Impact of Different Chemicals on Plant Types

ABSTRACT

How do different amounts of chemicals in fertilizer affect plant growth? Well, it was predicted that if the amount of chemicals increase above the optimal, then the height will decrease because if too many chemicals are added to the soil, they can burn the plants. In this experiment, three different plants were studied, soybeans, bell peppers, and cucumbers, to see the effects of fertilizer. Then, each plant was separated into four groups (a synthetic, organic, homemade, and a no fertilizer group) to allow for a change in fertilizer. In these fertilizers three main components were looked at: the amount of nitrogen, phosphorus, and potassium (N-P-K). The N-P-K tells how much of each chemical is in the fertilizer because if it is too high it could add too many chemicals to the soil resulting with fertilizer burn, which is when chemicals are overused, allowing them to draw moisture from the plants, resulting with root damage. As a result of the experiment, it was found that the homemade fertilizer groups ended with the greatest average height in each plant type: 0.51 cm for cucumbers, 2.78 cm for bell peppers, and 24.24 cm for soybeans. From this data, it has been gained that the more chemicals added to the plants decreased its chance of survival, and that smaller amounts of chemicals increase the growth of plants. Overall, this information can be used for big picture farming ideas, or even for the local farms that need new methods of farming.

INTRODUCTION

During this project the following question was studied: How do different amounts of chemicals in fertilizer affect plant growth? In this experiment, three different plants were studied, soybeans, bell peppers, and cucumbers, to see how different concentrations of chemicals affected them. To do this, each plant was separated into four groups to allow for a change in fertilizer. Soybean plants require moist soil all the time along with a natural amount of sunlight (“Soybean”). Whereas, bell pepper plants must have well drained soil and a natural amount of sunlight (“Solanaceae”). Cucumber plants require full sun and a consistent water supply (“Cucumber”). Overall, all of these plants are typically grown in similar types of soil with added fertilizers to replenish the soil.

When choosing a type of fertilizer to replenish the soil, three main components are looked at: the amount of nitrogen, the amount of phosphorus, and the amount of potassium. Together they form an N-P-K (Nitrogen-Phosphorus-Potassium) that tells how much of each chemical is in the fertilizer. Therefore, if the N-P-K is very low, then there will not be a sufficient amount of these essential elements for plants in the soil. If the soil is not replenished with all the chemicals it needs, then the plants will not have access to the chemicals to complete typical functions. The nitrogen increases leaf growth and a healthy green color, while the phosphorus helps to develop the roots and create seeds. Lastly, the potassium increases the growth rate and the stability of the stems. Therefore, the N-P-K is very important because if it is too high it could add too many chemicals to the soil which would result in the damage of many plants (“Fertilizer”).

If the amount of chemicals increase above the optimal, then the plant height will decrease because if too many chemicals are added to the soil, then they can burn the plants, meaning that each chemical contains a small amount of sodium in the form that is used. Therefore, when too much fertilizer is applied to the plants, the sodium draws a large amount of moisture out of the plants resulting with a brown discoloration and root damage (Carroll). Overall, it is expected that the plants with synthetic fertilizer will be burnt due to the overuse of the fertilizer. Whereas, the organic fertilizer will not burn the plants as much, but overall the homemade fertilizer will allow the soil to use the most nutrients.

EXPERIMENTAL METHODS

In this experiment, three plant types, cucumbers, bell peppers, and soybeans, were exposed to four different conditions, a homemade fertilizer, an organic fertilizer, a synthetic fertilizer, and no fertilizer at all. Each plant type was potted in its own flat, with two columns of 20 seeds each. These columns were then split in half to create a total of four columns, each labeled with a different type of fertilizer. After this, the types of fertilizer became water soluble by adding Jobe's Organic fertilizer to water for the organic fertilizer, by adding Miracle-Gro fertilizer to water for synthetic fertilizer, and by combining chicken guano and wood ashes in water to create the homemade fertilizer. These fertilizers were then applied by administering one ounce of the previously indicated fertilizer to each column every two weeks, starting when the seeds were first planted. The plants then continued to receive 12 hours of light each day along with enough water to moisten the soil.

