The Miracle Formula

Final Report

Question

Does the amount of each ingredient and pH of chemical fertilizer affect how tall a soybean, watermelon, or pumpkin plant grows?

Science Background Report

The purpose of this investigation is to find out if different amounts of the three key ingredients in, and the pH of, chemical fertilizers affect how tall soybean, watermelon, and pumpkin plants grow. The investigative question is, does a soybean, pumpkin, and watermelon plant grow taller when fertilized with different amounts of the three key ingredients of chemical fertilizers? This topic is important to the scientific community because if the findings show a more environmentally-friendly fertilizer, soybean, pumpkin, and watermelon farmers would be able to increase their crop yield without having to worry about seriously harming the environment or going over budget. It is also important because of the growing use of soy products in manufacturing as well as food production. Additionally, soybeans recently surpassed corn to become the most produced crop in the United States, and watermelons and pumpkins are important food items for both humans and livestock. If this project could increase these crops, it

could completely change manufacturing and food processing across the country by enabling more products to be made.

The independent variable is the amount of each ingredient. The ingredients used will be Nitrogen, Phosphorus, and Potassium. Several things were found about the independent variable. Nitrogen helps plants have more foliage and grow faster. It was hypothesized that the plants with the most Nitrogen would end up the tallest. The substitute for Nitrogen was household ammonia since it was listed as one of the ingredients in fertilizer, and it holds nitrogen. However, the pH (the acidity or alkalinity of something) of ammonia is very high, so it will be diluted for the purposes of this experiment. Phosphorus helps with photosynthesis. It can also help the plant grow faster. The substitute for Phosphorous was baking powder since it contains phosphates. This will also be mixed with water. The pH of this was 6. Finally, Potassium helps with the overall quality of the plant, as well as the crop that it produces. It can also play a role in several different plant processes. The substitute for Potassium was potassium chloride because it holds potassium. It is also one of the main sources of potassium in professional-grade fertilizers today. This will be made into a liquid-like solution. This was measured at a pH of 4.

The dependent variable is how tall the plants grow in centimeters. From the research on the independent variable, we learned some things about the dependent variable. Plants grow faster and taller when they have the right combination of Nitrogen, Phosphorus, and Potassium in their soil. It is known that a plant that is tall is healthy. This was the knowledge of the dependent variable that was most relevant to our experiment.

The hypothesis is: if a soybean, pumpkin, and watermelon plant is fertilized with the maximum amount of Nitrogen that the pH range will allow, then the plant will grow taller and have more foliage because the primary purpose of Nitrogen is to create new cells. It is expected that when there is more Nitrogen in the fertilizer, the plants will grow taller and healthier, which should be proven in the data we collect. The type of data that will be collected is the height of the plants.

Hypothesis

If the strongest possible dilution of ammonia while keeping within the optimal pH range is used in a fertilizer blend in soybeans, pumpkins, and watermelons, then, those plants will grow taller than those with more potassium or phosphorus because ammonia, or nitrogen, is the ingredient that helps the most with growth processes.

Procedure:

Red group (Experiment 1)

1. Gather materials.
2. Label cups with ratios.
3. Measure soil, 315 grams per cup.
4. Measure potting soil, 85 grams per cup.
5. Mix and measure fertilizers, 2 tablespoons per cup.
6. Mix soil and fertilizer and put in cups.
7. Put 2 soybean seeds in cups, 2 centimeters below the surface, fill holes.

8. Fill the syringe with 2 teaspoons of water and water plants daily.
9. Record in notebook and spreadsheet software germination date and date planted.
10. After germination, measure the height of plants every other day until the experiment ends.
11. Record final heights of plants.
12. Input data in the spreadsheet.
13. Conclude results.

Revisions to the Procedure (Blue group) (Experiment 2):

1. Remove all failed subjects from the red group.
2. Gather new materials.
3. Label cups with ratios.
4. Measure soil, 315 g. for soil for each cup.
5. Measure potting soil, 85 g. per cup.
6. Measure and mix fertilizer, 1 tablespoon of fertilizer per cup and measure pH.
7. Mix soil and fertilizer, put mix in cups.
8. Put two soybean, pumpkin, or watermelon seeds in each cup, 2 cm. From top of soil in cups labeled pumpkin, watermelon, or soybean.
9. Fill syringes with 2 teaspoons of water, water daily.
10. After plants germinate, record germination dates and measure height every other day until experiment ends.
11. Record final heights of plants and put in spreadsheet.
12. Conclude findings.

