarly to the ones without used coffee grounds or manure.

Moving on to interpreting the data, it has been shown that all plants but plant 4 for "No used coffee grounds" survived. On day six, plant four died. The speculated reason for this may be due to the nature of the weeds. Weeds are known to compete for air, water, and other

nutrients. All the other plants must have been taking in more water, leaving little to no water for plant 4. Another reason for this could just be that the seed for plant 4 wasn't good enough to grow entirely.

Next, the plants with ½ teaspoon of used coffee grounds, on average, died around day six to seven. However, plant three died on day three. This could be due to this plant being weak from the start as it was observed that this plant did not germinate as fast compared to the other white clovers. The plants with one teaspoon of used coffee grounds died relatively quicker, dying between day four and day five. However, plant three died on the second day. This could be due to the plant having a quicker response to the caffeine and nitrogen that are harmful to Dutch White Clovers.

Finally, looking at ½ teaspoon of cow manure, we can conclude that the cow manure did not adversely affect the weeds nor positively affect them. This can be similarly said for the plants with one teaspoon of cow manure. Other than plant five, which died after germination. It is believed that the cow manure did not play a role in plant five's death because it was observed that plant five was already wilting prior to placing one teaspoon of cow manure.

Conclusion

In conclusion, the hypothesis, "If used coffee grounds are sprinkled on white clover plants in lawns, then there will be fewer white clover plants in the lawn," was, in fact, proven correct. When looking at the data, one can observe that the higher the dosage of used coffee grounds, the faster the white clovers will die. Farmers and gardeners can use used coffee grounds to kill weeds (specifically Dutch White Clover) that are affecting their garden in a negative way. This is a much more sustainable and environmentally friendly way of getting rid of them without using the harmful chemicals that The Lawn Doctor, The Weed Man, and many other companies

put in their weed killer spray. If one uses these, they risk having harmful chemicals attached to their crops and leaching into fruits and vegetables they may have to grow. There's absolutely no reason to risk this when used coffee grounds have been proven to completely kill these weeds.

Limitations of Research

My limitations of research are definitely how I was unable to conduct my experiment on a larger scale. Farmers and gardeners don't use small trays to plant and grow crops. They have acres of land where they plant. If I had an extensive landscape to test this out on, I believe I could have gotten a more accurate result that would benefit farmers and gardeners even more.

Project Improvements

If I had to do this experiment again, I would definitely start this project much earlier so I can see the effects of used coffee grounds in the long term. With this time, I would compare against more sources and not just cow manure such as compost, horse manure, and more.

Errors

An error that occurred during this experiment was when my weeds underwent transplant shock. This is because I transplanted them too early and didn't water them enough after transplanting them to the tray. I learned from my mistake and had to restart my experiment with the germination process.

Learners Outcomes

I learned that plants need a lot of water when they're seedlings but then again not too much water. I also learned that I need to be extremely gentle and careful with these plants especially when conducting an experiment with a deadline.

Acknowledgments

First, I want to show my appreciation and gratitude towards Dr. Nan for being my mentor throughout this entire science fair project. Dr. Nan brought in several supplies for me to use, such as the planting tray and used coffee grounds. Dr. Nan checked my paper for grammar and made sure my explanations were logical. Dr. Nan also made sure my experiment was running smoothly. I would also like to thank Mr. Deisher for helping me through the process as well. Mr. Deisher helped me create an abstract and background, and he also checked my paper for mistakes. Mr. Deisher also brought me used coffee grounds. I would also like to thank my parents for obtaining the supplies I needed to conduct this experiment and helping me plant my weeds. I would finally like to thank my classmate, Revant Jear, for also bringing used coffee grounds in for me to use.

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Logbook

Beginning of Germination

End of Germination. Switching plants to the tray.

Transferred to tray

Plants that had used coffee grounds slowly died.