This particular experiment lasted five weeks, all in the winter season. During the experiment, two types of data were collected: the plant height and the plant color. A ruler was used to obtain the height in centimeters while a color scale was created to keep track of the plant color. The scale used is as follows: 1=White 2=Light Green 3=Green 4=Dark Green 5=Brown. A log was also kept every day once the first plant sprouted.

RESULTS

Plant Height

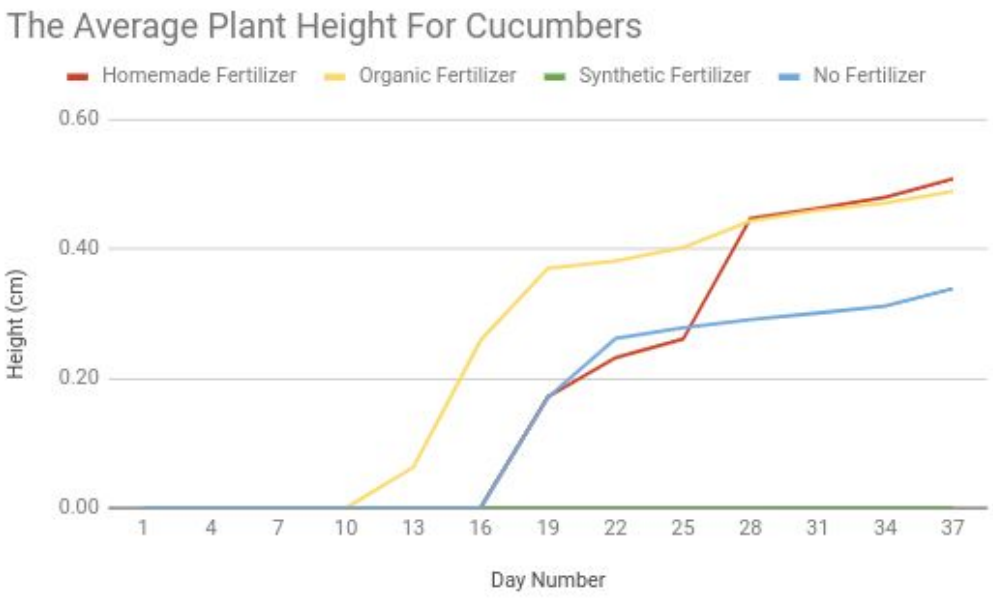
Plant height continuously had the highest increase in the homemade fertilizer groups, typically followed by the organic, synthetic, and then no fertilizer groups. The groups with the homemade fertilizer had the greatest average height in each plant type of 0.51 cm for cucumbers, 2.78 cm for bell peppers, and 24.24 cm for soybeans by the end of the experiment. This was 0.17 cm taller than the control group for cucumbers, 1.77 cm taller than the control group for the bell peppers, and 9.87 cm taller than the control group for the soybeans. Therefore, the plants with the homemade fertilizer were receiving the correct amount of nutrients needed for the specific plant types.