Materials:

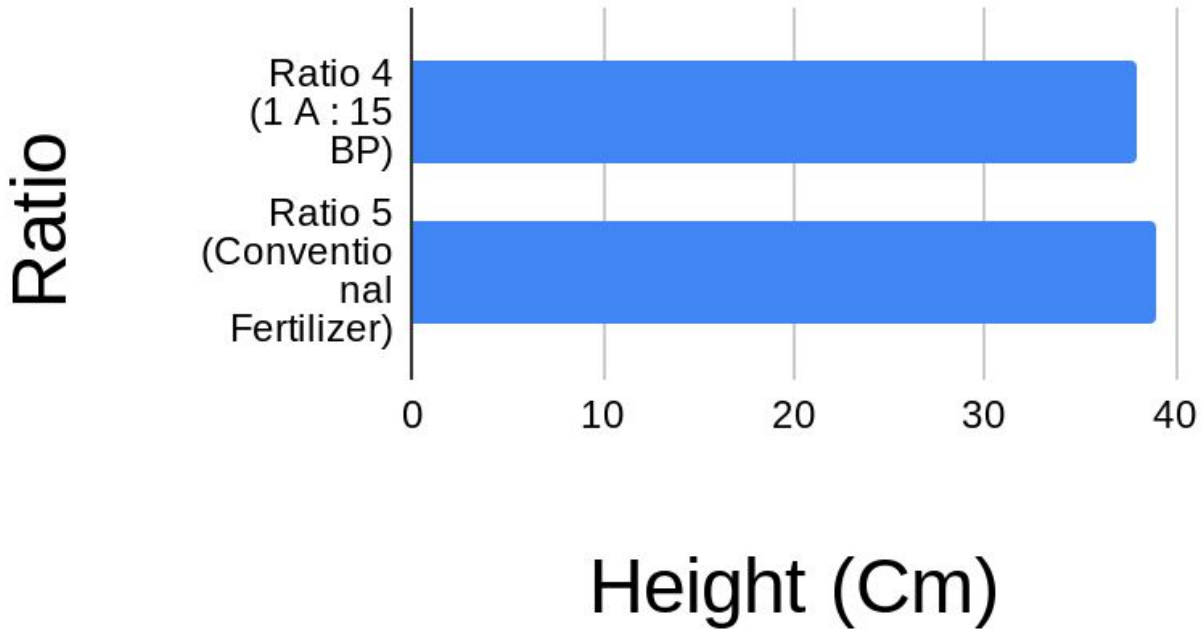
- Baking Powder
- Ammonia
- Potassium Chloride
- Tablespoon
- 20 soybean seeds
- 12 pumpkin seeds
- 12 watermelon seeds
- 23 cups
- 4 syringes
- Water
- Topsoil
- Potting soil
- Notebook
- Pencil
- Centimeter
- Spreadsheet software
- Printer
- Masking Tape (Blue and Red)
- Sharpie
- Boxes