Plant Color

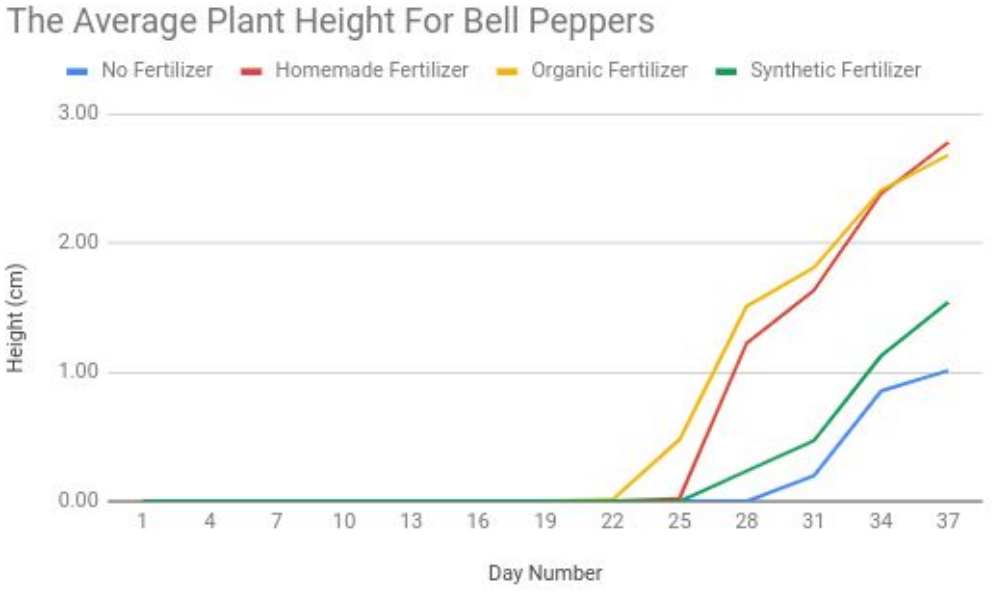
The plant color increases consistently as each plant grows. This is seen in Graph 4 where all four averages increase at the same rate. This graph also shows that the homemade fertilizer groups have the largest increase in darkness at 1.9 for the bell peppers. The cucumbers also showed the homemade fertilizer plants with the darkest plants at 0.6, but by day 37 they decreased in color to 0.4. Finally, the soybeans had the overall darkest coloring at 3.2, but this color came from the organic fertilizer group. The scale used to rate the color is as follows: 1=White 2=Light Green 3=Green 4=Dark Green 5=Brown. Most plants started out very low on the scale and then they increased as their height increased, just as shown with the bell pepper plants in Graph 4.

Tables:

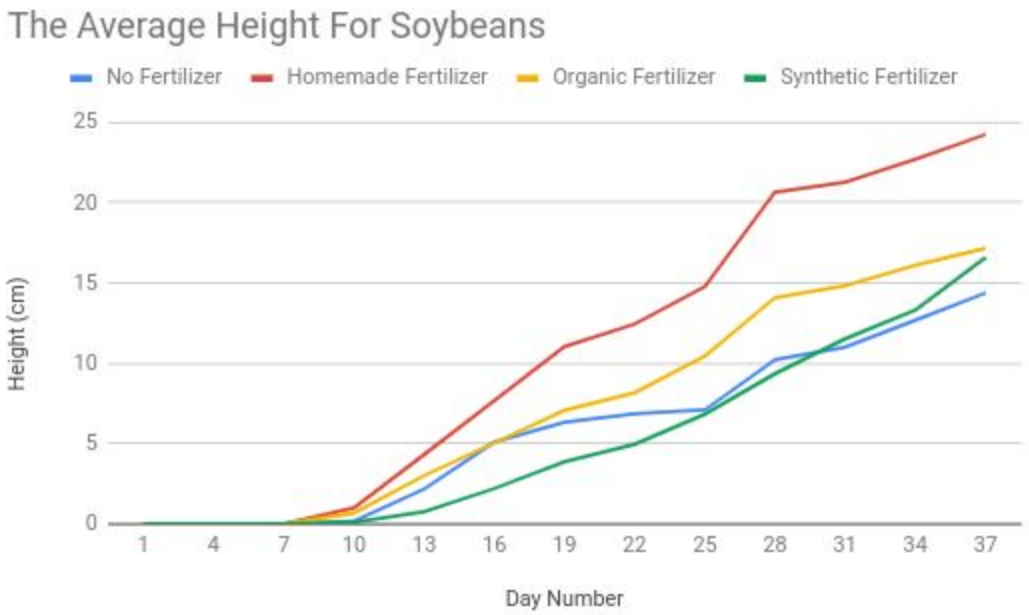
All tables are included in the Appendix



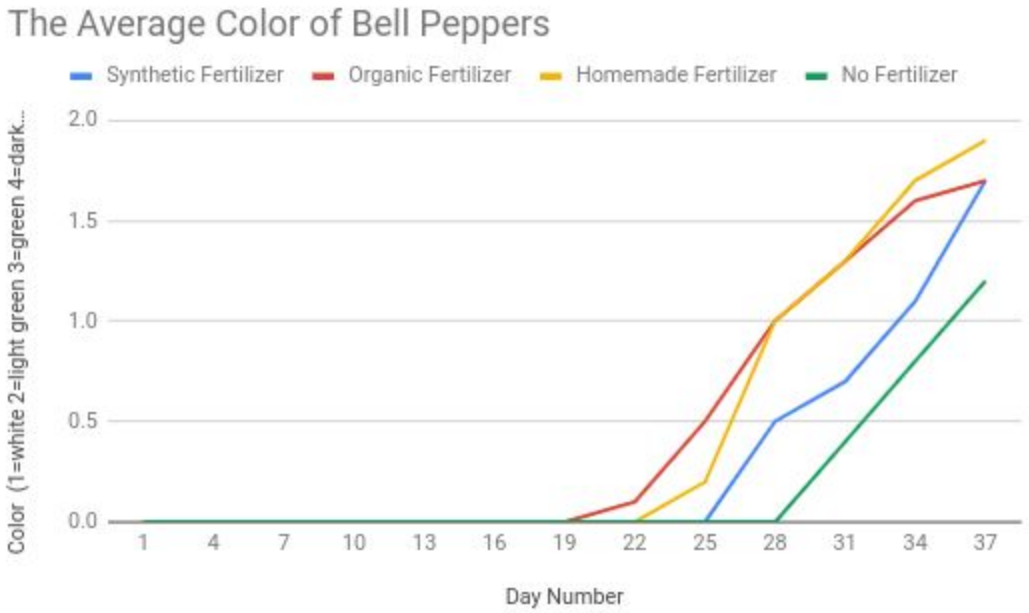
Graph 1. The homemade fertilizer plants had the biggest height increase followed by the organic fertilizer. The plants with no fertilizer applied had the most gradual height increase, whereas the synthetic fertilizer plants did not grow at all.



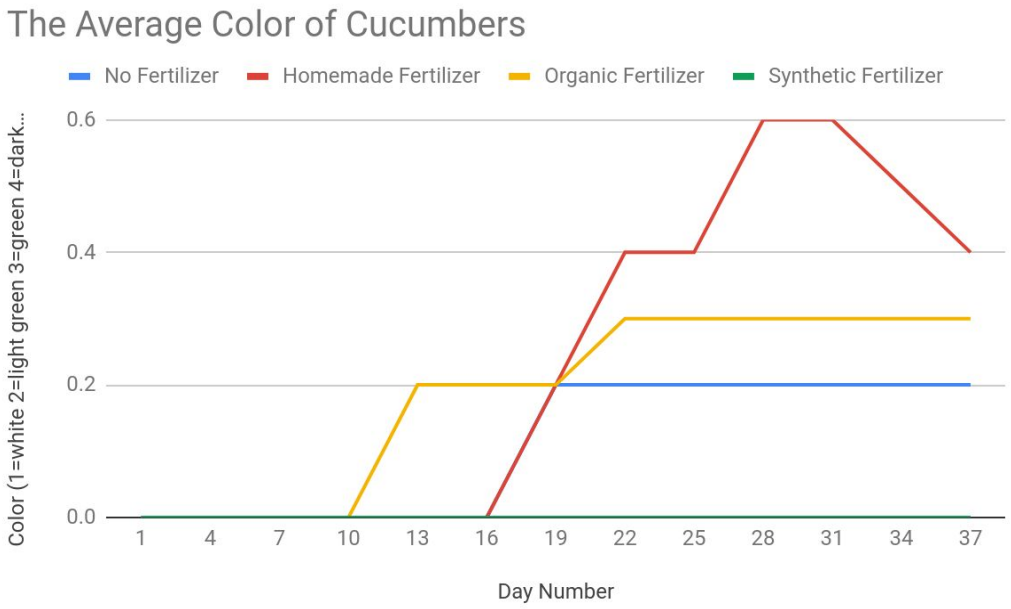
Graph 2. The homemade fertilizer plants had the largest height increase followed by the organic fertilizer plants. The synthetic fertilizer plants had a lesser height increase than the organic fertilizer plants. The no fertilizer plants ended with the lowest height increase out of the group.