- pH meter
- Table
- Computer
- Gloves
- Magnifying glass
- Measuring tape

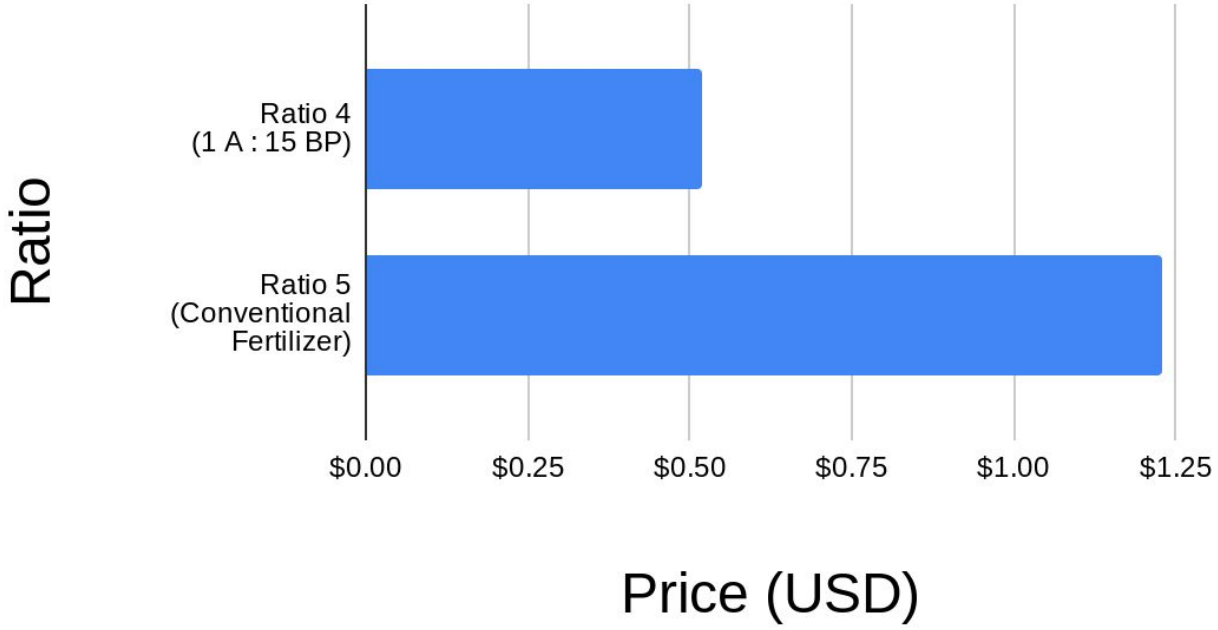
Data

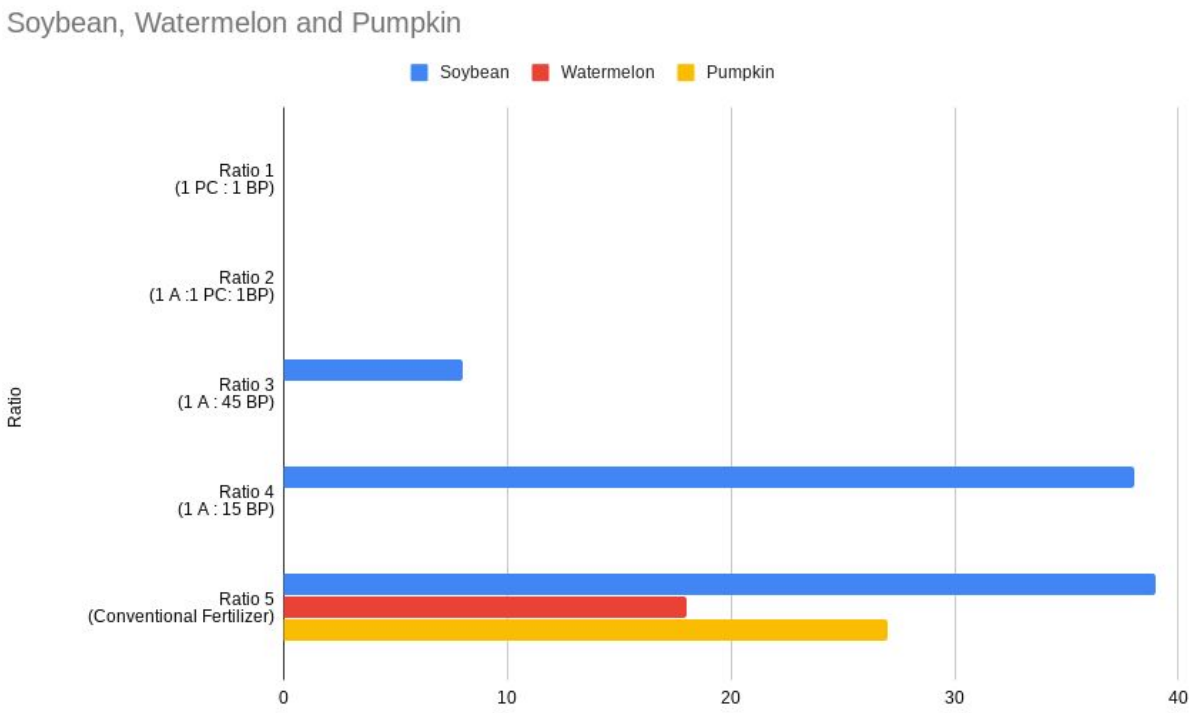
Ratio #'s	Ratio	pH
1	1 Potassium Chloride: 1 Baking Powder	4
2	1 Ammonia : 1 Potassium Chloride : 1 Baking Powder	4.5
3	1 Ammonia : 45 Baking Powder	6.25
4	1 Ammonia : 15 Baking Powder	7
5	Conventional Fertilizer	7

Average Soybean Height in Top Two Ratios (cm)



Ratio 4 Price vs. Conventional Fertilizer Price





Conclusion

The purpose of this experiment was to find out how pH and the amount of each ingredient in chemical fertilizers affect how tall a soybean, watermelon, or pumpkin plant grows. For this experiment, custom fertilizer ratios were created and pH was tested multiple times.