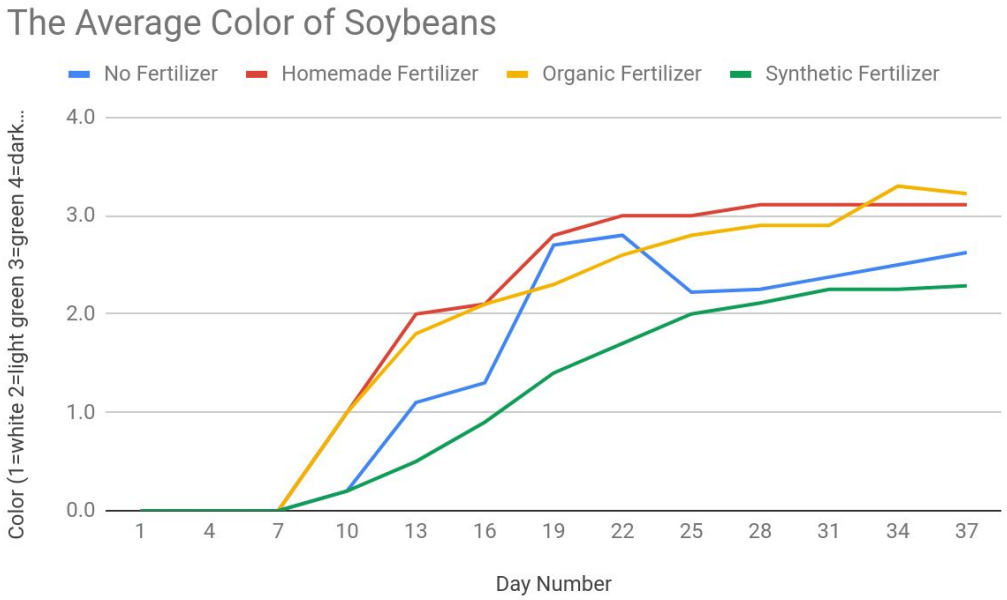
Graph 3. The homemade fertilizer plants had the largest height increase followed by the organic fertilizer plants. The synthetic fertilizer plants increased their height just a bit less than the organic fertilizer plants. The no fertilizer plants come in last with the lowest height increase.



Graph 4. The homemade fertilizer plants have the darkest color increase. The organic fertilizer plants gradually increased to the next darkest color and the synthetic fertilizer plants drastically increased to reach the lightest.



Graph 5. On average the homemade fertilizer plants have the darkest color while the organic fertilizer plants have the second darkest plants. The no fertilizer plants have the lightest colored plants and the synthetic fertilizer plants did not have a color at all because they did not grow.



Graph 6. The organic fertilizer plants have the darkest plants while the homemade fertilizers fall right behind. Next comes the no fertilizer plants with a decent darkness and the synthetic fertilizer has the lightest color.

CONCLUSIONS

Analysis: The results for the cucumber experimental groups support the hypothesis because the more chemicals added to the plants decreased its chance of survival. Therefore, cucumber plants require a small amount of N-P-K during their growth process. In the synthetic group, no plants grew at all, leaving the next least likely group, the organic fertilizer group, to have growth. This group had one plant grow, and so did the no fertilizer group. This leaves the homemade fertilizer group; here two

plants grew. However, the results show that in this group the plants started to see a decline in health around the 34th day. This is most likely due to fertilizer burn, further meaning that the chemicals in the fertilizer contain a small amount of sodium that draws a large amount of moisture out of the plants when it is over applied, resulting with a brown discoloration and root damage (Carroll). Due to these conditions, this group clearly supports the hypothesis.

The results for the bell pepper experimental groups support the hypothesis in different ways. These plants seem to have not been affected as much by the different levels of chemicals because there were no signs of fertilizer burn. This information slightly proves the hypothesis wrong, but with the comparison of the average heights of the plants, part of the hypothesis can be proven to be true. Once again, the homemade fertilizer plants ended with the most height increase, showing that smaller amounts of chemicals helps the plant grow more. Then, just like the cucumbers, the next largest height increase is the organic fertilizer, but is instead followed by the synthetic fertilizer. This shows us that the amount of chemicals needed varies between different plants because each plant type has a different tolerance for certain chemicals. This then leaves the no fertilizer group to have the smallest height increase. There still is a noticeable height increase, but there is a significant gap in between the top two heights, homemade and organic, and where the no fertilizer plants fall. This shows that any small amount of chemicals has an effect on the growth rate of plants.

The results for the soybean group are very similar to the bell peppers, as they do not show any signs of fertilizer burn. Once again, the homemade fertilizer has the most height increase, but this time the other groups are not quite as close in height. The next closest height increase is the organic fertilizer group, but there is a significant gap of 7.08 cm between the two plant heights. Therefore, the smaller amount of chemicals took a greater effect on the soybean plants. Right behind the organic fertilizer group is the synthetic fertilizer group, then followed by the no fertilizer group. This shows the same pattern as the bell peppers before, showing that the smaller amount of chemicals increases the growth of the plants. Further meaning that the synthetic fertilizer applies more chemicals per ounce than the organic or homemade fertilizers, allowing the plants to have a smaller growth rate. However, this does not go to show that a larger amount of chemicals always decreases the growth rate because in this case, along with the bell peppers, the growth rate still increased a small amount.

Overall, it is to be found that a smaller amount of chemicals is the most effective way to increase the growth rate of different plant types. The cucumbers require the smallest amount of N-P-K, considering that the homemade fertilizer had deadly effects on the plants. The bell peppers and soybeans also require a small amount, but their growth was increased by all three fertilizers. This further suggests that natural fertilizers, such as manure or ashes, are more effective than synthetic fertilizers due to the amount of chemicals present in the substances.

Errors: There were several errors in this experiment; one of the major errors was not having a large enough sample size. The data had a large amount of plants that did not grow, so if there was a larger sample size then it would have given a better range of growth to be averaged. Other errors included the temperature in the room. The temperature was unknown in the area and was most likely not kept constant due to the fact that the plants were growing by doors that led outside. This probably had a large effect on the results because the plants that were being grown are typically grown in a warmer climate where the temperature is consistent. A last possible error could have been the amount of light that reached the plants because there were some plants that were further away from the light source than others. This may have resulted in less growth due to the smaller amount of sunlight.

Improvements: If I were to rerun this experiment there are many things that would need to be improved. First off, I would like to have a consistent temperature that is warmer than that in this experiment to grow my plants that way they have more ideal growing conditions . I would also center

my focus on one plant type that way I can look closer at the different effects the fertilizer has. By changing my focus to one plant type it would leave me with the possibility to have larger sample sizes. Larger sample sizes would lead to more accurate averages in the plants. I would also like to change my second dependent variable of plant color to something less predictable such as the quality of roots. To study this variable, one could potentially use an agar solution or hydroponics to watch the root system as it develops. I would also like to further study the amounts of chemicals applied to the plants through fertilizers. This could be executed by measuring the amount of chemicals in the soil before the fertilizer was added and after as well. In this experiment the fertilizers became water soluble by following the recommended instructions on the packages, but when the fertilizers were applied I chose a specific amount to apply that was uniform for all fertilizer types. If I were to rerun this experiment, I would consider testing a different amount of fertilizer that would once again be uniform for all fertilizer types.

Extensions: There are many ways that this project could be used for future research and experiments. As a follow-up experiment, one type of plant could be used for this experiment to study how different combinations of Nitrogen, Phosphorus, and Potassium affect the plant type. This experiment also posed the question of how do roots react to different amounts of Nitrogen, Phosphorus, and Potassium.