It was discovered that plants in fertilizer Ratio 4 grew to an average of just one centimeter shorter than the control of conventional fertilizer. After a price comparison, it was confirmed that fertilizer Ratio 4 is $0.71 less expensive per pound than conventional fertilizer. The answer to the investigative question is that potassium chloride does not help plants to grow or develop nearly as much as phosphorus or nitrogen, as seen in the data tables.

The success of Ratio 4 can be explained with two pieces of data. First, it's pH was 7, which is just in the optimal range of a soybean plant. Also, it was the only ratio to contain baking powder Solution 1, which was proven to have a pH that was also in the optimal range.

The failure of the other ratios, including the Red Group, can be explained by extremely high and low pHs. For instance, Ratio 1 of the Blue Group, the second group, had a pH of 4. This acidity would have been too high for a soybean, watermelon, or pumpkin plant to grow. Many of the Red Group tests had very strong bases, with the strongest at a pH of 11. The data collected does not support the hypothesis, which predicted that the ratios with more nitrogen would grow the tallest. Although Ratio 4, the tallest growing ratio, did have ammonia (nitrogen), several others containing ammonia were unable to grow at all.

A challenge that was encountered during the investigation was the pHs from the Red Group being so high that the entire experiment had to be restarted. Some potential sources of error are the pH meter. This pH meter did not have a full range of pH, so there was no way of reading every pH perfectly. If this experiment was to be replicated, it would be wise to take the pH of the plain topsoil before anything is added to it. To expand on this experiment, other scientists may complete the same procedure with different crops to see if this formula works on anything besides soybeans, pumpkins, or watermelons.

Annotated Bibliography

Guide to Fertilizers. (n.d.). Retrieved December 9, 2019, from Brenntag website: https://www.brenntag.com/en-us/industries/agriculture/guide-to-fertilizers/index.jsp

This source was very helpful in giving information about what each ingredient in chemical fertilizers does. We used it in talking about our independent variable.

Preparing to plant melons > Soil and fertility. (2018). Retrieved January 9, 2020, from University of Minnesota Extension website: https://extension.umn.edu/fruit/growing-melons-home-garden#soil-and-fertility--1139160

This Web Page helped us understand the range of pH that we should make the soil and fertilizer in our ratios. This helped us with our independent variable in our research and our ratio-making process.

Pumpkin Production. (2005, June 20). Retrieved January 9, 2020, from Penn State Extension website:

https://extension.psu.edu/pumpkin-production

This Web Page helped us understand the range of pH that we should make our soil and fertilizer be when we made our fertilizer ratios.

Soil pH. (n.d.). Retrieved January 9, 2020, from CropNutrition website:

https://www.cropnutrition.com/efu-soil-ph

This source was helpful in telling about how soil pH is important. We will use it to talk about our independent variable.

Soybean Growth and Development. (2015, February 19). Retrieved December 12, 2019, from Corn Agronomy

website: http://corn.agronomy.wisc.edu/Crops/Soybean/L004.aspx

This source was helpful in giving information about the life stages of soybeans. We will use it to determine how healthy our soybean plants are.

Staton, M. (2012, March 28). Managing soil pH for optimal soybean production. Retrieved January 9,

2020, from Michigan State University website: https://www.canr.msu.edu/news/managing_soil_ph_for_optimal_soybean_production

This source was helpful in giving further information about soil pH. We will use it in talking about the independent variable.

What Makes Plants Grow? (2019). In Plant Connections: University of Florida (Rev. January 2015 ed., Vol. 3) [PDF]. Retrieved from https://edis.ifas.ufl.edu/pdffiles/4h/4H36000.pdf

This source was very helpful in giving information about plant habitats. We will use it in deciding where to preform our experiment.