ACKNOWLEDGEMENTS

I would like to thank everyone who had a hand in this project. I would like to thank my parents for providing the supplies I needed to complete this project. I would like to thank my science teacher for providing additional information about my project. I would like to thank my grandparents for providing a light source to grow the plants, all the seeds needed to experiment on, and for the flats to grow my plants in. And lastly, I would like to thank my peers for assisting me with any small task that was asked to complete.

Works Cited:

Carroll, Jackie. "Learn About Fertilizer Burn Of Plants." Gardening Know How, www.gardeningknowhow.com/garden-how-to/soil-fertilizers/what-is-fertilizer-burn.htm. Accessed 20 May 2019.

"Cucumber." Facts on File, 1AD. *Science Online,* online.infobase.com/Auth/Index?aid=19102&itemid=WE40&articleId=281673. Accessed 23 Sept. 2018.

"Fertilizer." *Plant Sciences,* edited by Richard Robinson, Macmillan Reference USA, 2001. *Science in Context,* http://link.galegroup.com/apps/doc/CV2643350101/SCIC?u=akr17416&sid=SCIC&xid=7366cd4e. Accessed 20 Sept. 2018.

"Solanaceae." *Plant Sciences,* edited by Richard Robinson, Macmillan Reference USA, 2001. *Science in Context,* http://link.galegroup.com/apps/doc/CV2643350215/SCIC?u=akr17416&sid=SCIC&xid=3e7550bb. Accessed 23 Sept. 2018.

"Soybean." *Plant Sciences,* edited by Richard Robinson, Macmillan Reference USA, 2001. *Science in Context,* http://link.galegroup.com/apps/doc/CV2643350216/SCIC?u=akr17416&sid=SCIC&xid=1665c723. Accessed 23 Sept. 2018.

APPENDIX

Table 1: No Fertilizer Cucumber Foliage Height in Centimeters

Day Number	Mean	Median	Mode	Standard Deviation
1	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00
19	0.17	0.00	0.00	0.54
22	0.26	0.00	0.00	0.83
25	0.28	0.00	0.00	0.88
28	0.29	0.00	0.00	0.92
31	0.30	0.00	0.00	0.95
34	0.31	0.00	0.00	0.99
37	0.34	0.00	0.00	1.07

Table 2: Homemade Fertilizer Cucumber Foliage Height in Centimeters

Day Number	Mean	Median	Mode	Standard Deviation
1	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00
19	0.17	0.00	0.00	0.54
22	0.23	0.00	0.00	0.56
25	0.26	0.00	0.00	0.60
28	0.45	0.00	0.00	0.95
31	0.46	0.00	0.00	0.98
34	0.48	0.00	0.00	1.02
37	0.51	0.00	0.00	1.09

Table 3: Organic Fertilizer Cucumber Foliage Height in Centimeters

Day Number	Mean	Median	Mode	Standard Deviation
1	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00
13	0.06	0.00	0.00	0.20
16	0.26	0.00	0.00	0.82
19	0.37	0.00	0.00	1.17
22	0.38	0.00	0.00	1.20
25	0.40	0.00	0.00	1.27
28	0.44	0.00	0.00	1.40
31	0.46	0.00	0.00	1.45
34	0.47	0.00	0.00	1.49
37	0.49	0.00	0.00	1.55

Table 4: Synthetic Fertilizer Cucumber Foliage Height in Centimeters

Day Number	Mean	Median	Mode	Standard Deviation
1	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.00
22	0.00	0.00	0.00	0.00
25	0.00	0.00	0.00	0.00
28	0.00	0.00	0.00	0.00
31	0.00	0.00	0.00	0.00
34	0.00	0.00	0.00	0.00
37	0.00	0.00	0.00	0.00

Table 5: No Fertilizer Bell Pepper Foliage Height in Centimeters

Day Number	Mean	Median	Mode	Standard Deviation
1	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.00
22	0.00	0.00	0.00	0.00
25	0.00	0.00	0.00	0.00
28	0.00	0.00	0.00	0.00
31	0.20	0.00	0.00	0.26
34	0.85	0.79	0.00	0.89
37	1.01	1.01	0.00	0.94

Table 6: Homemade Fertilizer Bell Pepper Foliage Height in Centimeters

Day Number	Mean	Median	Mode	Standard Deviation
1	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.00
22	0.00	0.00	0.00	0.00
25	0.02	0.00	0.00	0.04
28	1.22	0.66	0.00	1.34
31	1.63	2.41	0.00	1.39
34	2.38	2.82	#N/A	1.20
37	2.78	2.97	#N/A	0.82

Table 7: Organic Fertilizer Bell Pepper Foliage Height in Centimeters

Day Number	Mean	Median	Mode	Standard Deviation
1	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.00
22	0.01	0.00	0.00	0.04
25	0.48	0.00	0.00	0.82
28	1.51	1.49	0.00	1.50
31	1.81	2.12	0.00	1.46
34	2.41	2.83	0.00	1.67
37	2.68	3.02	#N/A	1.53

Table 8: Synthetic Fertilizer Bell Pepper Foliage Height in Centimeters

Day Number	Mean	Median	Mode	Standard Deviation
1	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00
10	0.00	0.00	0.00	0.00
13	0.00	0.00	0.00	0.00
16	0.00	0.00	0.00	0.00
19	0.00	0.00	0.00	0.00
22	0.00	0.00	0.00	0.00
25	0.00	0.00	0.00	0.00
28	0.24	0.16	0.00	0.26
31	0.47	0.46	0.00	0.47
34	1.13	0.97	0.00	1.04
37	1.54	1.27	1.27	0.97

Table 9: No Fertilizer Soybean Foliage Height in Centimeters

Day Number	Mean	Median	Mode	Standard Deviation
1	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00
10	0.18	0.00	0.00	0.56
13	2.19	0.83	0.00	2.65
16	5.11	3.54	0.00	5.52
19	6.34	1.53	0.00	7.71
22	6.86	1.64	0.00	8.43
25	7.11	1.48	0.00	9.95
28	10.23	2.51	0.00	13.31
31	11.00	2.99	0.00	13.76
34	12.69	4.10	0.00	15.19
37	14.37	6.99	0.00	16.07

Table 10: Homemade Fertilizer Soybean Foliage Height in Centimeters

Day Number	Mean	Median	Mode	Standard Deviation
1	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00
10	1.01	0.82	0.00	1.10
13	4.32	4.64	0.00	3.31
16	7.69	9.05	0.00	5.68
19	11.03	13.68	0.00	7.76
22	12.44	16.03	0.00	8.60
25	14.78	19.78	0.00	10.26
28	20.65	25.91	0.00	11.79
31	21.27	26.02	0.00	12.13
34	22.71	27.54	0.00	13.00
37	24.24	31.26	0.00	13.88

Table 11: Organic Fertilizer Soybean Foliage Height in Centimeters

Day Number	Mean	Median	Mode	Standard Deviation
1	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00
10	0.68	0.45	0.00	0.82
13	3.02	3.49	0.00	2.33
16	5.05	5.68	#N/A	4.21
19	7.07	8.03	#N/A	6.15
22	8.17	9.30	#N/A	7.05
25	10.46	11.78	#N/A	9.23
28	14.09	16.16	29.12	12.07
31	14.84	16.67	#N/A	12.69
34	16.11	19.01	#N/A	13.46
37	17.16	20.19	#N/A	13.63

Table 12: Synthetic Fertilizer Soybean Foliage Height in Centimeters

Day Number	Mean	Median	Mode	Standard Deviation
1	0.00	0.00	0.00	0.00
4	0.00	0.00	0.00	0.00
7	0.00	0.00	0.00	0.00
10	0.11	0.00	0.00	0.35
13	0.76	0.00	0.00	1.76
16	2.21	0.00	0.00	4.08
19	3.88	0.61	0.00	6.02
22	4.98	0.73	0.00	7.18
25	6.83	1.31	0.00	8.92
28	9.35	1.19	0.00	12.10
31	11.53	7.28	0.00	13.23
34	13.32	9.38	0.00	14.75
37	16.59	22.21	0.00	16.07